Jay Quade

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A Biographical Memoir by Thure Cerling, Julio Betancourt, Peter DeCelles, and David Dettman

Jay Quade was a leading authority on using stable isotopes geochemistry of soils to understand past climates, ecology, and environments. His work on multiple continents led to an understanding of global ecological change in the Miocene in response to declining levels of CO_2 in the atmosphere. This marked the expansion of grasslands and savannas in the tropics and subtropics. His work on using soils as environmental indicators has led to better understanding on the environments of human evolution, uplift of the Earth's highest plateaus, and the influence and importance of aerosols in soil processes.

Figure 1 Jay Quade. *Courtesy of the University of Arizona.*

Early Life and Education

Jay Quade was born on December 13, 1955, in Pasadena, California. His father, Jack Quade, was a stockbroker who realized his true love was geology and moved the family to Reno, Nevada, in 1961. He enrolled in the University of Nevada-Reno and completed a bachelor of science and master's degree in geology from its Mackay School of Mines. He spent the remainder of his career as a geologist for the Mackay School, the National Aeronautics and Space Administration, and Bendix Corporation. Jay's mother, Sally Quade, was a long-time schoolteacher and counselor. Together Jack and Sally provided Jay with a solid foundation for his love of learning and for spending time outdoors. The family backpacked and fished in the Sierra Nevada Mountains and worked gold claims on their weekends.

Jay followed his father's geological interest. As a boy, he and a friend excavated their own "mine" on land near the family property south of Reno. Their fathers, upon discovery of the expanding hole, deemed it beyond the limits of safety and filled it in with a backhoe. Jay also showed an early interest in ancient history, especially history involving battles, landscapes, and strategies. He organized the third and fourth graders in his school in a reenactment of the Second Punic War between the Romans and the Carthaginians. The concerned school principal went to see what the recess mêlée was about. Jay explained it was not what it looked to be; it was really a "friendly" battle, and he needed more troops on

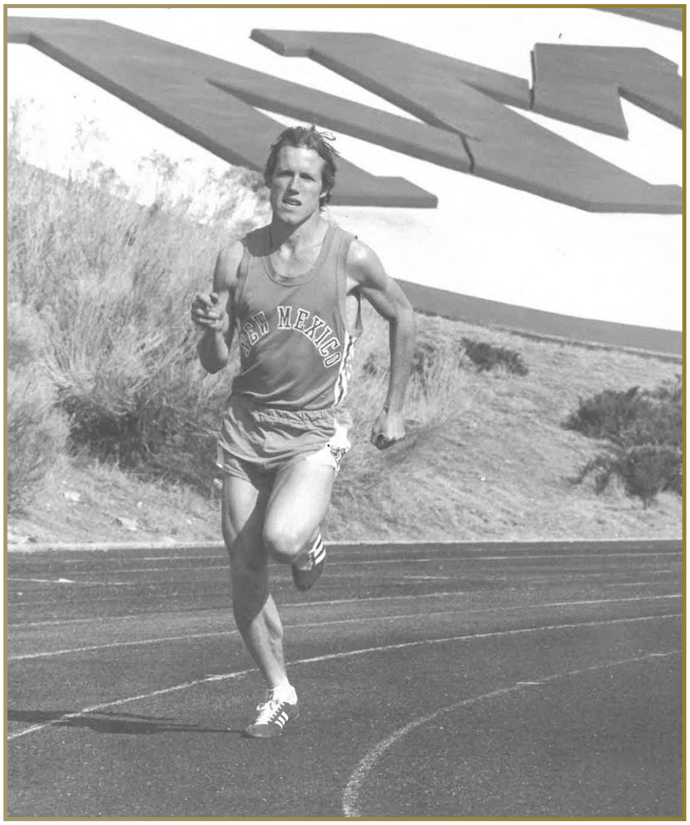

Figure 2 Jay running for the University of New Mexico's track team as an undergraduate. *From Quade Family photos, courtesy of Barbra Quade.*

both sides so could the principal please let him recruit the fifth and sixth graders? Unfortunately, the principal replied, "Absolutely not." Jay also organized his school chums to go on hunts for fossils and artifacts; he kept meticulous notes about where and what was found on these "expeditions."

Once in high school, Jay devoted himself to running track, especially medium to long distances. He set two all-time track records for the State of Nevada, and he continued to excel in track and field on an athletic scholarship at the University of New Mexico. Jay was twice named an All-American in middle-distance running, and he was part of the NCAA two-mile relay championship team in 1978. His extraordinary athleticism continued throughout his professional career: no hill was too steep, no transect too long, if important samples could be collected or critical observations could be made.

As an undergraduate at New Mexico, Jay continued pursuing early interests, taking courses not only in geology but also in history. A fellow student in all his classes in Greek, Roman, and medieval history was Barbra Valdez. Jay finally asked her for a date when they reached the Middle Ages. He planted a garden for her during their undergraduate years at the University of New Mexico.

Jay completed his bachelor of science degree in geology from the University of New Mexico in 1978. He then spent a year traveling in Europe and Africa, most notably Morocco, where he refined his expertise in desert geology and car repair, as these often went together, and he advanced his interest in foreign languages. Returning to the United States, Jay spent time building boats, improving his skills in carpentry. He eventually returned to academics and in 1982 Jay received a master's degree from the University of Arizona. He then went to work in Alaska for Phillips Petroleum and later Noranda Corporation in Nevada. Jay married Barbra Valdez in 1984 and they lived in a tent while Jay conducted field work in Nevada. He continued to hone his skills with cars, especially Volkswagens. His favorite VW was the split-window bus, which he sometimes fixed with pieces of metal or wire found along the side of the road. Only half-kidding, Jay often quipped, "If you can't find it on the side of the road, you don't need it." Jay and Barbra had three children: Kirstin, Gratianne, and Emeric. The family would later frequently join Jay in the field—western United States, Pakistan, Greece, Tibet, Nepal, Chile, and Australia—and the children often had jobs participating in fieldwork and expedition life. Daughter Kirstin recounted one such trip in the Australian Outback in her essay "Season of the Skulls" published in *The New York Times* in September 2016.

Jay worked at the Desert Research Institute in 1984 and then with Mifflin and Associates in 1986 on issues related to nuclear waste disposal at Yucca Mountain in southern Nevada. Coincidentally, Jack Quade had just published a mineral inventory of the Nevada Test Site. Jay continued working on problems related to nuclear waste while pursuing

Figure 3 "If you can't find it by the side of the road, you probably don't need it." Jay collecting firewood in the Atacama Desert. *Photo by Julio Betancourt.*

a Ph.D. at the University of Utah under Thure Cerling. One of those problems entailed the carbonates exposed in Trench 14, near the proposed nuclear waste site at Yucca Mountain. These carbonates had been discussed as an example of upward groundwater flow in the region. Jay demonstrated, however, that the Trench 14 carbonates formed by downward water infiltration and chemical precipitation of calcium carbonate in the soil profile. Had the "upwelling" hypothesis proven right, it would have been the death knell for licensing Yucca Mountain as a nuclear waste repository.

Jay's Ph.D. work also involved field work in the western United States and Pakistan. In Nevada, he studied soil profiles across altitudinal gradients to test models of soil carbonate formation, the incorporation of stable isotopes into soil carbonates, and the isotopic signatures from different types of vegetation. Jay applied this new understanding of soil carbonates in studying a paleosol sequence spanning the last 18 million years in the Siwalik Hills of Pakistan, at the foot of the Himalayas. He found a transition at the end of the Miocene from an ecosystem dominated by C_3-forests to one dominated by C_4-grasslands. The carbon isotope shift of >10‰ in the Siwalik Hills in the late Miocene was the first indication of an ecological change that marked the beginning of tropical and sub-tropical savannas worldwide. Studies by Jay and others later found similar late Miocene expansions of C_4 biomass in Africa and North and South America, a global change driven by falling atmospheric CO_2 levels and related changes in hydrology, seasonality, and fire.

Figure 5 Jay in a soil pit in the Atacama Desert, Chile. These soil pits were used to document salt transport and soil-forming processes in the desert environment. *Photo by Julio Betancourt.*

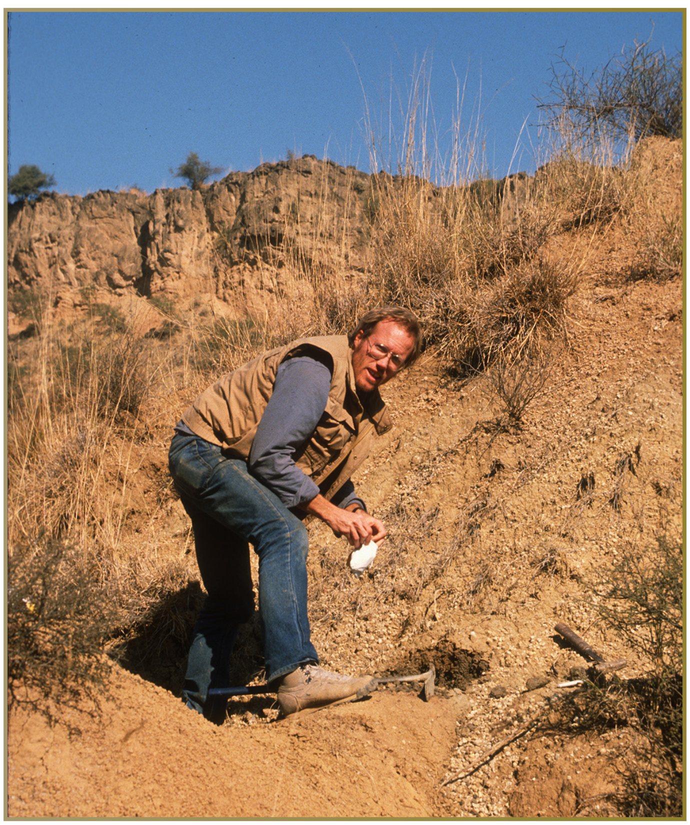

Figure 4 Jay collecting soil carbonate samples in the Miocene Siwaliks, Pakistan, in 1989. Samples were used to document ecological and climate change in the Miocene. *Photo by Thure Cerling.*

Research Career

After completing his Ph.D., Jay took a postdoc position at the Research School of Earth Sciences at the Australian National University (ANU). There, he used $^{87}Sr/^{86}Sr$ isotope ratios to demonstrate the relative contributions of local dust, ocean sea spray, and local bedrock to the formation of soil carbonates in different parts of Australia. Later, in the western United States, he applied those principles of strontium isotope chemistry to decipher dust sources and their role in soil carbonate formation. With this vision of Sr isotopes as tracers of surface processes, Jay demonstrated the importance of sea spray far inland from the Pacific Ocean into the Atacama Desert of northern Chile. In the southwestern United States, he used Sr isotopes to show that structural timbers in the prehistoric Great Houses at Chaco Canyon were transported from conifer forests on distant mountaintops.

During his time at ANU, Jay's familiarity with urine-encrusted packrat middens in the North American deserts motivated his exploration of analogous rat stick-nest middens in the Australian Outback. He also helped colleagues and students usher an impressive era of rodent midden research in the Atacama Desert. Jay's familiarity with the crystallized urine that indurates ancient rodent middens in the American and Australian deserts inspired an important discovery at an early Neolithic archeological site in central Turkey. Dung and midden layers accumulated over centuries were highly enriched in salts from urination by humans and animals. The concentration of these salts spiked shortly after 10,000 years ago with population growth and early animal domestication.

Following his postdoc at ANU, Jay took a faculty position at the University of Arizona, where he remained for his entire career. Jay's first office and lab were on Tumamoc Hill, a 680-acre ecological reserve and home to the university's Desert Laboratory, which he directed from 1992 to 2007. Although it required a daily 4.5-mile commute between "the Hill" and the main campus, working at the Desert Laboratory had its perks, including collaboration with an outpost of U.S. Geological Survey scientists based there.

At the University of Arizona, Jay continued his dual interests in field geology and isotope geochemistry applications. He recognized that the same care required for collecting samples and making field observations must carry over into the laboratory. After he moved his office from Tumamoc Hill to the main campus, Jay built a second, more extensive laboratory in the basement of the physics building. He focused on details of sample preparation and measurement because he realized that a thorough understanding of the techniques was necessary for creative isotope applications. He and his students designed calibration studies of modern isotope systems to develop a more complete understanding of how these systems record environmental variables. They also developed numerous tests of sample pre-treatment effects. Jay's strong background in analytical techniques allowed him to tackle methodological challenges such as the development of an extremely low blank ^{14}C extraction line, and he made significant contributions to cosmogenic ^{14}C analysis for dating Quaternary surfaces. In the last decade of his life, Jay added a new isotope methodology to his tool kit by pioneering the use of tunable infrared laser differential absorption spectroscopy to measure clumped isotope ratios. Jay's last project was to add triple-oxygen isotope analysis (^{18}O, ^{17}O, ^{16}O) to the existing laser system, which permitted reconstruction of both ambient temperatures and the degree of evaporation in ancient soils, lakes, and surface waters.

In addition to Jay's work in deserts and other dryland settings, he also worked in the jungles of Nepal and the high arid plateaus of Tibet, Argentina, and Bolivia over 6,000 meters in elevation. Jay's geological expertise was immense. He could work in almost any type of geologic terrane, from high-grade metamorphic rocks to igneous, sedimentary, and chemical deposits. Although not always fluent, Jay strove hard to learn and communicate in the local languages spoken across his diverse and remote field areas. His blend of broad historical and geological knowledge and fascination with local customs and cultures made him a master storyteller.

Jay's early training and firsthand experience in the American West, the launchpad for many methods used to reconstruct environmental change in radiocarbon time, primed his explorations in other arid lands. For his master's thesis in 1982, for example, Jay studied "black mats," distinct organic layers in the alluvial stratigraphy of desert valleys in the southern Great Basin. These and related groundwater deposits are often mistaken for lake deposits. In the southern Great Basin, however, Jay showed that they result from spring discharge and deposition in marshy environments, most commonly during the Younger Dryas period (13,000 to 11,700 years ago), when groundwater levels rebounded during the last deglaciation in North America. In addition to mapping wetland stratigraphies, Jay mapped and dated terraces, tufas, and other shoreline evidence for Pleistocene pluvial lakes in the many closed basins in the interior of the American West.

With his students and colleagues, Jay extended his mastery of wetland stratigraphies and shoreline evidence to reconstruct groundwater and lake levels in the Atacama Desert, the Bolivian Altiplano, the Arabian Peninsula, and the southern Tibetan Plateau. He was able to relate these hydrological fluctuations to millennial-scale variability in the South American, Indian, African, and Asian monsoons. For the Central Andes—from the Atacama Desert in northern Chile across the Bolivian Altiplano to the Chaco-Pampean plains of western Argentina—Jay identified a two-stage climatic oscillation between 18,000 and 9,700 years ago. He called this oscillation the Central Andean Pluvial Event (CAPE), a term he coined in 2008 that is still widely used by practitioners.

Soon after arriving at the University of Arizona, Jay realized that soil carbonates could do much more than simply estimate the fraction of C_4 biomass, an objective of his Ph.D. thesis. He became interested in how, during the Cenozoic, weathering of old, silicate-rich continental rocks (high in radiogenic ^{87}Sr) could have ramped up ocean drawdown of atmospheric CO_2 and therefore caused Cenozoic cooling. The only major rivers on Earth capable of driving the observed trend in seawater Sr isotope ratios are those that drain the Himalayas. Jay conceived the idea that the $^{87}Sr/^{86}Sr$ of Himalayan river waters could be tracked back to the mid-Cenozoic by analyzing paleosol carbonates in foreland basin deposits. This project involved several major expeditions using long sampling transects. He entrained a group of similarly interested faculty colleagues at Arizona to study

Figure 6 Titrating alkalinity in the field, Nepal. The titrations, water, and sediment samples were used to quantify the contribution of Himalayan rock weathering to marine strontium in the Cenozoic. *Photo by Nathan English.*

this problem in Nepal. After several years of hard and meticulous work, Jay proved that, although the highly radiogenic Sr isotopes were likely coming from the Himalayas, they were not associated with silicate rocks and thus could not be used as a proxy for silicate weathering. This work took place over a five-year timespan and launched a more than thirty-year effort by Arizona geoscientists on Himalayan geology and tectonics. In spin-off projects, Jay developed stable isotope paleo-altimetry methods and determined the timing of elevation gain in the Himalayan-Tibetan orogenic system. This seminal work illuminated the path forward for the next generation of geoscientists working in Tibet. Soon after developing these methods in southern Eurasia, Jay began to apply them to problems in the Andes and the western United States, where the results were equally groundbreaking. In the 2000s, the advent of clumped isotope analysis enabled researchers to measure the rare isotope ratio $^{13}C^{18}O^{16}O/^{12}C^{16}O^{16}O$, and a new opportunity also arose to estimate the temperatures of soil carbonate formation. Rather than immediately applying this to fossil samples, Jay set about systematically testing every step and assumption. Indeed, he was able to show that soil carbonates recorded soil temperatures during the season that the carbonate was formed, rather than the annual mean soil temperature. He also was able to show that the isotope ratios were reset at a burial depth of about four kilometers.

In 1999, Jay was invited to be the site geologist for an anthropological site at Gona, Ethiopia, along the Awash River, where the sequence of sediments spans almost five million years. Jay's work was critical in establishing the geochronological framework for the site, which included many important hominin specimens, including *Ardipithecus ramidus* in the older sediments and *Homo erectus* in the younger ones. Using carbon isotopes, as pioneered in his dissertation work, Jay and students were able to reconstruct paleoenvironments, including the amount of woody cover available for early hominins.

Teaching, Mentorship, and Field Camp

Jay was a popular teacher at the University of Arizona, especially in his courses in soil geochemistry, stable isotopes, geochronology, and Quaternary geology. Classes were intense and time consuming. He believed that the best way to bring a group of students with very different backgrounds of knowledge to a high level was to have them interact with the published literature. Students learned to point out creative approaches, critique the downplaying of inconvenient data, and double check all the calculations in scientific papers. Learning to write research papers was also emphasized. Classes frequently involved writing up a small set of lab measurements: students learned to extract related data from the literature, construct hypotheses, and discuss strengths and weaknesses of the chosen methods. These student mini-projects frequently planted the seeds for major published papers.

Field concepts and examples were incorporated into all his classroom teaching and enhanced through field trips, and students made important chemical measurements in the field when required. His students never forgot these experiences, especially Jay's good humor, which helped many students through the unexpected situations that frequently happen in the field. His stellar example of keeping a level head when plans go awry and never losing his temper or complaining about difficult conditions were important lessons for his students.

Jay mentored more than thirty-five graduate students, many of whom went on to earn doctorates and to successful academic careers. He was a very hands-on advisor, working closely with students both in the field and in the lab. For anyone who worked with Jay, the relationship was an apprenticeship in which the student was taught every detail of the object of study, process, and procedure. In courses and seminars, Jay was a gentle but demanding instructor. Students had to be prepared, as Jay would question them intensively to make sure they understood the material. He often worked from scratch through a derivation or a chemical reaction, thus demonstrating to the students how one goes about thinking on one's feet.

Jay taught geological field camps throughout most of his career, beginning at the Indiana University Field Station in the Tobacco Root Mountains of Montana the year after he had completed the same course as an undergraduate. At the University of Arizona, Jay taught summer field camp for most of the thirty-plus years he was a member of the faculty. His field camp courses were physically and intellectually challenging, covering an immense swath of the western U.S. Cordillera

Figure 7 Jay teaching field camp in the Wind River Mountains, Wyoming, to University of Arizona undergraduate students. *Photo by Peter DeCelles.*

from Arizona to Wyoming to California. The work was difficult, involving camping for five weeks straight in wilderness settings and shepherding up to twenty undergraduates from diverse backgrounds through complex geology and difficult topography with the goal of understanding two billion years of geologic history and the origins of the western mountains. The students learned how to work with rocks spanning the entire spectrum of geology, as well as landscapes fashioned by tectonic, glacial, volcanic, eolian, and fluvial processes. Perhaps more significantly, the students learned how to comport themselves as professional scientists in uncompromising settings, how to navigate independently in the wilderness, and how to deal with the challenges that nature dishes out, from snowstorms to forest fires, from broken-down vehicles to blown-out tents. Jay brought a sense of delight in discovery to his field teaching, which inspired his graduate students, undergraduates, and professional colleagues.

Jay died on October 17, 2025, and is survived by his wife, Barbra, and their children and grandchildren.

Selected Bibliography

1989 With T. E. Cerling and J. R. Bowman. Development of the Asian Monsoon revealed by marked ecological shift in the latest Miocene in northern Pakistan. *Nature* 342:163–166.

With T. E. Cerling and J. R. Bowman. Systematic variation in the carbon and oxygen isotopic composition of Holocene soil carbonate along elevation transects in the southern Great Basin, United States. *Geol. Soc. Amer. Bull.* 101:464–475.

1990 With T. E. Cerling and J. R. Bowman. Stable isotopic evidence for a pedogenic origin of carbonates in Trench 14 near Yucca Mountain, Nevada. *Science* 250:1549–1552.

1997 With L. Roe, P. G. DeCelles, and T. P. Ojha. The Late Neogene $^{87}Sr/^{86}Sr$ record of lowland Himalayan rivers. *Science* 276:1828–1831.

1998 With R. M. Forester, W. L. Pratt, and C. Carter. Black mats, spring-fed streams, and late-glacial-age recharge in the southern Great Basin. *Quat. Res.* 49:129–148.

2004 With N. Levin et al. Paleoenvironments of the earliest toolmakers. *Geol. Soc. Amer. Bull.* 116:1529–1544,

2007 With C. Garzione and J. Eiler. Paleoelevation reconstruction using pedogenic carbonates. *Rev. Mineral. Geochem*. 66:53–87.

2008 With J. A. Rech et al. Paleowetlands and regional climate change in the central Atacama Desert, northern Chile. *Quat. Res.* 69:343–360.

2012 With P. Reiners et al. Seismicity and the strange rubbing boulders of the Atacama Desert, northern Chile. *Geology* 40:851–854.

2013 With J. Eiler, M. Daëron, and H. Achuythan. The clumped isotope paleothermometer in soils and paleosol carbonate. *Geochim. Cosmochim. Acta* 105:92–107.

2022 With E. Dente et al. Central Andean (28–34°S) flood record 0–25 ka from Salinas del Bebedero, Argentina. *Quat. Res.* 109:102–127.

2023 With A. Hudson. Long-term east-west asymmetry in monsoon intensification on the Tibetan Plateau. *Geology* 41:351–354.