

Gene Shoemaker, left, pictured here with Edwin McKee, founded the Astrogeology Branch of the U.S. Geological Survey and was a leader of terrestrial and planetary meteorite impact research

# Eugene M. Shoemaker and the Integration of Earth and Sky

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## From Prodigy to Stargazer

The first of two children, Eugene Merle Shoemaker (1928-1997) was born in Los Angeles, California. His mother was a Schoolteacher. His father, a strong, enthusiastic man, was a teacher, coach, farmer, and trucker. Gene's early years were spent in Buffalo, New York. His mother enrolled him in kindergarten before the age of 4, and in the fifth grade (age 8), she suggested he take science classes at the Buffalo Museum of Science in a program of geology and related classes for high-school and college-level students. Gene talked about the program for years afterward, saying "it opened my eyes to geology, focused my interests, and turned me into an avid rock collector."

The Shoemakers returned to Los Angeles when Gene finished junior high, and his father hired on as a Hollywood movie studio stagehand. At 16, Gene graduated from high school and began his

freshman year at nearby Caltech. As a teaching assistant there, he taught much older students who were returning to school on the GI Bill, and he grew his trademark mustache in order to look older. Until I read books by Wilhelms and Levy, I didn't know Gene was a Caltech cheerleader, but that fits completely, as he was the one to talk to when you needed to be pumped up about science. He received his B.S. and M.S. degrees from Caltech in 1947 and 1948.

In 1948, Gene joined the U.S. Geological Survey (USGS) and began exploring Colorado and Utah for uranium deposits. That first summer, thinking about nuclear fuel and rocket development during World War II, it suddenly occurred to him that during his lifetime, man would go to the Moon. Gene wanted to be the first lunar geologist.

## Colorado Plateau and Marriage

Gene developed his field skills on the Colorado Plateau between 1948 and 1957. Gene had an adventurous spirit and, in 1949, took his first river trip down Glen Canyon; river running became a lifelong hobby that later led to an important publication. He was awarded another M.S. degree in geology at Princeton and began working toward a Ph.D., but postponed this goal to return to the USGS and the plateau.

In 1951, he married Carolyn Jean Spellmann, a schoolteacher from Chico, California, whose talent in pinpointing comets and asteroids would lead to important joint discoveries. Carolyn and Gene had three children.

Papers published during this time

focused on the structures of maars, salt anticlines, Hopi-Butte diatremes, and laccoliths of the plateau. Gene also produced geologic maps of Colorado quadrangles pertinent to uranium prospecting. His USGS research and mapping on the plateau, sponsored by the Atomic Energy Commission (AEC), brought him geographically and intellectually near the now famous Meteor Crater east of Flagstaff, Arizona. He sampled the crater to investigate its origin as a volcanic feature, an interpretation favored by a predecessor in lunar studies, G.K. Gilbert (1843-1918; first chief geologist of the USGS). Rather than volcanic detritus, he found curiously fused grains of coconino sandstone.

## Cratering Studies

In 1957, the AEC thought underground nuclear explosions might produce an effect similar to that of an explosive volcano. To find out where plutonium would go in an underground volcanic explosion, Gene studied the effects of shock in nuclear craters. He immediately saw the resemblance of these craters to Meteor Crater. From 1957 to 1960, he did his classic research on the structure and mechanics of meteorite impact, based on Meteor Crater.

Under pressure from Princeton to complete his degree, Gene wrote up this work and received his Ph.D. in 1960. His landmark paper on cratering studies at Meteor Crater noted the overturned crater rim strata, similar to that observed at nuclear craters. This and later work challenged the classic idea of uniformitarianism, emphasizing catastrophic effects. His cratering work influenced and contributed to studies of E.C.T. Chao. Gene became one of Chao's co-authors in an internationally acclaimed paper on the discovery of natural coesite at Meteor Crater. (Coesite, a high-pressure form of silica created during impacts, had been created in a laboratory by Coes in 1953.) Gene studied impact cratering throughout his life, both by exploring Earth, particularly Australia, and by studying the planets using remote sensing and mapping.

## Lunar Pursuits and the USGS Astrogeology Team

In 1957, Gene prepared a preliminary map of Copernicus Crater on the Moon. Using only photographs and telescopic measurements, he showed that he could unravel the sequence in which layers of rock were deposited. This map and Gene's infectious enthusiasm convinced NASA officials to sponsor a lunar geology

program directed by the USGS. In 1961, Gene began the USGS Branch of Astrogeology at Menlo Park, California. During the 1960s, he introduced crater counting as a method to date the lunar surface, led USGS teams that investigated the Moon's structure and history, and developed methods of planetary geologic mapping using telescopic images of the Moon.

Gene wanted to be an astronaut, but in 1962 was diagnosed with Addison's disease and knew he couldn't pass the stringent physical examination. Instead, he served as acting director of NASA's Manned Space Sciences Division, which developed and financed the scientific program on manned space flights. He was involved in the Lunar Ranger and Surveyor programs and continued with the manned Apollo programs.

In 1963, Gene pushed to establish a USGS Field Center in Flagstaff, Arizona, which had a tradition of astronomical observation and was close to Meteor Crater and a volcanic field, both of which were valuable for lunar comparisons. He helped train the Apollo astronauts in geologic fieldwork around Flagstaff, and, as the first lunar landing was televised, gave expert geologic commentary from a seat next to Walter Cronkite of CBS-TV.

After Surveyor I landed on the Moon in June 1966, Gene resigned as a NASA administrator and took on full-time research responsibilities as the chief scientist with the Astrogeology Branch of the USGS. Although he enjoyed working on Apollo 11, 12, and 13, the travel was taxing and the politics wearisome. Gene turned to academia, teaching at Caltech, and focused on terrestrial topics and astronomy. He returned to lunar studies in 1994, serving as science-team leader for Project Clementine, which incorporated new data concerning the Moon.

### Caltech, Academic Life, and Asteroid Surveys

From 1962 to 1985, Gene blended his astrogeology research for the USGS with part-time teaching at Caltech. He chaired its Division of Geological and Planetary Sciences from 1969 to 1972, but preferred to teach. According to one of his doctoral students, Susan Werner Kieffer, he was an unfailingly generous and intellectually honest mentor, preferring not to add his name to student's work. His stay at Caltech allowed him time to pursue his interest in age dating using paleomagnetism to date the Moenkopi Formation of the Colorado Plateau. He founded two paleomagnetism labs — at the USGS in Flagstaff and at Caltech.

At Caltech, Gene became a co-investigator with Larry Soderblom (USGS) on Project Voyager. Ahead of his time, Gene wondered about the future effects and rates of impacts on Earth. In 1973, with Eleanor Helin, he initiated the Palomar Planet-Crossing Asteroid Survey and designed a new stereomicroscope for asteroid and comet detection on photographic film.

In the late 1970s, Gene proposed that Carolyn work with him, and she began a study of astronomy. In 1982, the two began the Palomar Asteroid and Comet Survey. For the next 15 years, they worked at the USGS in Flagstaff, with periodic excursions to Palomar to observe the skies and summer trips to Australia to map impact craters on Earth. Their work was featured in a 1997 National Geographic documentary "Asteroids: Deadly Impact." Gene retired from the USGS in 1993, but held an emeritus position with the USGS and was affiliated with Lowell Observatory in Flagstaff.

### Diversification and Awards

Gene influenced science in numerous ways. He combined his knowledge of the Colorado Plateau with his love of river running to re-shoot, with his friend and USGS co-worker, Hal Stevens, the photographs taken on John Wesley Powell's second exploration of the Colorado River (1871-1872). The new images showed that many features looked as they had in Powell's time, but that landslides, floods, or other short-term events caused some major changes. This spoke against strict uniformitarianism in river systems. The men published "In the Footsteps of John Wesley Powell" in 1987.

Gene's exploration of Australia resulted in the discovery of one new crater, the confirmation of 20 proposed craters, and mapping of tektite fields. A decade-long sky survey for Earth-crossing asteroids and comets culminated in the discovery, with wife Carolyn and David Levy, of Comet Shoemaker-Levy 9. This comet impacted Jupiter in 1994, giving the world of science a major new insight into both the dynamics of comets and the planetary science of Jupiter.

Gene was the recipient of myriad awards, including honorary doctorates, the NASA medal for Scientific Achievement (1967), National Academy of Science Member (1980), the GSA's Arthur L. Day Medal (1982) and G.K. Gilbert Award (1983), the U.S. National Medal of Science (1992, the highest scientific honor bestowed by the president of the United States), American Academy of Arts and Science Fellow (1993), and many others.

Gene was a brilliant, exuberant, vibrant, and warm man whose booming voice, angry antics over copy machines, and laughter rang down USGS hallways. His temper, contrasted with his normally cordial nature, was famous; one fan still cherishes a mangled coke can Gene had beaten in an angry fit with a metal detector that fooled him into thinking the can was a piece of Canyon Diablo meteorite.

Gene died in a car accident on July 18, 1997, in Alice Springs, Australia, on field mapping trip with Carolyn, who survived and continues her work at the USGS. Colleagues knew of his unfulfilled dream to reach the Moon, and they granted his wish. On January 6, 1998, a small polycarbonate capsule carrying an ounce of his cremated remains traveled to the Moon aboard NASA's Lunar Prospector spacecraft.

### For more on Shoemaker

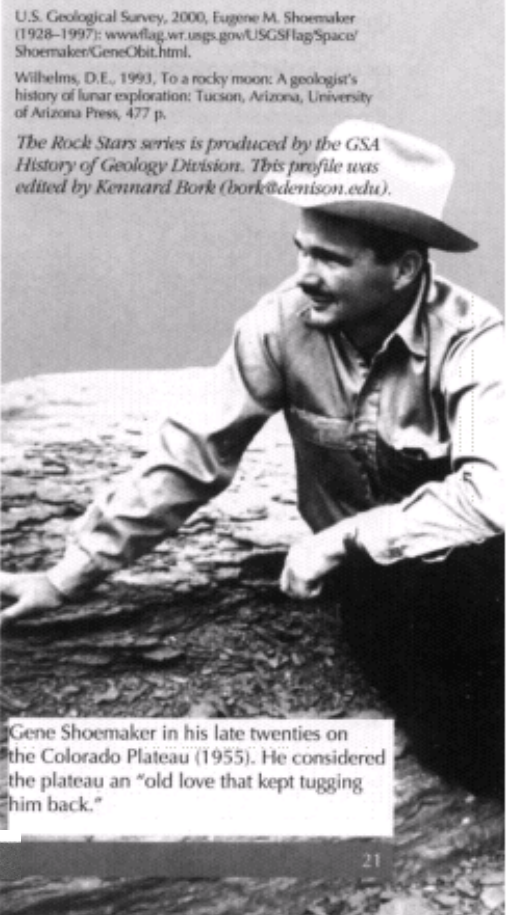
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Gene Shoemaker in his late twenties on the Colorado Plateau (1955). He considered the plateau an "old love that kept tugging him back."