IN MEMORIAM–ROBERT E. GARRISON

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Robert Coe and Hilde Schwartz

Professor Robert E. (Bob) Garrison died at his home in Santa Cruz in the presence of his wife Jan, son James and daughter-in-law Alma. He came to UCSC in 1968 as a fellow of Stevenson College and was one of the original faculty members who established the Earth Sciences Board at UC Santa Cruz and launched it on its way to international prominence. Bob was an extraordinarily kind and giving person in his relations with a large number of UCSC undergraduate and graduate students, researchers, faculty members and colleagues who have, in turn, gone on to make their own contributions and impacts. He and his wife Jan graciously opened their home and hearts to a long stream of students, visitors and their families from around the world and made them feel welcome and appreciated.

Bob and Jan Garrison in 2011

Bob Garrison was born in Texas during the Great Depression when many people, including his parents, were struggling because of the harsh economic conditions and lack of jobs. Searching for a brighter future, his family had migrated from Indiana to Texas because they had heard of jobs in the oil fields. After studying in night school, his

father landed a job as an accountant for Texaco for several years in Saudi Arabia. Upon return to his family, when Bob was still a teenager, he accepted an offer as auditor for Aramco, and eventually the entire family moved to San Francisco. Bob enrolled at Stanford University and graduated in 1955 with a B.S. in Geology, supporting himself by serving food in a campus dormitory. After serving two years in the Air Force, he returned to Stanford for an M.S. in 1958 and won a Fulbright Scholarship to study at the University of Innsbruck in Austria. That year in Europe marked an especially important point in Bob's life; it was then he met his lifelong partner, Jan, in a restaurant and gallantly offered to translate as she and a friend struggled over the menu at another table.

Following the Fulbright Bob returned to the states and worked for two years for Sunray DX Oil Company in Wyoming, where he developed an appreciation of the commercial applications of geology. In 1961 he began a Ph.D. program at Princeton University under the mentorship of Alfred Fischer, and returned the following year to Austria, where he and his advisor made seminal contributions to our understanding of the pelagic limestones and radiolarites of the Austrian Alps.

Bob and Jan were finally reunited after three years of correspondence, and in 1963 they got married. Two years later he completed his Ph.D. and accepted an offer of Assistant Professor from our sister campus in Santa Barbara. After a year, Bob and Jan moved north to the University of British Columbia, where Bob served for two more years as Assistant Professor, returning to California in 1968 to accept a tenured offer as Associate Professor at UC Santa Cruz in the new Earth Sciences program founded by Aaron Waters. He served as Chair from 1970-72, an especially formative time in faculty recruitment and program development, spent the next year as a Guggenheim Fellow with Jan and their 3 year old son James on sabbatical leave at Oxford studying British chalks, and was promoted to full professor upon his return.

For his doctoral research in the early sixties, Bob was among the first to apply transmission electron microscopy to obtain the high magnification needed to image the textures of very fine-grained sedimentary rocks from peel replicas of polished and etched samples. He showed that the pelagic limestones of the Austrian Alps consist of planktonic micro- and nannofossils deposited particle by particle on the sea floor, and that the resulting carbonate ooze gradually cemented together at or near the sea floor by inorganic recrystallization. This was contrary to the widespread view that lithification of carbonate sediments required either diagenesis in fresh water or burial to great depths. In subsequent years Bob confirmed and refined this hypothesis of early diagenetic cementation in studies of pelagic limestones in Washington and California and in various ocean environments. In 1967 he was a coauthor of the first

electron-microscope atlas devoted to this topic. He showed as well that the silicic pelagic sediments of the Jurassic Austrian Alps, radiolarian cherts, were biogenic in origin, not–as often supposed because of their close spatial association with sea-floor basalts–genetically related to volcanic activity.

This early work led naturally to the long-term research project he began in the seventies on California's iconic Monterey Formation, important for understanding both paleoclimate and resource accumulation. Found now in basins both on- and offshore along the entire length of California, the Monterey is the source and sometimes the reservoir of almost all the petroleum found in California. Bob and his students showed that its calcareous and siliceous rocks formed from microfossils nourished by active ocean upwelling and deposited in Miocene hemipelagic basins. Their studies of the Monterey and similar rocks around the world confirmed the connection between active coastal upwelling and the accumulation of hydrocarbons, phosphates and diatomites.

The breadth of Bob's knowledge and research is especially evident in his work with NASA. In 1966 Bob joined Aaron Waters at Newbury Crater, Oregon, to assist in geologic field training Apollo astronauts. Five of this group went on to fly on Apollo missions and three walked on the surface of the moon. Bob studied two samples of lunar rocks collected during the Apollo 12 mission and presented his results at the Second Lunar Science Conference in Houston in 1971. Applying the same electron microscopic technique he used in his dissertation, his coauthors and he showed that the rocks were breccia, with most of their fine-grained matrix consisting of tiny bits of unaltered silicate glass plastically molded against each other and welded to larger clastic fragments. They concluded that lunar breccias are deposits from hot base-surge clouds of impact debris, condensed from rock volatilized by major meteor impacts. In 1969 Bob began his long association with the Deep Sea Drilling Project, the highly successful international research consortium now in its 53 rd year. During his career he served as Sedimentologist on three ocean-drilling expeditions and a member on several advisory and executive panels. His first expedition, during DSDP's initial year of operation, was Leg 6 to the northwestern Pacific Ocean. It confirmed the geophysical prediction, based on the revolutionary seafloor-spreading hypothesis, that this region would contain the oldest part of the world's ocean basins: namely, Jurassic-aged seafloor, no more than 200 million years old. He and his colleagues also showed that prominent sequences of thin seismic reflecting layers, supposed earlier to be stratigraphically continuous turbidite beds, are actually broadly time-transgressive, cherty layers alternating with pelagic ooze on the seafloor.

Bob's second expedition was the famous Leg 42A in 1975 to the Mediterranean to reinvestigate the controversial story of the Mediterranean salinity crisis: a period from 5.97 to 5.33 million years ago when repeated disruption of flow from the Atlantic Ocean

through the Strait of Gibraltar led to near-desiccation of the Mediterranean Sea and deposition of thousands of feet of evaporite salts in the Mediterranean basin. Bob and his team's meticulous microscopic examination of the DSDP core sediments from the last stages of the crisis, coupled with the shipboard paleontologist's identification of benthic foraminifera just before the crisis, made a strong case for their deposition by periodic influx and evaporation of marine waters into largely dry, deep basins. Active inquiry continues into the detailed paleo-oceanographic conditions that prevailed during deposition of these immense salt beds. Bob's third expedition was Leg 112 to the Peru margin, where action of the Coriolis effect on the northwestward flowing Humboldt Current induces upwelling conditions like those due to southeastward flow along the California margin.

The Neogene and Quaternary siliceous and phosphatic sedimentary record recovered in the drill cores on the Peru margin showed that phosphogenesis there was similar to that preserved in the Monterey Formation, but different from that recorded in more voluminous phosphate deposits in the southeastern U.S. and the Middle East.

As the UCSC Faculty Research Lecturer in 1982, Bob devoted his address to explaining how marine geology had come to play a pivotal role in understanding the earth and why it behooved the campus to increase its presence in this area. One of his proudest accomplishments, he recounted recently, is that his persistent advocacy finally succeeded in the early 90's with the creation of a new marine geology faculty position in Ocean Sciences and another in Earth Sciences. As a result, UCSC is now a leader in the field of paleoclimate and its implications for the anthropogenic climate change that the world currently faces.

In 1994 Bob took an offer to retire early from teaching under the VERIP program, but by no means did he slow down. He became an emeritus professor in the Ocean Sciences Department and a Visiting and Adjunct Professor at Moss Landing Marine Laboratories, and he accepted a position briefly with the National Science Foundation as Director of its Geology and Paleontology Program. It took but a year for him to realize that life as a DC bureaucrat was not to his taste and resign from the NSF, but he did remain actively engaged as a member of NASA's 7-person panel focused on crew training and skills needed for a 500-day Mars landing mission. The panel, which included Harrison Schmitt, the only geologist to explore on the moon, recommended that the Mars expedition crew be weighted heavily in favor of primary surface science over spacecraft expertise, in marked contrast to the composition of the Apollo lunar landing teams.

After his return to Santa Cruz Bob shepherded his last three graduate students to their degrees, making a total of 22 PhD and 11 masters degrees that he supervised during

his career. He authored 15 more papers, edited three volumes on hydrocarbon seeps, and devoted much time and energy to giving lectures and organizing and participating in field trips and conferences, mainly in the Middle East, Europe and the Americas. A high point for Bob and Jan was their participation in a three-month cruise around the world with the Semester-at-Sea program in 1998. He led field trips in South America and the Far East, participated in many more, and the two of them spent several memorable days in India visiting places where Jan was born and grew up.

Bob Garrison was both an excellent all-around geologist and an outstanding sedimentologist. He made critical contributions to science through his research, publications, influence on colleagues, and shaping of his many students. He fundamentally changed our understanding of the origin, distribution and diagenesis of fine-grained marine sediments, most notably calcareous, siliceous and phosphatic rocks. Throughout his career many honors and awards came his way: he was a Fulbright Scholar (twice), a Guggenheim Fellow, Fellow of the Geological Society of America and the American Association for the Advancement of Science, and recipient of the Society for Sedimentary Geology's Pettijohn Medal for Excellence in Sedimentology and its Fritsche Lifetime Achievement Award.

Bob was also a superb and thoughtful teacher at all levels. He participated in the Stevenson College core curriculum and created the course in Sedimentation and Stratigraphy that was required of all Earth Sciences majors. He also taught a specialized, microscope-based course in Sedimentary Petrology and shared teaching of a capstone course in field geology in the summer on a rotating basis. As a result he got to know almost all the students majoring in Earth Sciences. Bob helped students develop a broad understanding of the world's geologic and cultural diversity by bringing his extensive international experience (and an inexhaustible stream of visiting colleagues) into his classes, seminars and field trips.

Much of Bob's scientific curiosity was guided by his concern for the human condition, with a focus on the origin of the sedimentologic resources of energy and fertilizer necessary for our communal well-being. He was committed to providing opportunities in academia to people who were outside of the traditional pathways long before it was an explicit goal of the university. His influence on an entire generation of students, collaboration with his many colleagues, national and international, generosity with his own time, lively wit and genuine modesty regarding his own accomplishments are hallmarks of Bob Garrison's life and career.