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ROBERT PHILLIP SHARP
1911–2004

A Biographical Memoir by
CLARENCE R. ALLEN

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BY CLARENCE R. ALLEN

One of the leading figures of American geology, Robert P. Sharp, died peacefully at age 92 in his home at Santa Barbara, California, on May 25, 2004. Sharp's multitude of contributions on the physical processes that have modified the surface of Earth, as well as Mars, are true scientific classics. They have substantially enhanced our understanding of the unique roles of water, wind, and ice in modifying planetary surfaces. Virtually an equal contribution was Sharp's leadership and vision in geological academia and his spawning of a generation of students who have become scientific leaders themselves.

I first met Bob when I was a graduate student at Caltech in the late 1940s. Although I was not under his direct supervision, he recruited me as a geophysicist into several of his glaciological field teams in Alaska, Canada, and elsewhere. We subsequently became fellow faculty members at Caltech, and I coauthored a number of papers with him. Most importantly, however, we became close friends as fly-fishing and backpacking partners, especially on numerous trips to California's Sierra Nevada and the Yellowstone region—endeavors that continued well into retirement for both of us.

Sharp was born in Oxnard, California, and spent the greater part of his youth in the local Ventura County area. His grandparents on both sides had been regional pioneers, and the families were mainly involved in agricultural ventures. Sharp grew up closely associated with farm ways and mores, and throughout his life he invariably arose in the morning at the first inkling of light in the eastern sky. It was in his youth that he developed the highly disciplined ways that were such hallmarks in his subsequent professional career and personal life.

Sharp's primary and secondary schooling were not remarkable, but two of his youthful activities were especially important to him. First were the many camping and fishing trips he took with his father, grandfather, and uncles, particularly to the Owens Valley and Mono Basin of eastern California—both areas to which he returned numerous times in his subsequent studies. Sharp's paternal grandfather was particularly influential in honing Sharp's skills in trout fishing, an activity that Bob pursued avidly throughout his life. A second activity that, in Bob's words, "had considerable influence on me," was the Boy Scouts, which again had a very strong outdoor flavor. Much later in life, in 1978, he was honored with the Distinguished Eagle Scout Award by the national Boy Scout organization.

Exactly why Sharp chose to attend the California Institute of Technology as an undergraduate is not clear. Neither of his parents had even graduated from high school, but Bob was obviously ambitious, curious, and talented. One of his close high-school friends was somewhat of a "boy-wonder scientist" and was so determined to go to Caltech that Bob also applied to Caltech, perhaps simply out of competitive spirit. His friend later washed out, but Bob not only survived the very difficult freshman year but also gradually gained confidence and blossomed. He started out in engineering,

switched to chemistry, and then to geology after taking an inspiring introductory course from Caltech's John Buwalda—a course in which he first began to understand the intriguing rocks and land forms that he had tramped over on his earlier fishing and camping trips. Bob later said that "discovery of the subject of geology was one of the great good fortunes of my life." He was particularly intrigued by the fact that one might make a living doing something that was so much fun.

Sharp had participated in football, basketball, and track in high school but had not been an outstanding athlete. In college, however, he participated more avidly, primarily in football and track, and it was clearly an important character-building experience for him. In his senior year he was quarterback of the Caltech football team, which was surprisingly good in its league and even played UCLA in the Coliseum. Much later Sharp was named by *Sports Illustrated* as one of 25 former gridiron stars who had gone on to very significant careers.

Sharp went on to pursue doctoral work at Harvard, primarily at the urging of one of his highly respected Caltech mentors, Ian Campbell. After the intensely regimented academic program at Caltech, Bob found the Harvard atmosphere more relaxing, and he obviously enjoyed the opportunity to delve into a wider variety of subjects and activities. Among other things he took up sculling on the Charles River.

Sharp essentially chose his own Ph.D. thesis project and then persuaded the noted Harvard geomorphologist, Kirk Bryan, to supervise it. A new topographic map had just been issued of the Ruby-East Humboldt Range area of northeastern Nevada, and with this as a base for field mapping, Sharp saw the opportunity to contribute to the understanding of basin and range structure, which was then—and still is to this day—somewhat of an enigma. What is it that controls the

remarkably uniform and repetitive series of north-trending, equally spaced mountain ranges of the geologic province that extends from southern Oregon south through Nevada, and into eastern California and western Arizona? Sharp first recognized and documented the episodic, asymmetric uplift of the Ruby-East Humboldt Range, which began about 5 million years ago, and he emphasized that the rocks of the range interior had been highly deformed and modified in a much earlier history of regional mountain building than that which controlled the range-bounding faults that define the mountains today—something that has now been shown for many ranges of the Great Basin. He also found that the summit areas of the range had been extensively glaciated during the worldwide Pleistocene glacial period, and his studies of the landforms associated with that glaciation sparked an interest in glaciers and glaciation that persisted throughout his subsequent career. Seven major publications arose from Sharp's thesis work, at least two of which are now recognized as true classics.

Bob worked alone and enjoyed occasional days off fishing in the lakes and streams of the remote high country. He later warned me that one must not mix fishing and geology: "You cannot go into the field dreaming that at 5:00 p.m. you will lay down your geologic hammer and pick up your fly rod." A productive day must be fully devoted to one or the other.

Between the two long summers that Bob worked in Nevada, he received an invitation from his former Caltech mentor, Ian Campbell, to participate in a two-month geologic expedition boating down the Grand Canyon from Lees Ferry to what is now Lake Mead. The expedition was to be sponsored jointly by Caltech and the Carnegie Institution of Washington. The inner gorge of the Grand Canyon was at that time essentially *terra incognita* in terms of its geology,

and Sharp eagerly jumped at the chance to help unravel its mysteries. He was worried that Harvard might cut off his student stipend during the interval, but Harvard not only allowed him to take leave from his thesis activities but also gave him a "traveling fellowship" as well. Three senior geologists led the 1937 trip: Ian Campbell, John Maxson, and J. T. Stark. Later, E. D. McKee joined the group at the foot of the Bass Trail. The only other participants, in addition to Sharp, were three boatmen. Sharp was very much the junior geologist of the group, and he later described his role as that of "the gun bearer, so to speak."

The specific geologic studies to be carried out by senior members of the group had been parceled out rigidly, and Sharp found himself searching for an activity that did not "step on toes." Early on, as they approached the inner gorge of the Grand Canyon he became intrigued by the two profound geologic discontinuities separating the three major rock groups of the canyon. The oldest rocks in the deepest part of the gorge (now known to be some 2 billion years old) were made up of crystalline units typified by the Vishnu schist. These had been uplifted and then truncated by regional erosion prior to deposition of overlying sedimentary rocks of Algonkian age (about 1 billion years)—a regional discontinuity termed by geologists a "unconformity." It represented a period of elapsed time between the erosion of the older deformed rocks and deposition of the younger overlying rocks, in this case about a billion years. Both of these older rock units had still later been tilted, uplifted, and then once again eroded in a second regional unconformity, prior to the laying down of the great layer-cake series of near horizontal, varicolored sedimentary rocks that are the most striking feature of the upper two-thirds of the Grand Canyon that is seen by visitors today.

The winding path of the Colorado River and its many tributaries made for superb three-dimensional exposures of these two profound semihorizontal unconformities, and whenever the group paused, Sharp took to observing and documenting them by ascending the tributary canyons of the gorge, where possible. One of the senior geologists commented that Bob climbed "so fiercely" that he wore out the soles of his boots. He often found himself a thousand feet or more above the river when the group was ready to shove off again, but he appreciated the patience of Ian Campbell and the others in putting up with his ventures. His objective was to understand better the fundamental erosional and depositional processes, as revealed by the truly unique exposures of the ancient eroded surfaces and the younger overlapping sediments. Bob's subsequent publication on the ep-Archaen and ep-Algonkian erosion surfaces of the Grand Canyon is another true geologic classic. Most geologists today would probably agree that it is by all odds the most significant geologic contribution to come from the entire expedition, albeit by the very junior "gun bearer" member of the group.

Shortly before Bob left Harvard, and through the auspices of a former Caltech classmate Richard Jahns, he met Jean Todd, who was pursuing graduate work in geology at Radcliffe College. Bob and Jean hit it off, and they were married in 1938.

Jobs were scarce when Sharp obtained his doctorate, and he felt lucky to land an academic position at the University of Illinois (at $1,800 per annum), where he served until called into the army in 1943. Probably because of recommendations by his former Harvard professors, he was recruited in 1941 to participate in an expedition along the Alaska-Yukon border by Walter Wood, director of field exploration for the American Geographical Society. Sharp was the only geolo-

gist of the group, which was oriented primarily toward map making and mountain climbing, but he managed to gather data for several papers on the glacial history and soil development in the remote region on the Canadian side of the St. Elias Range.

With Sharp's extensive wilderness experience it is hardly surprising that World War II found him in the Arctic-Desert-Tropic Information Center of the U.S. Army Air Corps researching and writing survival manuals for downed fliers in the North Pacific-Alaska region. In carrying out these assignments he had some unique experiences. In order to test survival techniques he was at one point put ashore alone—with nothing but a rudimentary survival kit and not even a tent—on uninhabited Agattu Island in the westernmost Aleutian chain. Captain Sharp not only managed to survive well (mainly by primitive fishing and by gathering shellfish), but when the "rescue" boat arrived some time later, he also had with him his field notes on the geology of the island, which were published the following year as the first scientific description of extensive uplifted sedimentary rocks in the Aleutians—previously thought to be almost solely volcanic in makeup.

In another survival episode that was to help shape Sharp's later career, he and Bradford Washburn, a noted Alaska mountaineer, were put down on the north slope of Mt. McKinley in midwinter, together with a hapless young Air Corps pilot who had never before even camped out. Sharp and Washburn's assignment was to observe how the flier reacted to the very harsh environment and to advise the Air Corps on what survival equipment and knowledge should be made available to fliers who might be downed under such circumstances. During the several weeks of snowshoe traverses that it took for the trio to reach the Alaska Railroad, in constantly subzero temperatures, it very quickly became

clear that the only practical answer for a neophyte under such circumstances was to not travel at all. As a young World War II Air Corps flier myself, I can testify that servicemen were subsequently instructed that if downed in inhospitable terrain, they should almost always stay put awaiting rescue and not try to walk out. As a sidelight of this venture Sharp became fascinated with the nature and mechanics of glacier flow, to which he devoted much of his subsequent professional career.

At one point Sharp's army unit had been stationed briefly at the University of Minnesota, and he had come to know a number of the eminent geologists there. Subsequently, and while he was still in the army, he was asked to join the University of Minnesota faculty, which he did upon discharge. By this time Sharp was building up a very notable publication record in a wide variety of geologic endeavors, and after only a couple of enjoyable years at Minnesota, he was avidly recruited by both Stanford and Caltech. Sharp had looked forward to eventually returning to the West, and after prolonged consideration elected to return in 1947 to Caltech, where he spent the remainder of his academic career.

In 1947 the Division of Geological Sciences at Caltech was a good but not a distinguished department. Its notable strengths were in seismology (with Beno Gutenberg, Charles Richter, and Hugo Benioff) and in vertebrate paleontology (with Chester Stock, division chair). Three years following Sharp's arrival Stock died unexpectedly, and the search was on for a new leader. It remains unknown what travails took place during the search, but in 1952 Sharp emerged at age 41 as the new chair, an appointment that was welcomed by the students, of whom I was one, and seemingly by the division faculty, many of whom were senior to Sharp. Thus was to begin a new era of vigorous growth and delving into new areas of earth sciences. That's another story in its own,

to which we shall return after summarizing Sharp's own personal research career.

Taking over as division chair undoubtedly had some dampening effect on Bob's research efforts, but it certainly wasn't obvious. He continued to get some research support from Walter Wood, and in 1951 he embarked on a major drilling program on the Malaspina Glacier in southeastern Alaska, in an attempt to better understand the physics of glacier flow. Up until that time there had been only limited success in determining the velocity gradient with depth in a flowing glacier—with its implication for the flow law of ice. Mechanical drilling is very difficult in a temperate glacier (which is at the pressure-melting point almost throughout), and Sharp designed and built a thermal "hot-point" system that succeeded—with innumerable travails—in implanting a hollow aluminum pipe to a depth of 305 meters into the glacier, which was about half of the total ice thickness at that point, which I determined with seismic charges. The subsequent incremental deformation of the pipe was measured with a photographic inclinometer on four subsequent occasions, over a period of several years. These revisits were significant backpacking ventures in themselves.

Partly because of the logistical difficulties of carrying out a complicated drilling program on the Malaspina Glacier—hundreds of miles from the nearest hardware store—Sharp chose in 1957 to initiate a somewhat similar but expanded effort on the Blue Glacier on the slopes of Mt. Olympus in Washington state. Here supplies could be flown in from nearby Port Angeles by a short ski-plane hop. He assembled a crew of colleagues and students who worked for a number of subsequent years on a variety of glaciological efforts aimed at better understanding the mechanism of glacier flow, such as the intriguing question of what proportion of the observed surface flow results from internal ice deformation as opposed

to basal sliding. Among the participants (the Blue Glacier gang), many of whom went on to careers in glaciology and related fields, were Carl Benson, Noel Hinners, Barclay Kamb, Mark Meier, James Savage, Ronald Shreve, myself, and, of course, Bob Sharp.

In a move that turned out to have dramatic scientific payoff Sharp convinced Samuel Epstein, one of Caltech's recently arrived geochemists from the University of Chicago, to participate in the glacier studies. Epstein had been developing laboratory techniques for using the ratio of stable isotopes ^{18}O and ^{16}O in understanding geological processes, and the hope was that similar studies might reveal something about the history of the old ice within a glacier, such as the temperature and atmospheric conditions under which the original snow had been deposited in the icefield. The sampling and laboratory techniques developed by Epstein and Sharp were tested successfully on the Blue Glacier, as well as on the Malaspina Glacier in Alaska and the Saskatchewan Glacier in Alberta. But most importantly, this led directly to their later pioneering studies in Antarctica, where a vastly longer time column of ice layers could be obtained from deep cores. Such studies today, based in part on Epstein and Sharp's pioneering work, are a primary window into climatic changes over the past hundreds of thousands of years and are immediately relevant to the problem of global warming.

One of the other surface geological processes that Sharp puzzled over was the importance of wind. Is it a significant geological agent, and how could its role be understood and quantified? To throw light on these problems Sharp designed and set up novel observation and sampling stations at several sites in sand dune areas of California's Coachella and Imperial valleys, as well as in the Kelso dunes of the eastern Mojave Desert. These studies served to shed considerable light on

the way sand moves and how sand ripples are formed and change.

Of all the wind-related enigmas that fascinated Sharp none was more frustrating and long-lived as that of the origin of the sliding stones of Racetrack Playa, near Death Valley. Here scattered boulders resting on the playa surface—derived from the adjacent steep mountain slopes and weighing up to 35 kg—had clearly skidded across the playa surface on seemingly chaotic paths and had left distinct grooves as trails on the clay surface. High winds in association with icy winter conditions on the high-altitude playa had long been suspected of being a key factor, but no one had ever demonstrated this. Sharp visited the remote locality 16 times during a seven-year investigative period, carefully mapping the tracks of 30 individual boulders. During this period, all but two of the boulders moved several meters in three discrete sliding episodes. Neither Sharp nor anyone else to this day has recorded ever seeing the skidding in actual action, but he reasoned, mainly from the geometry of the trails and the nature of the skid marks, that very high winds together with a thoroughly wetted playa surface were necessary conditions. Physicists recruited by Sharp confirmed that high-wind stresses within the thin boundary layer might indeed be adequate to start the stones to move, and once the static friction was broken, they would essentially "sail." Although some of the tracks suggested that individual stones may have been locked together within large wind-driven ice sheets, Sharp demonstrated that the presence of ice was not a necessary prerequisite. He readily admitted that the phenomenon "was hardly a matter of great scientific import," but it was certainly an intriguing and provocative one—and one that garnered a fair amount of public interest.

In about 1961 another important chapter in Sharp's scientific career began with attempts to understand geologic

surface processes on planet Mars. Caltech physicist Robert Leighton had been asked by NASA's Jet Propulsion Laboratory, operated by Caltech, to submit a proposal for TV imaging on Mars. Leighton was designing the imaging instruments themselves but turned to Bob Sharp to lead in the image interpretation. Bob in turn recruited Bruce Murray, his colleague in the division, and the trio made up the TV investigative team. The first fly-by mission, *Mariner 4*, revealed much about the cratering history of the planet, but later missions, particularly the *Mariner 9* orbiter, clearly portrayed the spectacular canyons of the Martian surface, which came to be the subject of much debate. Sharp and his colleagues were, of course, not the first to suggest that fluid action—probably by water—must have played the major role in developing many of these channel-like features. However, the trio together with Murray's student Michael Malin systematically garnered and put forth the evidence in a series of landmark papers that depended heavily on comparisons with planet Earth. For example, significant terrestrial analogs—very familiar to Sharp—were the gigantic geomorphic features in central and eastern Washington state carved by and deposited by the massive Pleistocene "Spokane floods," which were in turn caused by rupturing of ice dams in the upper Columbia River. The team argued that the origin of the water on Mars had been primarily lithospheric and not atmospheric, particularly as indicated by the evidence for groundwater sapping associated with headward growth of many of the canyons. These interpretations have been largely verified by subsequent Mars missions.

Sharp participated in the Mars program at JPL for more than 10 years. He later stated that no activity of his career involved a more demanding and exhausting effort, and anyone associated with the Mars program will testify to Sharp's very major leadership role in it during this period.

Now let us return to Bob Sharp's other major area of contribution—that of leading Caltech's Division of Geological Sciences upon becoming chair in 1952. The immediate question, in light of Chester Stock's death, was what to do about the vertebrate paleontology program, and the extensive vertebrate fossil collection. Over a period of seven years the division grappled with this issue, but it gradually became clear that other emerging areas of earth sciences simply appeared more exciting and, especially, were more appropriate for Caltech. For example, the geologists then had very good rapport with the Caltech chemists and physicists, but only very limited mutual interests with the biologists, who might otherwise have been logical cosponsors in a continuing vertebrate paleontology program. In the end it was decided instead to put a major effort into the emerging area of geochemistry, and in fact the proceeds from sale of the valuable vertebrate fossil collection went to building one of the first geochemistry laboratories.

The new emphasis on geochemistry was a major shift in the division's direction, and although clearly led by Bob Sharp, it was a divisionwide decision that the great bulk of the faculty supported. It was not, however, looked upon so favorably by many classical geological colleagues around the country (including a number of division alumni), who literally accused Caltech of "selling out" geology to the geochemists. Sharp pleaded for patience, however, and in retrospect most members of the earth scientist community today agree that the somewhat gut-wrenching decision was an innovative, forward-looking, and daring move on Caltech's part.

In setting up the new geochemistry program Sharp turned for advice to Caltech chemist Linus Pauling, who suggested that we recruit Harrison Brown from Chicago to spearhead the effort. This was successful, and Brown then convinced Samuel Epstein and Claire Patterson, both also then at

Chicago, to join him in Pasadena. Sharp later commented that Harrison Brown "had a half-life of only about 5 years" on any given endeavor, which turned out to be true, but Brown nevertheless was a major factor in getting the new program successfully underway, and Sharp was grateful. Soon thereafter Gerry Wasserburg, again from Chicago, was also added to the new group.

Sharp's hope, and that of the division, was that the new geochemists would interact with the more classical geologists in attacking earth science problems with new and imaginative tools, and this turned out to be exactly what happened. As described above, Bob himself teamed up with Sam Epstein to carry out pioneering geochemical studies relevant to paleoclimates. Several of the classically trained geologists of the faculty turned much of their attention to problems where geochemistry might provide new insights. Notable among these were Heinz Lowenstam, Hugh Taylor, and Leon Silver.

With the maturation of the geochemistry program the division again looked for promising areas into which to move, and Frank Press, who was then director of the division's eminent Seismological Laboratory, urged that ocean-floor geophysics be the next target. Everyone agreed that this was indeed an exciting field, particularly with the plate tectonics revolution then underway. But the division decided that a small, inland school like Caltech was simply not the appropriate place to start a major new oceanography effort. Sharp argued that "owning a ship is like marrying a harem; you've got problems."

Again under Sharp's leadership and after prolonged discussion the division instead embarked on a new program in the field of planetary science. The presence in Pasadena of the Jet Propulsion Laboratory was a strong argument in favor of this move, and Sharp even received the blessing

of the Caltech astronomers, who were deeply engrossed in far-out space and were quite willing to give away the solar system to the geologists. Like the geochemistry development, this turned out to be a forward-looking move and had an invigorating effect on the rest of the faculty. Bruce Murray, for example, although trained as a classical geologist, turned his attention to planetary science endeavors and subsequently spent six years as the JPL director. Once again Bob Sharp was among those who took advantage of the new horizons to delve into the origin of the surface features of Mars. And a surprisingly high proportion of the current scientific leaders in the nation's space exploration program are graduates of what is now termed the Division of Geological and Planetary Sciences.

Although Sharp sought and received the faculty's support in all of his major moves, he can take the great bulk of the credit for leading the division to its current distinguished status—through his truly remarkable vision, unselfishness, and leadership skills. Throughout his 16-year tenure as chair of the division Sharp maintained a full graduate and undergraduate teaching load—even into "retirement." In addition, his teaching was legendary, particularly his introductory geology course for first- and second-year students. Upon nomination by a group of undergraduates, he was named in 1950 by *Life* magazine as one of the top 10 U.S. college teachers of the year.

Sharp was particularly concerned about the young faculty of the division. His files reveal that virtually every year—almost as a ritual—he wrote to Caltech's president complaining that the salary increase awarded to him should have instead gone to the young faculty. Typical is his letter of March 3, 1974, to Harold Brown, president at the time. "Here is my annual letter of protest regarding your note of Feb. 28th reporting a salary increase…Caltech can and should use its meager

resources for salary adjustments on younger people. They are the future, not us old codgers."

If there was one activity that Sharp enjoyed above all, it was the planning and leading of geological field trips for students, alumni, and others. Bob had a knack for planning such trips so that they ran like clockwork and yet were relatively informal and relaxed. His ability to enthrall participants with his vivid explanations is renowned. Perhaps most notable among these trips, albeit somewhat unique, were three Grand Canyon boat trips organized by the division as part of a major fund-raising effort—eventually culminating (much to Bob's embarrassment) in the establishment of the endowed Robert P. Sharp Professorship at Caltech. A number of eminent Caltech trustees and their families participated in these trips, which were roughly patterned after Bob's pioneering trip down the Grand Canyon in 1937, and other Caltech leaders included professors with special interests in the canyon—Barclay Kamb, Gene Shoemaker, and Leon Silver. It was indeed a remarkable bargain to be escorted down the river by these leading scientists, although the "fee"—in reality a donation to Caltech—was $50,000 per individual or $75,000 per couple.

Another related tradition founded by Sharp was the annual Project Pahoehoe field trip to Hawaii for division students nearing graduation, graduate or undergraduate. Bob went to considerable effort to solicit private funding to endow support for these yearly trips, which are vividly remembered by former students, and they continue today under younger professors. In addition, for many years Sharp led a yearly field trip to the Owens Valley and elsewhere for the division's nonacademic staff members and their families, which are likewise recalled with warmth and nostalgia. His repeated alumni trips to Alaska, Yellowstone, and Iceland are particularly well remembered. As part of his regular teaching

program Sharp ran innumerable field trips—all camping-out affairs—and many students who had little or no background in geology (particularly graduate students in seismology and planetary sciences) signed up for these courses solely for the joy of participating in these field trips, which were often among their most fondly remembered—as well as profoundly educational—experiences at Caltech.

As a natural outgrowth of Bob's love of field trips, in his later years he took to writing geologic field guides for nonscientists. Together with coauthors he researched and published some five volumes on different areas of the American West, some in several editions, and he was in the midst of writing a roadside guide to Idaho at the time of his death. These beautifully illustrated guides had remarkable public as well as scientific reception and have served to make his name known to a wide spectrum of admirers.

Throughout his professional career Sharp tended to shun service on national committees and advisory boards, for which his experience and wisdom were often sought. He declined more than once the presidency of at least one major professional society, and he participated only modestly in activities of the National Academy of Sciences (elected to membership in 1973). Not only did his severe dietary restrictions and rigid habits make out-of-town hotel living unpleasant for him he also strongly felt that he owed his primary obligations to the educational institution he served; he did not want to become unduly distracted—as he felt a number of his colleagues had been. And insofar as I am aware, he only served on one commercial board, that of the family citrus enterprise started by his grandfather, on which he served for many years until his death.

On the other hand, Sharp was certainly not overtly antisocial. In fact, he thoroughly enjoyed leading field trips and participating in team research activities, such as those on the

Malaspina and Blue glaciers. And he had an immensely wide circle of lasting friends, including many eminent Caltech trustees as well as a host of nonacademic employees. He wrote more postcards to personal friends in a single day than most of us do in 10 years.

Despite a career devoted largely to rigorous outdoor activities—many under very trying circumstances—Sharp was plagued with numerous health problems throughout his life. He described himself as being somewhat sickly in his grammar- and high-school days, and he had continuing periodic bronchial problems. A knee injury sustained while playing football as an undergraduate at Caltech came to haunt him in later years. A severe lifelong stomach problem—akin to an ulcer—seemingly led to his exceedingly rigid eating schedule: Dinner was on the table (or off the campfire) *exactly* at 6:00 p.m. even if the hatch was on and the trout were just beginning to rise. His student field trips were renowned for departing on the dot of the hour, even leaving would-be participants standing on the steps. For many of us it was not clear whether the stomach problems were the cause of the extreme self-discipline or vice versa. In any event Bob was never one to complain, and he was very seldom in a dour mood. It was always both a pleasure and a privilege to be in his company.

Numerous national honors were bestowed on Bob Sharp during his career. The two that he prided above all were the Penrose Medal of the Geological Society of America—its highest honor—in 1977, and the National Medal of Science, presented to Sharp by President Bush senior in 1989. In his response to the presentation of the Penrose Medal he commented, "Few scientists in other professional fields seem to enjoy and savor their work as fully as do the earth scientists."

Sharp died from injuries that resulted from a fall in his Santa Barbara home, where he was still actively working on a number of writing projects. He is survived by two children, Kristin and Bruce, and by his caregiver, Silvia Cockrun. His wife Jean preceded him in death in 2000.

It is an intriguing enigma that Bob Sharp, with his profoundly rigid self-discipline and his basically conservative ways, would nevertheless leave a lasting legacy of truly forward-looking innovation in both his scientific and academic ventures, and be remembered so fondly as an immensely warm and generous individual by a multitude of friends from all walks of life.

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