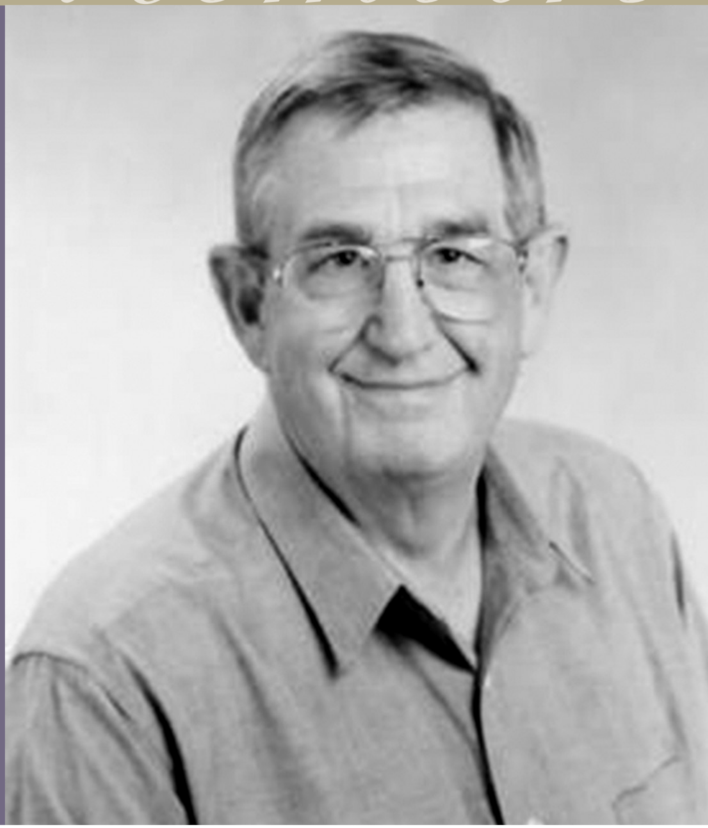
Robert G. Coleman

1923–2020

BIOGRAPHICAL *Memoirs*



A Biographical Memoir by
W. G. Ernst

NATIONAL ACADEMY OF SCIENCES

ROBERT GRIFFIN **COLEMAN**

January 5, 1923–October 18, 2020

Elected to the NAS, 1980

Photography by Coleman family

By W. G. Ernst

Robert Coleman, an internationally recognized geologic field mapper and geochemical mineralogist-petrologist, made enormous contributions to scientists' knowledge of the geologic evolution of contractional continental-margin subduction zones and to the genesis of the ocean-floor-to-upper-mantle lithosphere (that is, ophiolites—sections of Earth's oceanic crust that have been thrust onto the edges of island arcs and continental margins). During four decades of studying the origin and geologic history of western California and southwestern Oregon, Coleman rose to become a world authority on circumpacific tectonics, petrogenesis of the oceanic lithosphere, and the petrotectonics of Alpine-Tethyan convergent suture zones, chiefly in central and eastern Asia. His Ph.D. thesis on the New Idria (central California) Mineral District was a classic work documenting protrusion—that is, diapiric ascent—of a large, low-density ultramafic complex.

Coleman attended Oregon State University, where, after several dropouts and wartime service in the Marine Corps, he earned a B.S. (1948) and an M.S. (1950), both in geology. He received a Ph.D. from Stanford University in 1957. During his doctoral studies, he also worked for the Atomic Energy Commission and in 1954 joined the staff of the U.S. Geological Survey. Departing the USGS in 1982, he became a professor at Stanford until his retirement from academia in 1993, after which he continued productive research until virtually his dying day.

Robert Griffen Coleman was born on January 5, 1923, in Twin Falls, Idaho, to Frances Roberta Coleman (*née* Brown) and Lloyd W. Coleman. His father held a succession of jobs in the dairy industry, which resulted in frequent family moves to new towns in Oregon and central California. Bob, as he was known to everyone, at times was a hired hand (for example, milking 500 head of Holstein cows daily). He played football at Springfield, Oregon, High School, then went on to Beaverton High School and its winning all-state football team in 1940. After spring graduation, he became a member of the Oregon State University (OSU) elite crew combating fires in the university's McDonald Experimental Forest. In the fall he enrolled at Oregon State on a football scholarship. OSU went to the Rose Bowl the next January, but Bob had become a disciplinary problem for the coach. Dismissed from the team, he temporarily left the university for a range of manual labor jobs in Portland, Sitka, Alaska, and, once again, fighting fires in Oregon. He returned to OSU on his football scholarship, but his troubles continued, so in March 1942 he left and joined the Marine Corps. Still playing football, for the Marine service team at Cherry Point Air Base, North Carolina, Bob matured rapidly and advanced to staff sergeant as an elite radar technician.

Mustering out after the war, he returned to OSU now fully committed to academic studies, and in 1948 he completed accelerated work for his B.S. in geology. He married Cathryn Jane Coleman (*neé* Hirschberger) and seamlessly transitioned into the OSU master's program. He was elected to Phi Kappa Phi and also received his M.S. in geology in 1950. He initiated doctoral work at Stanford University that fall. His first son, Robert Griffen, Jr., was born at Stanford University Hospital.

During his dissertational studies Bob also worked as a mineralogist for the Atomic Energy Commission in New York City. In 1954 he joined the U.S. Geological Survey (USGS), based in Washington, D.C., but studied mineral resources of the Colorado Plateau. His second son, Derrick Job, was born in Portland in 1952, and younger brother Mark Dana was born in D.C. in 1954. Bob and Cathryn moved their family to the USGS Menlo Park, California, regional center in 1957. He received his Ph.D. from Stanford that same year, while Cathryn was designing and supervising the construction of their home in the area.

Bob was now poised to begin the fruitful geologic journey that identified him as a remarkable scientific innovator and research leader in studies of the Earth. Probably few of his academic colleagues would suspect that Bob had a rather checkered youthful start on which to build such a spectacular career. (I myself warmly refer to him as "Bubba" based on his early football prowess. Who knows how such dedicated athletic efforts and cooperative teamwork may have influenced his future growth as a passionate, yet objective, Earth scientist?)

As a scientific leader in the USGS, Bob continued pursuing geologic, mineralogic, and plate-tectonic problems in young mountain belts while concurrently serving as chief of the Field Geochemistry and Petrology Branch (1957-1961, 1977-1979), as well as the

Isotope Geology Branch (1964-1968). He only agreed to undertake these somewhat onerous administrative duties provided he could administer the Survey technical staff from the Menlo Park regional center. He supervised the USGS geologists while continuing to conduct a host of geologic field mapping projects and state-of-the-art laboratory-based analytical studies. Initially these works chiefly dealt with the geochemical and petrotectonic evolution of high-pressure/low-temperature rocks of the Franciscan subduction complex in western California and southwest Oregon (Fig. 1).

Fig. 1. Bob Coleman (front center) with USGS, Japanese, and UCLA colleagues at Goat Mountain, northern California Coast Ranges, June 1965. (Photo by the author.)

Subsequently, his other major research projects included studies of the Dunn Mountain peridotite massif of northwestern South Island, New Zealand, mafic igneous rocks of Saudi Arabia and the Red Sea, the Semail ophiolitic nappe of Oman, and the structural architecture of the Klamath oceanic accretionary stack in northwest California and southwest Oregon.

After serving for 28 years as a geologic leader and role model for the Survey's "Menlo Park mafia," Bob took early retirement from the USGS to begin a fruitful program of research and teaching as a professor at nearby Stanford University (1982-1993). His legendary research thrusts in northwestern Kazakhstan, the southern Urals, and various parts of China, Mongolia, and Central America with Stanford, Chinese, Japanese, and Russian colleagues rapidly followed, opening new doors and providing fresh insights into intracontinental collision zones typified by high- and ultrahigh-pressure subduction-zone metamorphism. On officially retiring from Stanford, Bob broadened his investigations of the natural occurrences of ultramafic rocks through pioneering geobotanical investigations of serpentinites and serpentine soils in California, Oregon, and Cuba with a special focus on human health.

Built upon the findings of his Ph.D. research on the New Idria serpentinite body, Bob's 1957 dissertation had opened up all of the California Coast Ranges to new geologic research projects on the voluminous Franciscan sedimentary rocks of Jurassic-Cretaceous age. These chaotically mixed strata were sourced largely from the then-active

Sierran volcanic-plutonic arc, but the erosional detritus from the arc was deposited on the impinging oceanic Farallon plate. His research projects here, which typically were staffed with collaborating USGS colleagues, elucidated the imbricate structure of the accretionary thrust sheets that had decoupled from the down-going outboard oceanic plate. Bob emphasized the high-pressure/low-temperature origin of the characteristic minerals that formed in Franciscan metamorphic rocks—for example, jadeite, aragonite, and glaucophane—and recognized that they indicated subduction depths of at least 20 to 35 km. Such lithologic sections were then recovered via a buoyant return flow of the Franciscan mélange. Serpentinite bodies (diapirs), such as the one he described at New Idria, represent the hydrated, low-density portions of the uppermost mantle making up the basement beneath the overlying, layered oceanic crust.

Bob's early and continuing research projects in the California Coast Ranges set the direction for a range of future studies. His Ph. D. research at New Idria led to a spectrum of studies of the oceanic uppermost mantle in New Zealand and, later, the Persian Gulf area, whereas the geobotanical and human health aspects of serpentine minerals and serpentinite rock exposures illuminated the environmental hazards posed by associated toxic heavy metals. His detailed metamorphic investigations on high- pressure/low temperature Franciscan metabasaltic rocks, such as blueschists and eclogites, gave rise to studies of pristine oceanic basalts flooring the western Pacific, the Red Sea, and the Persian Gulf, as well as vast tracts of far-traveled ophiolites stranded within the continental crust of central and eastern Asia.

Bob spent 1961-1962 in the South Island of New Zealand, studying the less-hydrothermally altered Dunn Mountain ultramafic massif. In this research, he documented the geochemical and structural alteration of another, relatively pristine, deep-seated segment of oceanic lithosphere (that is, uppermost mantle) prior to its tectonic uplift. Its emplacement into the upper continental crust was likely due to later transpressive plate motions.

Back in the United States, Bob emerged as an international authority on ophiolites and the tectonic evolution of segments of oceanic lithosphere now sequestered along continental margins. He organized and led a famous 1972 Penrose Field Conference on the topic. The conference attendees came to agree on a subsequently widely recognized definition of what was thought to comprise an undisturbed, intact section of the oceanic crust and uppermost mantle. Most ophiolite field occurrences, in fact, lack parts of the idealized section, having been severely disrupted by the obduction (that is, overthrusting) process. However, this memorable conference illuminated the critical plate-tectonic significance of ophiolite complexes globally (Fig. 2).

Fig. 2. Bob Coleman pointing to outcrops of the Jurassic Coast Range Ophiolite at Cuesta Ridge, north of San Luis Obispo, summer 2003. (Photo courtesy of Clifford A. Hopson.)

Bob's New Zealand and southwestern Pacific work sharpened his interest in the extant oceanic lithosphere, and resulted in his selection as a research member on two major scientific drilling cruises: the 1972 Red Sea Leg of the *U.S.S. Glomar Challenger* and the 1976 *USSR Dimitri Mendeleev* West Pacific Cruise. These shipboard studies of present-day oceanic crust segued in 1973 to an interdisciplinary research project of the Semail Ophiolite nappe, spectacularly exposed in the desert of Oman. Bob pursued this major project over five years with extramural colleagues Cliff Hopson, Françoise Boudier, and Bob Gregory. They documented the ultramafic-mafic nature of a segment of oceanic lithosphere that had been thrust onto the Arabian Peninsula attending Late Cretaceous sea-floor spreading followed by convergent plate motion in the Persian Gulf.

Fig. 3. Bob Coleman with alpinist, Prof. Peter Bearth at Zermatt, Switzerland, July 1971. Bearth was the first to recognize and describe eclogitized pillow basalts in the Western Alps. (Photo by the author.)

While continuing these diverse research projects on convergent plate junctions in both Circumpacific and Alpine-Tethyan realms (for example, Fig.3), in 1979 Bob initiated yet another major research thrust, in the central Klamath Mountains of northwest California and southwest Oregon. With USGS colleague Mary Donato and extramural workers from Stanford and UCLA, the group studied the upper Paleozoic and lower to mid-Mesozoic oceanic sedimentary strata, as well as interstratified ocean-floor volcanogenic units that underlie the Klamath Province. Similar to the Franciscan Complex, the Klamath lithologic section comprises a series of imbricate, east-dipping accretionary tectonic sheets. The map units mark the western, oceanic edge of the North American continent juxtaposed against an outboard paleopacific oceanic crust. Geochronologic, stable isotopic, and bulk-rock petrologic-geochemical data support the interpretation that the Klamath accretionary complex represents an oceanward, northwest salient of the coeval Sierra Nevada volcanic-plutonic arc.

Then in 1981, with Steve Graham, J. G. Liou, Edmund Chang, Ruth Zhang, and Xiaomin Wang, Bob pioneered a decade of new collaborative research efforts in northeast, central, and northwest China and Mongolia (Fig. 4). This Stanford group began reconnaissance—then detailed—projects that documented the existence of both relatively young (Jurassic-Cretaceous) and old (Neoproterozoic) continental crustal rocks. The continental terranes evidently had been subducted, recrystallized under relatively high-pressure/low-temperature conditions, and then exhumed. The group's discovery proved that active convergent plate tectonic processes were responsible for the accretionary assembly of the SinoKorean continental crust.

Fig. 4. Hands on Bubba! He sits surrounded by Stanford and Chinese colleagues in Beijing, summer 1987. (Photo courtesy of Stephan A. Graham.)

Bob began still another collaborative petrotectonic research project in 1993, this time in central Asia (specifically, northern Kazakhstan and the south Ural Mountains), with colleagues from Stanford and the Russian earth scientists Nick Sobolev, Nick Dobretsov and Vlad Shatsky. The central Asian compressional suture zones were the sites of subduction of continental crust-capped plates that had evidently descended to depths of 100-125 km before buoyantly returning to the upper crust. The presence of rare, newly crystallized microdiamond and coesite (a dense form of SiO_2)—both ultrahigh-pressure phases—encased in dense, refractory host minerals constitutes clear mineralogic evidence requiring recrystallization of the continental crust at profound subduction depths.

In 1999, with Stanford University associates, Bob began studying the biospheric nature of serpentinite-bearing upper crustal terranes. These pathfinding interdisciplinary investigations included describing the geobotanical development of depauperated flora as a consequence of the pronounced lack of important chemical nutrients in Mg-rich serpentine mineral-containing soils. In another investigation, a toxic hazard recognized as associated with such soils uncovered the possibility of human bio-assimilation of Cr^{+6} derived from serpentine-bearing near-surface environments.

With Tatsuki Tsujimori and J. G. Liou, Bob conducted yet other investigations into the genesis of serpentinites and genetically associated metasomatic rocks, especially jadeitite, in New Idria, Guatemala, and Cuba. These reconnaissance studies focused on the mineralogic, geochemical, and structural histories of such hydrated ultramafic bodies as they evidently ascended from shallow mantle depths into the upper continental crust.

Somewhat poetically, in a new collaborative work with Steve Graham and Bob Gregory, Bob recently returned to his early, pioneering Ph.D. study of the New Idria serpentinite massif. This nearly completed manuscript chronicles the ascent and exhumation of the ultramafic diapir, and its erosional supply of detritus to the adjacent San Joaquin Valley. Sadly, Bob did not live to see this work completed.

Petrologist at Large

Earth scientists investigate parts of the home planet at a range of scales from less than an Å (that is., 0.1 nanometer) to Earth tracts extending over 10,000 km, and from the fluid envelopes of the encircling oceans and atmosphere to the solid Fe-Ni planetary inner core. Geologists measure terrestrial samples in their analytical and experimental laboratories, and in some cases, travel to the ends of the Earth to study special, even one-of-a-kind, rocky sections of the crust and uppermost mantle.

Bob, however, was far more peripatetic than most Earth scientists. In introducing him for a lecture at UCLA, Stanford, or a national/international geoscience meeting, I occasionally joked that NASA was tasked to investigate and quantify the nature of the Solar System, if not the entire Universe—whereas Bob got the Earth. The geographic regions he dealt with in some of his many technical publications touched scores of locations around the world.

In addition, Bob's field trips linked to numerous international meetings provided enrichments in his cultural breadth of knowledge beyond the pure science. As an example, attending a Pacific Science Congress held in Tokyo in 1966, he and I later journeyed to the southwestern Japanese island of Shikoku with colleagues Yotaro Seki and Yosuke Kawachi. We investigated the high-pressure/low-temperature metamorphosed lithologic section of a Jurassic-Cretaceous accretionary prism cropping out in the central part of the island. The geologic section sits astride the profound junction between a continental margin igneous arc on the north and an outboard, subducting paleopacific oceanic plate on the south. The trip was highly informative, but Bob was equally impressed with the scenic natural beauty of Shikoku and by the indigenous graphic art and sculpture so attuned to nature and deeply ingrained in the Japanese culture. I noted that, returning home, Bob became visibly immersed in graphic art projects and in artistic wood-working.

In another example, in 1983 my wife, Charlotte, and I met Bob and Cathryn in Rome, rented a car, and drove through Umbria and Tuscany exploring regions famous for their weaving. Cathryn was an accomplished weaver. And, having spent our previous year in New Zealand, my wife had learned spinning and weaving. Because of the firm guidance provided by our wives, we spent most of our time visiting the picturesque hilltop fortified towns—even more famous for their world-class culinary and graphic arts. We then drove on to attend the International Ophiolite Conference held in Firenze, the revered Renaissance capital of Europe. Our experiences in northern Italy provided a valuable education for two geoscientists whose eyes had customarily been fixated too closely on the ground.

Bob and I had equally memorable experiences while camped in NW Kazakhstan and in the South Ural Mountains with Russian colleagues. An enthusiastic and practical can-do camper, he left his indelible mark on them as well as on many other Earth scientists at geologic locations in other far-flung parts of the globe, *e.g.*, Oman, Mongolia, Cuba, and western China. Bob was a unifying, collaborative force wherever he went—practical, energetic, flexible, and adventuresome—everything a field-based geoscientist should be.

The Man

A hard-charging geologic mapper and indefatigable mineralogist-petrologist-geochemist, Bob seamlessly combined his studies documenting natural occurrences of rock complexes with an analytical data stream based on the principles of solid-state physics and major-element chemistry. In addition, he was a capable geobotanist. But what set Bob apart from most Earth scientists—and scholars in general— was his willingness, even eagerness, to discuss and test alternative hypotheses and outside-the-box conjectures of other workers with both critical enthusiasm and an open mind. He was especially generous with his time and data-based experience and scientific judgment. Like most other colleagues, I have had many “tests of concept” (*i.e.*, arguments) with Bob over our conflicting geologic interpretations, but he never ever took offense—a reaction all too common among we so-called objective, dispassionate scientists (Fig. 5).

Fig. 5. "Bubba's Club House—the House that Cathryn Built"—where socializing and intellectual discourse were the norm among the Colemans and friends, colleagues, and students. This November 2018 photo shows Bob holding forth at the kitchen table, a pile of manuscripts on his left, and beer bottles scattered about. Bob is intensely looking into the camera, eager to talk geology, not politics. Across from him sits the antagonist (*i.e.*, the writer) wearing aviator glasses and baseball cap, and on either side the younger students (*i.e.*, colleagues) J. G Liou and Dennis K. Bird. (Photo courtesy of Dennis K. Bird.)

He was supremely practical, perhaps as a reflection of his diversified work experience growing up in farming communities, and then serving in the U.S. Marine Corps. Bob organized our tasks and duties in remote hinterlands, as well as on oceanographic cruises where technicians were supposed to relieve the scientific crew from essential donkeywork. He made sure that the research projects were done properly—and led by personal example. If my Jeep were to breakdown far removed from civilization, I would want Bob as companion and take-charge boss.

Epilogue

It was in geologic field areas where "the rubber meets the road" that Bob's former students, national/international colleagues, and the many recipients of his unhesitatingly generous help cherish their memories of him. He was first and foremost a geologic explorer, working at the frontiers of what was then known about the origin and development of continental margin arcs and the adjacent oceanic lithosphere. He was equally effective as an approachable yet charismatic teacher of the home planet's petrologic evolution—formally with students, and informally as a research leader and role model. Earth science historians will recognize Coleman as a major contributor to the elucidation of the quantitative petrochemical and plate-tectonic evolution of oceanic lithosphere (*i.e.*, ophiolites) and of convergent margin subduction-zone blueschist-eclogite genesis. Those of us lucky enough to have been influenced by this remarkable gentleman and insightful Earth scientist are grateful for his friendship. We thank him for his unstinting, altruistic feedback and scholarly support, and we deeply mourn his passing. Robert G. Coleman will always be remembered by family and colleagues as an especially friendly, generous person, a remarkably versatile, accomplished Earth scientist, and a warm human being.

Bob received abundant global recognition during his long and enormously productive research life, but election to the U. S National Academy of Sciences (1980), and the Russian Academy of Sciences (1994) are unequivocal indications of his intellectual impact on the global geosciences. He was also honored by election to Fellowship in the Geological Society of America (1960), the Mineralogical Society of America (1960), the American Geophysical Union (1986), and the American Association for the Advancement of Science (1993). In addition, Bob received a Fairchild Distinguished Scholarship from the California Institute of Technology in 1981. In 2016, he was awarded Stanford's School of Earth, Energy and Environmental Science's Distinguished Alumni Award. In terms of service, Bob was a member of numerous committees of the U. S. National Academy of Sciences, as well as the International Deep-Sea Drilling Project and its successor organizations.

Attended by his son Griff, daughter in-law Jane Beule, and grandson Daryl, Bob Coleman died peacefully after a brief illness requiring an emergency trip to Stanford Hospital. He was 97, and was cheerfully, defiantly looking forward to reaching the century mark. Cathryn, his beloved wife of 53 years, had preceded him in death, but he lived on independently for 18 more years. He was actively working on a major geologic research paper at the time of his death.

I thank Bob's sons, Mark, Dirk, and Griff, for providing helpful information about their father. Due to the currently active Coronavirus Pandemic, an informal, digital memorial celebration of their father's life was hosted by Mark. It took place on November 10, 2020 and was attended remotely by 72 colleagues, friends, and family. This remarkable outpouring provides an imperfect measure of how broadly Bob influenced the lives of many people worldwide. Their uniformly warm, gracious testimonials were utilized in this biographical summary. Bob's personal as well as scientific interactions are deeply cherished by several generations of colleagues and friends, and he is poignantly missed by all of us.

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