looking at the samples. Just put them in the bag!" Papanastassiou says.

His vested interest stemmed from the knowledge (and hope) that some of the lunar samples collected by the Apollo astronauts would wind up at Caltech for study. "They were spending too much time discussing what they were seeing and debating whether to take this rock or the other one," Papanastassiou says. "Pick up both!" he says he wanted to tell them. "You have the capability; you don't have to decide!"

By the time Neil Armstrong made his famous small step on the Moon in the summer of 1969, Papanastassiou had already been a graduate student at Caltech for several years. Most of that time he spent working feverishly with Gerald Wasserburg, the late John D. MacArthur Professor of Geology and Geophysics, Emeritus, to construct a high-precision mass spectrometer designed specifically for interrogating Moon samples. The instrument, which separates ionized atoms according to their mass, was dubbed Lunatic I.

Wasserburg and five other Caltech faculty members—geologist Leon Silver (PhD '55), geochemist Samuel Epstein, geologist and planetary scientist Arden Albee, geologist Hugh Taylor Jr. (BS '54, PhD '59), and Donald Burnett, Caltech professor of nuclear geochemistry, emeritus—were among the 100 or so scientists selected by NASA to analyze the Apollo astronauts' lunar haul.

Geochemist Clair Patterson also played a crucial role in developing the clean-room technologies that allowed Caltech scientists to extract and process trace amounts of materials from the lunar samples without fear of contamination.

Lunatic I was the first fully digital instrument of its kind, and its precision was 30 times better than any that came before. Lunatic I—now held in the collections of the National Museum of American History—was a decisive factor in NASA's decision to entrust Moon samples to Caltech for study, according to Burnett. "We were fully expecting that we would be approved to do this because we knew we had the best ways of doing it. We had been planning since 1966 on. We were ready, and it was all based on the Lunatic I mass spectrometer," he says.

But the Caltech scientists' confidence was tempered by the knowledge that all the preparation in the world would not matter if the lunar samples failed to make it to Earth in good condition. "If we were delivered a sample, we could do all this analysis on it," Burnett says. "But whether the samples got back safely and were not ruined in the process of reentry and recovery—that was far from obvious. We were terrified."

Fortunately, the Apollo astronauts delivered, ultimately carting home more than 800 pounds of lunar rocks and soil. With Lunatic I's unrivaled precision, Wasserburg and his colleagues determined that the igneous samples returned by the Apollo missions defined an extended range of volcanic activity between 3 billion to 3.9 billion years ago. Lunatic I also played a key role in discovering the first evidence of the "late heavy bombardment," a period roughly 4 billion years ago when the bodies of the inner solar system were pummeled by asteroids and comets.

> "Lunar Trailblazer will really demonstrate the power of small satellites to answer important questions in planetary science."
>
> –Bethany Ehlmann
>
> Lunar Trailblazer mission principal investigator

"The Apollo program started off for political reasons. It was not done for science. It was done to show that we could beat the Soviets," Burnett says. "But what's left standing now is the science that has come out of the lunar samples. That is the true legacy of the Apollo missions."

The Caltech scientists contributed to the Apollo program in other ways too. Wasserburg belonged to a select cadre of senior scientists known as the "Four Horsemen" who advised NASA throughout the Apollo missions. Silver, the late W. M. Keck Foundation Professor for Resource Geology, Emeritus, instructed the crews of the Apollo 13, 15, 16, and 17 missions in geology. Silver often took his astronaut students to the Orocopia Mountains in the desert southeast of Indio, California, where he would teach them how to assess, analyze, and record their surroundings like a geologist.

Caltech faculty were crucial to the success of the Apollo program, says Asif Siddiqi, a space historian at Fordham University and a former Eleanor Searle Visiting Professor of History at Caltech and The Huntington Library, Art Museum, and Botanical Gardens. "You can't really tell the story of Apollo without them," he says.

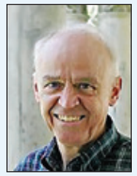
With Lunar Trailblazer, Siddiqi adds, Caltech is once again at the forefront of lunar research. "Caltech has already staked its claim on the history of lunar science. Lunar Trailblazer has the potential to really add fundamentally to our knowledge of the Moon," he says. "It's one of the most exciting missions to the Moon that I can think of right now."

They Put an "M" on the Moon

NASA scientists capitalize "Moon" and "Sun" when referring to Earth's Moon and Sun but not when referring to other such objects.

In Memoriam

Read more about their lives at **magazine.caltech.edu/post/in-memoriam**



Marc-Aurele Nicolet (1929–2022)

Marc-Aurele Nicolet, professor of electrical engineering and applied physics, emeritus, passed away on December 6, 2022, at age 93. His research focused on solid-state device technology and thin-film processes. Specifically, he studied the reactions of thin films with semiconductors (as well as ways to suppress these reactions) and analyzed thin-film materials using backscattering spectrometry and X-ray rocking curves—a way of analyzing single-crystal films. Nicolet became an associate professor in 1965, and he earned tenure in 1973. He retired in 1998.

Jason B. Saleeby (1948–2023)

Jason B. Saleeby, professor of geology, emeritus, passed away on January 16, 2023, at age 74. Saleeby, who worked at Caltech for 37 years, performed tectonic and geochronological studies of orogenic terranes of western North America, emphasizing the paleogeographic development of the Pacific Basin and its margins—specifically, the North American Cordillera, the mountain chain system that stretches along the Pacific Coast. A champion of getting into the field, he combined his hands-on approach to geology with lab-based expertise in geophysics, petrology, geochronology, and thermochronology to provide analysis from the continental scale down to the microscale.

Nelson Rising (1941–2023)

Nelson Rising, chairman emeritus of Rising Realty Partners, former member of the Caltech Board of Trustees, and life member of the Caltech community, passed away on February 9, 2023, at age 81. He shaped the landscape of Los Angeles and San Francisco, among other California cities, and played an influential role in state politics. Named to the Board in 2006, Rising became a senior trustee in 2013. He chaired the Buildings and Grounds Committee and was a member of the Executive and Investment committees. Rising founded Rising Realty Partners, an environmentally conscious real estate investment and operating company, with his son and current CEO, Christopher Rising, and partner, Scott McMullin.

Richard M. Rosenberg (1930–2023)

Richard M. Rosenberg, retired chairman and CEO of Bank of America, member of the Caltech Board of Trustees, and life member of the Caltech community, passed away on March 3, 2023, at age 92. Rosenberg was first appointed to the Board in 1989. During his tenure as chairman and CEO of Bank of America, Rosenberg strengthened the firm's retail franchise and corporate operations. The company became the second-largest bank in the United States, achieving record earnings, stock price, and dividend levels, and establishing itself as a leader in community reinvestment programs. He retired in 1996.

Gaylord E. "Nick" Nichols (1932-2023)

Nick Nichols, an administrator and honorary alumnus who worked at Caltech for 53 years, passed away on January 14, 2023, at age 90. Nichols joined JPL in 1957. He worked on projects including the Ranger, Mariner, and Surveyor unmanned missions and served as manager of planning and business operations for energy and technology applications, manager of external affairs, and special assistant to the director. In 1983, Nichols was appointed director of the IRC, which offered executive education courses and management training for business leaders in the technology and science sectors. Soon after, Nichols founded the Caltech/MIT Enterprise Forum, renamed the Caltech Entrepreneurs Forum in 2013.