PREFACE

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Jim Moore is singularly equipped from personal experience to tell the story of the pioneering scientists who populate this epochal history. Many of his own field studies, conducted across several decades, retrace and elaborate those of the giants of whom he writes here. By both temperament and accomplishment, he would have found himself particularly welcome around their campfires.

Jim's reserved manner veils a piercing intellect, insatiable curiosity, and great wellsprings of energy. Throughout a diverse career, his knack for discerning details and processes overlooked by others has triggered important new hypotheses. If a maverick nature is indeed—as psychologists hold—the best predictor of achievement in science, then Jim's future was early foretold. As an undergraduate recently trained in rock climbing, he and two colleagues, in the middle of the night, rappelled hundreds of feet down the front face of Stanford University's dominating Hoover Tower and taped five descending 4-foot-long, black footprints to mark a monster's gait: a classic caper now writ large in Stanford lore.

Jim's long and diverse research career has centered on the geology of the southern High Sierra; his work there was begun as a graduate student and then pursued intermittently over three decades. He is recognized as the principal geologic mapmaker of the region, and his reports still shape our understanding of the processes that formed that greatest plutonic rock mass in the United States. A nomination for a scientific medal extolled "Moore's legacy of exquisite published mapping of more than eight fifteen-minute quadrangles [covering about 2,000 square miles] of rugged mountain terrain that stands as the authoritative framework for all related studies of the Sierra Nevada's . . . geochemistry, geochronology, and structure."

But the subject of this book, however broad, concerns only one of the several lives in science that Jim has led—rising to international prominence in each. He knew from childhood camping that he would enjoy a career in field studies. Degrees in geology from Stanford (B.S.), the University of Washington (M.S.), and Johns Hopkins (Ph.D.) prepared him for a lifelong career at the U.S. Geological Survey (USGS), begun in 1956 and interrupted only by stints as a visiting professor at Dartmouth College and later at Stanford.

The architect of several pathbreaking ideas concerning geologic problems of the

seafloor, Jim was the first to organize and execute a program of SCUBA ocean dives to document, with sound motion picture equipment, the formation of pillow lava at the front of an advancing lava flow offshore of Hawaii. Their now classic documentary revealed for the first time how water reacts with molten lava to form the most abundant rock on the planet: pillow basalt. That process had been one of the great enigmas of Earth science.

The advent, in 1964, of Jim's radical theory about the nature and history of giant seafloor landslides ignited a quarter-century of heated conflict before the theory was vindicated. That debate and the ascendance of his theory were recently highlighted in an hour-long, globally televised documentary film titled "The Runaway Mountain" which—much like his submarine lava film—now widely pervades geology curricula.

Jim and his brother George were the first to map sedimentary deposits on the flanks of various oceanic islands and to reinterpret them as the products of giant waves (tsunamis). They thus opened the possibility in 1984—now seen to be very real—that such deposits could be laid down by tsunamis driven by massive submarine landslides. Concomitantly, the landslide-tsunami theory—because it appeared at a critical period in which the "volcanists" and the "meteorite impactors" were arguing the cause of mass extinctions—invited thinking about the role of bolide-impact-engendered tsunami deposits at mass-extinction boundaries, triggering a global search for such evidence.

Jim has also shown how the volcanic islands in Hawaii and Iceland have grown and evolved, and early recognized that the Hawaiian Islands are sinking as a result of the downflexing of the oceanic crust under the load of the great volcanic pile produced by the geologically rapid, relatively recent growth of the islands. That revelation facilitated the reinterpretation of coral-reef structures found far below current sea level. And from studies extending over more than a decade in Iceland and Canada, he documented the dynamic processes of volcanoes that had erupted under glaciers (now long since melted).

In seeking to explain the nature of the volcanic seafloor crust, Jim has made dozens of dives far down into the ocean depths in mobile submersibles. While he was aboard *Alvin* during the FAMOUS (French-American Mid-Ocean Undersea Study) program in July 1974, the vessel alarmingly wedged itself in a crack on the seafloor. Those working frantically on the surface marveled at Jim's nonchalance while trapped at 8,000-foot depth for several hours before *Alvin* broke free.

Jim was drawn to the ongoing activity in 1965 at Taal Volcano, in the Philippines, and documented the spectacular eruptions that led to the recognition of the volcanic

phenomenon defined as "base surge." Among the most devastating of volcanic hazards, base surge entails high-velocity, ground-hugging clouds of hot gases and incandescent ash traveling at upwards of 90 miles per hour that incinerate everything in their path. Understanding their lethal character has figured prominently in the preparation of volcanic-hazard assessments.

He was among the first USGS geologists to arrive at Mt. St. Helens in March 1980 to measure and document the precursory activity culminating in its cataclysmic eruption on 18 May. As a principal investigator on the pre-blast monitoring team, he documented the awesome deformation of the volcanic edifice. Had large areas not been closed to the public by early warnings based on the work of these USGS scientists, more than 5,000 lives would likely have been lost. After the collapse and explosion, Jim continued his study of the dramatic changes the volcano had undergone.

Possessed of three hundred scientific publications, numerous honors, appointments to positions of institutional leadership, and a cadre of acolytes who have since distinguished themselves, Jim retired from the USGS in 1995 at the highest attainable rank for a federal research scientist. But retirement—which he has accepted only in a formal sense—provided him the opportunity to write *Exploring the Highest Sierra*, a sumptuous volume from Stanford University Press in 2000 that quickly became what one reviewer called "a bible" for the region. As a USGS Scientist Emeritus still engaged in a number of projects, he continues to ride submersibles to the deep-sea floor, deliver invited lectures around the world, and collaborate with an international cast of colleagues. Studies that Jim and a co-author excitedly described to me about two years ago have since been published: the discovery and definition of an entirely new class of disk-like volcanoes, 2–3 miles wide, with remarkably flat tops that lie on the flanks of the Hawaiian ridge. Formed, they postulate, by the impoundment of a submarine lava lake within a circular wall of volcanic rock, the perfectly horizontal lava surface established at inception becomes a guide to later tilting of the seafloor.

Jim's fifty-year pattern of cornucopian productivity extends to this book, which treats the endeavors and triumphs of men he has long regarded as among the most significant contributors to modern Earth science. Foremost among them is Clarence King, the first director of the U.S. Geological Survey. Many of King's accomplishments were familiar to Jim early in his USGS career, but later, after he had looked into King's life story in some depth, he came to realize how much of his own experience and work had touched upon that of King. Like King, Jim reconnoitered Yosemite, climbed Lassen Peak and Mount Shasta, hiked the highest Sierra, and ascended the crest of Mount Whitney (at seventeen, with older brother George). Near the summit of Mount Shasta, Jim warmed his hands over the same hot spring that had comforted

King in 1870, and each—almost a century apart—camped high on the same crest. On a winter trip with two companions, Jim traversed the knife-edged south ridge of Mount Clark, near Yosemite, and—with the vision burned in memory—jumped across the treacherous chasm that King and James Gardner had dared on their pioneering ascent of the mountain, in 1866.

During his first summer job, in 1950, as a USGS field assistant, Jim participated in the geologic mapping of the Virginia City area in Nevada, and traversed Gold Hill, where King and Gardner—after having ridden for three hard months across the plains—were burned out of their lodging, in 1863. Enthralled by the giant stone foundations of the Cornish pumps that remain today at Virginia City, Jim consumed the first published volume of King's Fortieth Parallel Survey, *Mineral Industry*. That remarkable treatise graphically details the mining methods at the Comstock Lode, and the awesome steam-driven pumps—each burning 22 cords of firewood a day—that drew water at the mines from depths of greater than 2,000 feet.

Studying the southern High Sierra for his Ph.D. thesis and later for the USGS, he mapped much of the terrain covered by King in 1864 and avidly perused King's *Mountaineering in the Sierra Nevada*, a volume that some held as the cornerstone of a new school of California literature. During work in the Sierra, Jim attained the summits of Mounts Silliman, Brewer, Tyndall, Williamson, Goddard, and Whitney, all of them first discovered, mapped, and named in 1864 by William Brewer's party, of which King and James Gardner were members. Jim also climbed Mount Clarence King and Mount Gardiner, both named by Brewer and Gardner when King made his second attempt to climb Mount Whitney. The conquest of a major peak bonds one, in ways that defy expression, to those who have gone before.

Studying the geology and ore deposits of Lyon, Douglas, and Ormsby counties in western Nevada from 1958 to 1961—a region that partly overlaps the area of King's Fortieth Parallel Survey—Jim traced the intricate shoreline of ancient Lake Lahontan, a feature that King had discovered and named. The daunting aridity of the Basin and Range country sensitized Jim to the struggles of King and Gardner during their first, fever-stricken season of the Fortieth Parallel Survey in the desolate wilderness of the Carson and Humboldt sinks.

Ascending the peak of Shastina, the parasitic cone on the west side of Mount Shasta that overlooks the jagged ice and giant crevasses of the Whitney Glacier on the north side of the main peak, Jim sensed why King so exulted when he first viewed this world of mobile ice in 1870. It was a scene that refuted the geologists who had previously climbed the mountain, missed the glaciers, and proclaimed the absence of glaciers in the United States. And upon reaching the wind-blasted spot on Shastina's

crater rim where King and his party, with primitive equipment, had spent a freezing night above 12,000 feet, Jim poignantly realized the rigors of their trial.

Fifty years with the U.S. Geological Survey have afforded Jim a firm grasp of the workings and history of the organization that seems still to lie in the shadow of its founder. King's polymathic genius and extraordinary accomplishments—particularly the founding and shaping of the most productive Earth science institution in history—moved Jim to write this informative and moving account from an apposite vantage point atop his own distinguished career.