Memorial to Eldridge M. Moores 1938–2018

Geoscience Pioneer, Educator, and Community Organizer

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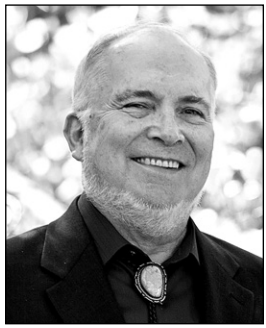


Eldridge Morton Moores was born on 13 October 1938 in Crown King, Arizona. He died unexpectedly on Sunday, 28 October 2018, in Quincy, California, on a field trip he was leading in the northern Sierra Nevada foothills. He is survived by his wife Judy; three children, Geneva Moores and husband Peter de Boor, Brian Moores, and Kat (Moores) Conley; and the three de Boor grandchildren, Corwin, Jasper, and Malva.

Eldridge interacted closely with the Earth from a very early age. His father wanted him to join the family business in mining and hauling, and he worked as a teenager driving various vehicles in Arizona mines. At 16, he graduated from a high school in Phoenix and enrolled at the California Institute of Technology. Conversations with his Caltech resident adviser sparked the idea of majoring in geology and led to two summers working in Alaska. Eldridge graduated from Cal Tech with a B.S. (with honors). His admittance as a geology graduate student to Princeton University cemented his career path.

At Princeton, Eldridge did his Ph.D. research in Nevada under the supervision of John Maxwell. He mapped young faults in the White Pine–Grant Range in east-central Nevada that had previously been identified as unconformities; he was ahead of his time in interpreting them as extensional, low-angle normal faults. Finishing his Ph.D. in 1963, he stayed at Princeton for a postdoctoral fellowship but changed his research focus to the Vourinos ophiolite of Greece. He showed that the lower part of its ultramafic complex was metamorphic tectonite. This concept was different from earlier models that interpreted Hellenic ophiolites as extrusions of mafic-ultramafic magmas into sedimentary troughs. Shortly after returning from his research trip to Greece, he met his wife-to-be, Judy (née Riker), at a change-partner dance at Mount Holyoke College in

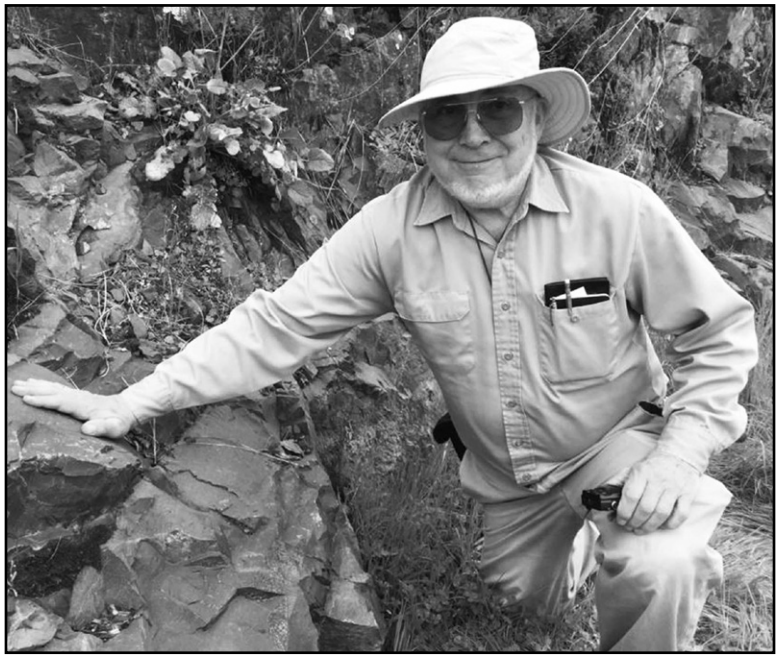
Massachusetts; three weeks later they were engaged, and then married the following June.

Eldridge also traveled to Tuscany and Liguria (Italy) with Harry Hess and Maxwell in 1964 to examine the Ligurian-Apennine ophiolites. Maxwell and Eldridge took a keen interest in mélanges in the Apennines that led to their collaborative studies of the Franciscan Complex of California. This trip convinced Hess that ophiolites were fragments of ancient oceanic crust, which prompted Eldridge to connect with Fred Vine at Princeton University to develop a research project on the Troodos ophiolite of Cyprus. His work on Troodos with Vine led to the publication of one of Eldridge's most influential papers. Moores and Vine (1971) argued that: (1) the Troodos sheeted dike complex was a result of seafloor spreading at a Tethyan mid-ocean ridge; and (2) the southern termination of the ophiolite was a fossil oceanic transform fault, and hence the Troodos ophiolite was a product of a paleo ridge–transform fault setting. These insights into the oceanic crust–ophiolite analogy constitute one of Eldridge's seminal contributions to the Plate Tectonic Revolution and instigated extensive research in Troodos by the international geoscience community that continues today.

In 1966, Eldridge was hired in the Department of Geology at the University of California at Davis (UCD), just as the Plate Tectonic Revolution was getting under way. He stayed at UCD his entire career, rising through the ranks to professor. In his early years at UCD, he took a sabbatical at the University of Geneva (Switzerland), where he examined collisional structures in the Alps. His observations there strongly affected his views of western U.S. Cordillera tectonics. He advocated for an alpine-style collision model for the Middle Jurassic Nevadan orogeny, whereas the ruling theories insisted on Andean-style convergent margin tectonic evolution of western North America throughout the Mesozoic. In his 1970 *Nature* paper, Eldridge proposed that "the emplacement of large ultramafic sheets represents the collision of a continent with a subduction zone dipping away from the continental margin" (arc-continent collision). This view contrasted sharply with the ophiolite "obduction" concept, in which an ophiolite was emplaced from the subducting oceanic plate by a thrust antithetic to the subduction zone. Eldridge argued for the development of an orogenic belt by initiation and termination of multiple subduction zones with differing polarities, in contrast to other orogenic models that proposed protracted landward-dipping subduction history. His 1984 *Geology* paper with Howard Day (also at UCD) introduced a collision-driven overthrust model for the Sierra Nevada. He led many field trips for visiting geologists and students to the Jurassic Smartville ophiolite in the Sierra Nevada foothills to show the early, E-directed thrust faults in support of his collision model. He also discussed during these trips how hydraulic mining along the Yuba River in the gold rush years changed the fluvial dynamics all the way down to the Sacramento River delta. Eldridge was a staunch environmentalist.

Eldridge worked with Jim Valentine (University of California at Santa Barbara) on the plate tectonic regulation of faunal diversity and sea-level changes. Their papers published between 1970 and 1974 outlined the important role that plate tectonics plays in evolution, including provinciality, diversity, and extinction of marine life. All these studies emphasized the importance of creating new oceans at mid-ocean ridges and how openings-closures of ocean basins affected the evolution of life.

Eldridge was unusually innovative and did not shy away from controversy. He was always coming up with unconventional ideas to challenge the ruling hypotheses. His 1986 *Science* paper is a good example: it suggested that 2500–1000 Ma oceanic crust was much thicker in comparison to modern oceanic crust, causing a reduced contrast between the elevation of oceanic and continental realms in the Precambrian. He thought that this phenomenon was analogous to the hypsometry of modern Venus rather than that of modern Earth. It was a bold idea, and correct about the Precambrian oceanic crust being much thicker, but his reasoning to propose this model—the absence of 2500–1000 Ma ophiolites in greenstone belts—was inexact. Numerous papers published in subsequent years documented the occurrence of ophiolites in the Paleoproterozoic greenstone belts. His 2002 *GSA Bulletin* paper on pre–1 Ga ophiolites subsequently set the record right.



From December 1988 through February 1989, Eldridge, along with Ian Dalziel, Sue Kay, Warren Hamilton, and others, participated in a month-long cruise to the Chilean Patagonia–Antarctica that was organized by the National Science Foundation (NSF) Antarctic Program. Discussions on RV *Polar Duke* during this expedition must have been exhilarating for all. It took less than two years after this cruise for Eldridge to publish his 1991 *Geology* paper introducing the SWEAT hypothesis connecting the southwest United States to East Antarctica as part of an early Neoproterozoic supercontinent (Rodinia), and for Ian Dalziel to publish, nearly simultaneously, his 1991 *Geology* paper, "Pacific margins of Laurentia and East Antarctica–Australia as a conjugate rift pair: Evidence and implications for an Eocambrian supercontinent." Both advocated a new continental reconstruction in the late Neoproterozoic. The SWEAT concept fueled a large number of NSF-funded projects in Antarctica for the next 15 years.

Eldridge was reluctant to accept the suprasubduction zone ophiolite concept (introduced in 1984), which was based on geochemical data from the Troodos and Oman ophiolites, suggesting that most ophiolites must have formed above subducting slabs. His strong criticism was that none of the Eastern Mediterranean ophiolites was associated with arc volcanoes. Moores et al. (1984) postulated that oblique subduction could lead to the formation of a ridge-transform system above a subduction zone, without development of proximal arc volcanoes, as observed in the modern Andaman Sea. In 2000 he and his co-authors published a paper, entitled "Tethyan ophiolites, mantle convection, and tectonic 'historical contingency': A resolution of the 'ophiolite conundrum.'" Eldridge and his co-authors argued that earlier subduction episodes modified volumes of mantle, which were tapped by later upwelling and partial melting beneath oceanic spreading centers resulting in an apparent suprasubduction zone geochemical character for the resulting igneous rocks.

Eldridge's decades of research contributions are recorded in more than 130 scientific articles and two widely read textbooks, *Structural Geology* (1992, 2007) and *Tectonics* (1995), both co-authored with Robert Twiss at UCD.

A dedicated teacher, Eldridge especially enjoyed teaching his tectonics course. He had elegant handwriting, which he used effectively on the wide blackboard of a large UCD auditorium, filling up every inch with tectonic diagrams. His presence in the department attracted many geoscientists from the peri-Pacific countries, Europe, and North America, who would drop in and present seminars. UCD geology students and faculty alike enjoyed this intellectual buzz, followed often by an invitation to Eldridge and Judy's house to continue discussions over delicious desserts and drinks. The hospitality of Eldridge and Judy made the department a special, social place for all its citizens.

Eldridge served as department chair in 1971–1972, 1973–1976, and 1988–1989, and his commitment to inclusion helped shape his department. He played a major role in hiring the next generation by championing diversity and scientific breadth, and in transforming the department into a powerhouse as the Department of Earth and Planetary Sciences. Eldridge retired in 2003, but even as emeritus professor he was generous with his time. He believed that there was no better classroom for teaching geology than out in the field. Many of his graduate students, inspired by Eldridge's vision of the central role that science and scientists should play in shaping public policy, built successful careers in academia, government, and industry.

In 2011, Eldridge and Judy founded the Eldridge Moores Distinguished Visiting Scholars Fund in the Geosciences at UCD. In 2016, they made a planned gift to support UCD students conducting fieldwork through the Eldridge and Judith Moores Field Geology Fund. In June 2016, nearly 100 faculty, students, alumni, and friends gathered to celebrate his 50-year legacy at UCD.

Eldridge was a leader in The Geological Society of America. As editor of *Geology* (1981–1987), he transformed it into a premier geoscience journal. The mission statement of *Geology* as a journal publishing "timely, innovative, and provocative articles" goes back to Eldridge's vision at its beginning. He also saw the need for *GSA News & Information* to evolve, and he played a key role in creating *GSA Today*, with its monthly science article; he was also its first science editor. He served as GSA president in 1996 and received GSA's Distinguished Service Award in 2006. He served as vice president of the International Union of Geological Sciences (IUGS) and made sure that the International Geological Correlation Program (IGCP) remained a viable global program, supported by IUGS and UNESCO.

Eldridge didn't restrict his love of geology—he shared it with the world. He was particularly proud of leading John McPhee, the author of *Assembling California* (1993), on a series of field trips across the Sierra Nevada, across the Sierra foothills and the Mother Lode, and across the Great Central Valley to the Coast Ranges and wine country. These trips and their animated discussions resulted in a vivid explanation of how the land in California was put together in this popular science book.

Eldridge was passionate about linking geosciences to societal issues. Over the years, he became the go-to authority for news media on geology-related matters in Northern California. He and Judy introduced more than a thousand people to California geology through field trips. Together they edited (with Lauret Savoy) *Bedrock: Writers on the Wonders of Geology* (Trinity University Press, 2006). Eldridge devoted countless hours to increasing public awareness of the important role that geosciences should play in our society. He worked to elevate earth and planetary science in K–12 education in California. Along with Judy, Eldridge worked as a member of Tuleyome, a nonprofit local conservation organization that is dedicated to preserving our regional environment and public lands.

Eldridge was an important member of the larger UCD community. He played cello in the University's Symphony Orchestra for 28 years. He and Judy were deeply involved with the Davis community and shared their passion for the arts and sciences with all. Eldridge and Judy lived in a house in West Davis, where they enjoyed gardening and attending the Unitarian Universalist Church.

Eldridge ended every email with a quotation from Will Durant, an American philosopher: "Civilization exists by geologic consent, subject to change without notice." It was his belief that we must understand our planet in order to persevere as a society, and the quote has become the informal motto of the department at UCD.

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