THE ADVENTURE, JOY, AND VALUE OF SCIENCE:

Lessons from a Field Geologist in Antarctica, Mount St. Helens, and the American West

By Peter D. Rowley

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For some of the author's research listings, see Notes.

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DEDICATION

This book is dedicated to all persons who are mentioned here.
This book is their story too!

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PREFACE

Creators of movies and fiction commonly depict scientists as nerdy, shy, skinny, and rather unattractive, glasses-wearing persons. Or as wearing long white lab coats and sitting indoors fiddling with numbers or computers. And if that is not bad enough of a portrayal of individuals who make up most of my friends, the public vision of what they do—namely science—is even worse: something that may be occasionally interesting but is predominantly boring and largely irrelevant to what an average person does.

Not so! For a scientist—and for me as a geologist—almost every day is exciting and fun, with the goal of our daily work being publication or data releases of the results, thus creating new knowledge! Most conclusions, when published or otherwise released, have practical value to the citizen taxpayer, although some value may not become fully evident until years later. For us scientists, an "aha" moment can occur on an ordinary day in the office or lab during the task of compiling data. Or it can occur out in the "field," as it often has done for me. Geologist Chuck Thorman, a friend, describes geology as a great detective story, as one assembles facts on route to reaching conclusions. Or, as to quote the lyrics to one of my favorite songs, "Life's Been Good" by Joe Walsh of the Eagles, "they say I'm crazy," but "I'm just looking for clues at the scene of the crime." Collaboration with others is always a major part of the job, for doing science requires that we necessarily, happily, and unselfishly share data and ask for and value input from others, whether critical ("Are you nuts?") or supportive. I have found that most of the highly productive (in this book I use "productive" for the ability to produce lots of publications or other data releases to the public) scientists have a great sense of humor, which,

as you'll see, shows up as practical jokes on others, laughter over beers together, and an almost universal practice of kidding and "putting-down" our closest colleagues—and they of us.

This memoir records a career that is typical of most in science, a story intended for curious folks of all ages but particularly youth to give them an idea of what to expect if they choose science, and to assure them that such work is worth doing. My career, however, is atypical in that I have been fortunate to experience more adventure than most, in fascinating areas of great beauty, a happy result of luck during a simple attempt to benefit society while pursuing my curiosity. Fortuitously, my story has some important lessons to the non-scientist reader on how science operates, in an era of massive societal transformations (and ignorance) as climate change reaches a critical level and denial abounds. Therefore, this memoir is not only about my scientific career and personal things, but the times in which I lived and their impact on science. In some chapters I make observations on world events and how they influenced others and me. For example, environmental movements surged in the 1970s, then waned, and although now the topic of climate change has become the world's most pressing problem, world leaders are doing little about it and most citizens are too busy to care. In other chapters I write about the Vietnam War, changes in perceptions about science, and of course American politics. Regarding politics, the past eight years (as I wrote this book) have witnessed the greatest collective stupidity in the history of the USA: first it was the election and presidency of Donald Trump and, during and since then, the infantile reactions by citizens to masks and vaccines for COVID-19, to the "Big Lie" that Trump did not lose the election, to the January 6 insurrection and its denial, and to truth in general. During this time, the Republican party has shown a gross contempt for democracy, for facts, and for science.

There is a saying that it is not the things you do but the things you do not do that you later regret. I have been fortunate enough to have acted on my dreams and ambitions, and this book will tell you of most of them, and how they turned out. Action requires making decisions. I made most of these decisions easily. Perhaps at the time my choices seemed natural because of the serendipity of having a choice in the first place. Furthermore, most positions in which I found myself seemed to be the result of strange coincidences. I chose the fork in the road that seemed the most interesting or exciting, or that would teach me something.

Although most decisions in my life were easy, writing this book manuscript was *not*. There always seemed to be something more pressing to be done. What finally got me moving was a June 2018 Nevada Public Radio interview with a Hells Angels biker who had been recently released from twenty years in prison for killing a person or two, whereupon he had written a memoir. I figured that if he could justify a memoir, so could

I. I started typing the next day!

I've mentioned loving science. What made my career more enjoyable was the soundtrack that's accompanied my life, especially that of rock and roll. Many persons throughout time have found experiencing music to be a deep need within them, and they have had their own musical preferences to meet it. My favorite bands are Credence Clearwater Revival/John Fogerty, The Rolling Stones, The Band, and Bob Dylan. Yet other types of great popular music also characterized this period of the 1960s to 1990s. Early country and western music, with Willy Nelson, Waylon Jennings, and Emmylou Harris, was also terrific and crossed into rock-music formats. And I like Bluegrass music, such as that of Bill Monroe, and folk songs by Gordon Lightfoot, Kingston Trio, Nitty Gritty Dirt Band, and Arlo Guthrie, and the gospel/country/rock music of Aretha Franklin, Ray Charles, Mahalia Jackson, and Dolly Parton. The music and lyrics of these and other artists have inspired me, have been an escape from boredom or stress, have provided memories, and have been part of life's fun. Therefore, you'll find woven into most chapters a few words from some of my favorite songs that bear on that chapter. Some songs (e.g., "Wooly Bully" and "The Weight") have mostly nonsensical lyrics but are happy. My life, like that of most scientists, has been satisfying and amusing, and music has been and remains an integral part of it.

The most important aspects of this memoir are truth and accuracy. Most events concerning my personal life are based on memories, yet I found that these are quite accurate, even in remembering names of persons whom I knew for only a month or so. Beyond memories, I rely on letters from people with whom I have stayed in contact, and on fifty years of my Christmas newsletters, some of which I saved. Events in my professional life I recorded and published or wrote down in many dozens of field notebooks (averaging two per year), that include descriptions and conclusions about rock outcrops I visited each field season, plus some personal information. Of my five field seasons in Antarctica, part of a long career with the U.S. Geological Survey (USGS), I also kept journals and wrote lots of letters to my wife and kids, Mom and Dad, and friends, and many letters were saved and returned to me. I also retain the originals of the field notes of all Antarctic participants and copies of all draft geologic maps we compiled (in 2017, I sent copies of all these field notes and maps to the Ohio State University Polar Library and to the British Antarctic Survey). The field notes, journals, and letters contain our geologic observations, with dates and locations. Similarly, events during three years of working at Mount St. Helens were recorded in detailed field notebooks, and the events of the first hundred days of the eruptions are in *USGS Professional Paper 1249*, cited below in the Notes. If my recollections are inaccurate despite all these records, I take full responsibility and apologize for that.

This memoir is written as my way of saying thanks, of repaying a debt, by crediting in detail the many remarkable persons I have met who have not only inspired and mentored me, but whose friendships have kept me going. Some have been my family. Some have been my teachers. Most others have been collaborators on scientific problems. Still others have contributed significantly in various ways to the enjoyment of what I did each day. All have had a major role in instructing me in science and in life. I have stolen many of their stories and adventures, and these purloined tales are also given below. Their stories provide additional examples of how science operates. My references to persons in the text indicate my deep gratitude to each, so those persons are not specifically credited in the acknowledgments. Nonetheless, I have kept in touch with most of them over the years in letters and in annual Christmas cards and newsletters. And those persons who still live when I was writing this memoir knew about it and agreed to contribute to it in this way.

INTRODUCTION

Louis Armstrong's song, "What a Wonderful World", is to me the best and most joyful popular song ever written and sung, and an optimistic way to start the story of a lucky life. That life has been founded on curiosity. Curiosity forms the foundation of science, yet discovery forms the excitement of science. Of the two, the former presumably derives early on from parental influences and, if it survives the hormones of junior high school, it is the main reason a person enters professions in science. Productivity (writing) in science, which commonly follows discovery, similarly requires favorable genetics and early skills, but it is more likely the result of mentoring, training, and good luck. Most personal scientific discoveries are mundane (many scientists are merely figuring out what some in previous generations knew already), but the mental excitement can be profound. Most discovery comes from the always necessary and sometimes enjoyable evaluation of reams of data collected through laborious work conducted in the field, lab, and literature review, and it occasionally results in "aha" moments. A few discoveries, however, are unique and unexpected, a "eureka" moment, although these rarely happen unless considerable background work has already been done.

Science consists of branches of study that apply objective scientific

methods to understanding the physical universe. The key to science is how it is done, namely the scientific method, which is systematic accumulation of data by observation, measurement, and experiment. This results in an hypothesis that is first proposed, then tested, then modified as necessary. Commonly multiple working hypotheses are developed to explain a phenomenon, then whittled down impartially to one or more. Scientists cannot discard data simply because they are troublesome or outliers, so any hypothesis must explain all data. Rising above the level of an hypothesis is a theory, which to a scientist is something that is accepted even though it cannot be proved correct (because science is discovery of data, and new data keep being added, so conclusions are never final, thus proved). And, once an hypothesis or theory is proposed, as Albert Einstein once stated, "no amount of experimentation can ever prove me right; [yet] a simple experiment can prove me wrong." Of course, because no hypothesis can ever be proved correct, scientists can sound as wishy-washy as a group of lawyers, even for concepts as foundational as gravity or evolution, for which nothing has been found in hundreds of years to prove them wrong. Objectivity is critical: first, the objectivity of the scientist herself, then the objectivity of peer reviewers and editors who consider for publication the papers describing the scientist's findings.

In contrast to such objective science is something I call biblical "science," in which the hypotheses are proposed first, perhaps by the Bible, and only then does the "scientist" look at data, specifically trying to prove that each favored hypothesis is true. They do that by accumulating evidence that supports the hypothesis and by rejecting evidence that does not support the hypothesis. In other words, there is no objectivity. Citizen "scientists," some highly educated (though rarely in the topic on which they are speculating), and even trained scientists need considerable self-discipline not to lose their objectivity when proposing an hypothesis. Of course, biblical science is not science; it is a far cry from how Einstein operated! For conclusions of this type coming from the literal interpretation of the Bible, for example, the "evidence" may be passages from the Bible itself because the "scientists" consider those passages to be the word of God and therefore true. Yet we see many more examples of biblical science that are not related to fundamentalist religion. This kind of "science" includes reports of aliens/UFOs/alien abductions, the supposed location of Noah's Ark, crystals, Atlantis, astrology, soothsayers/psychics, a hollow earth, Immanuel Velikovsky's many nitwit ideas, reasons against evolution, opposition to vaccination, homosexuality is a choice, and so forth. Particularly appalling examples include "scientific studies" that purport to show that people of color are mentally inferior to whites, ignoring the fact that all of us are *Homo sapiens* who have cross-bred to varying extents over many tens of thousands of years. Conspiracy theories, so beloved by Republicans, result from this same non-objective thinking. Most ads on TV are at best non-objective and at worst intentionally deceptive, including those that claim that "clinical trials" or "scientific studies" support their product; such studies are in fact typically done by the very company that made the product, thus hardly passing a test of objectivity. The key to avoiding loss of objectivity is to seek out rigorous peer reviews by experts in the field about which one is theorizing.

I attempt in this memoir to put faces (my own and many others') of scientists doing their job in one branch of science—geology—that I witnessed. I want to share with you the joy of doing science, a profession that requires one to think creatively. I want to show you that a career in science is exciting, not only mentally, but also physically through the field work we scientists do. In addition to objective accumulation of data and their interpretation, science requires writing up of results for peer review and publication or for oral presentation, and this step is fun too. Beyond that, no scientist works alone, and collaboration with others adds a much higher level of enjoyment.

Finally, science benefits society. That benefit may not be as immediate as the benefits from professions such as nursing or policing. But even if long in coming, science must result in the accumulation of knowledge that can be turned into a societal benefit at some future time. Moreover, most benefits from scientific professions become evident both practically and, in many cases, relatively quickly, at least in the time it takes for scientific conclusions to be presented or published. For example, scientists and analysts working on the COVID-19 pandemic of 2020–2023 daily provided valuable internet information and press briefings. Scientists such as doctors and nurses (treating patients), statisticians (analyzing tests and tracing cases), and lab technicians (doing testing and exploration) gathered, analyzed, and parsed information to try to find a vaccine or other form of relief; results of those studies were made public daily, changing behaviors and doubtless saving the lives of those who took the time to listen.

Science is one of the few professions in which the object is to think thoughts and have ideas that nobody has ever thought or had before. In whatever discipline or field that a scientist is in, each project is one of exploration. Such exploration does not have to be with a dog sled into unvisited lands. It can be exploration of the gene, where one of the main tools is a microscope. Nor does such exploration necessarily entail something visible, for it can be in the mathematics of a feature, as for example that of an orbit of a planet or of an atom. Or it can entail interpretation of a geophysical pattern regarding what the interior of the crust, mantle, or core of the earth looks like, with the knowledge that you will never see anything about which you are speculating. Regardless of the scientific discipline, a scientist uses whatever has already been discovered as a

stepping stone to discovering something new. Indeed, scientists advance by climbing on the shoulders of predecessors, always acknowledging such previous work. Whatever the discipline, whatever the subject, or whatever the method, in all cases, practicing science is an adventure!

This memoir focuses on my own scientific specialty—that of field geology, which concerns the study of geology in the out-of-doors, where all the rocks and surficial sediments are. Excelling in field geology requires a person who does her best thinking in the field. That person is more often a generalist than a specialist (a generalist knows a little about almost everything, and a specialist knows a lot about almost nothing). Rocks have different lithologies (that is, descriptions, including mineral types, color, degrees of consolidation, etc.), which in college Introductory Geology (Geology 101) are commonly subdivided into sedimentary, igneous, and metamorphic rocks. Unconsolidated young sediments at the surface (surficial deposits) also have different lithologies and origins, such as from recent landslides, stream deposits, and sand dunes. Furthermore, the rocks and young sediments have different ages, depending upon when they were formed or deposited, ranging from yesterday when a flash flood spread new stream gravel, to a lithified sandy beach formed more than a billion years ago (for with time, pore spaces between grains of clay, sand, and pebbles are filled with minerals deposited by groundwater, like the white calcium crusts that accumulate on a faucet or shower head). The relative age of sedimentary rocks, which were originally deposited in horizontal layers, can be determined by stratigraphic position, that is, older rocks are below and relatively and successively younger rocks are progressively in higher up layers. Fossils in these sedimentary rocks provide the start of determining absolute age (in years), for paleontological study of similar or identical fossils allows correlation with sedimentary rocks in other parts of the world that have been dated by isotopic methods. Isotopic dating provides numbers, generally in millions (Ma) or billions (Ga) of years before present, that can be assigned to some rocks by measuring relative amounts of isotopes (an element with the same number of protons in its nucleus but differing from another in its number of neutrons) in minerals in those rocks.

The main thing that a field geologist produces is a geologic map, which shows how various rock types are distributed across a particular area, generally shown by different colors, and the relationship of those rock types to each other and to towns and other cultural or geographic features in the area. Making a map requires two actions—observation and interpretation—and a map contains both. A geologic map shows contacts (boundary lines) between different rock types and sediments. Rocks and sediments may have been deformed by structures such as folds and faults, and the locations of these are also plotted. Putting a map together is known as geologic mapping. Making a map is not a routine or entirely descriptive exercise (although some persons have disparaged it in these ways) but requires interpretation, for contacts and structures may be partly covered by soil and vegetation. Foot traverses of the area make up most of the effort, although one first examines flight lines of vertical aerial photos of a similar scale to the map. Library and lab work follow the field work. Lastly, in addition to the map, a field geologist must include or produce later (generally both) a report that discusses her observations and interpretations.

Maps are made in quadrangles, block by block. A quadrangle is a rectangular map bounded by lines of latitude (parallel east-west lines) and longitude (north-south lines that meet at the poles). These are published in a map series of a prescribed scale. The map scale that one uses depends on the objective of the mapping and determines the amount of effort and time spent. The USGS publishes paper copies belonging to three main series of topographic maps (quadrangles), in which topography is shown by contour lines. The most famous (used by hikers and engineers) and the most detailed scale of published topographic quadrangles by the USGS is at 1:24,000 (1 inch on the map equals 24,000 inches on the ground; or, put another way, 1 inch on the map is almost 0.4 miles on the ground), and the paper map (quadrangle) stands about a foot and a half wide and nearly two feet vertically. The map represents 7.5 minutes of latitude and 7.5 minutes of longitude. It represents an area (in southern Utah, for example) that is about 7 miles east-west and 9.5 miles north-south, about 67 square miles, but because latitude lines converge at the poles, a quadrangle is smaller toward the poles. The Topographic Division of the USGS published 55,000 of these 7.5-minute quadrangles between 1947 and 1992 in the lower 48 states. You may also buy an intermediate-scale topographic quadrangle, at 1:100,000 scale (1 inch on the map is about 1.6 miles on the ground), which covers 30 minutes of latitude and 1 degree (60 minutes) of longitude, and such a quadrangle stands almost 3 feet wide and 2 feet high. This 1-degree quadrangle (or 1-degree sheet) represents an area that is about 55 miles east-west and 35 miles north-south in southern Utah, or about 1900 miles^2. The third map sold, considered to be reconnaissance scale, is a 1:250,000-scale quadrangle (1 inch on the map is a little more than 4 miles on the ground), which covers 1 degree of latitude and 2 degrees of longitude, and it stands about 2.3 feet wide and 1.4 feet high. This 2-degree map represents an area that is about 108 miles east-west and 68 miles north-south in southern Utah, or about 7300 square miles.

Geologic mapping on the three types of quadrangles requires quite different amounts of detail/accuracy such that each type can be published after a reasonable amount of field work (two or three summer field seasons). James Gilluly (1896–1980), an eminent USGS geologist (a member of the National Academy of Sciences, employed by the USGS from 1922

to 1966) that I used to see regularly in the USGS library in Denver after he retired, had a rule of thumb for fieldwork, regardless of scale: he suggested accomplishing about a square inch of geologic mapping per day. Therefore, it was most fun to map a 7.5-minute quadrangle, for it gave you the time to visit most outcrops. And it was least fun to map a 2-degree sheet, where a square inch covered a great deal of land and you did much of the work preparatory to mapping by working on aerial photos in the office before you went to the field, then field checking your office work by driving all the dirt and paved roads in your field vehicle but not being able to spend much time on outcrops except those near the roads; each 7.5-minute quadrangle (of which there are 128) within the 2-degree sheet needed to be done at a rate of almost one per day! That is why it is known as reconnaissance geology. This was our mapping scale in Antarctica, about which more later.

Undertaking field work is of course much more than whacking on rocks. The person who does field geology, being a general geologist, is curious about things besides the rocks and sediments in her field of study. Moreover, knowledge about soil and vegetation commonly allow one to make better interpretations of underlying rocks, and one must also apply knowledge about geophysics and chemistry. And the experience of field work is made better by the beauty and quiet of the hills and mountains traversed, the smell of sagebrush and pinyon, waiting out a cool downpour under a tree or cliff, the wild animals one will see or hear, and many other experiences. Even the screams of peregrine falcons on thermals above, and the howl of coyotes make an all-day traverse entirely worthwhile. For a field geologist, the rocks are the most interesting of these experiences because each outcrop visited provides a new discovery and a piece in a jigsaw puzzle that allows us geologists to project rock distributions and interpret what happened to the rocks. The next outcrop to which one hikes becomes the next piece in the puzzle, and so on. Geology is the perfect profession for the curious!

A person is not doing science unless she releases the data to the public, generally by publishing her findings and interpretations. Publication must reveal everything (tables of supporting data, followed by interpretations) she has discovered, with no withholding of secrets, no company-confidential data, and no leaking of information to a company or person who might profit from a discovery. For example, USGS geologists may discover rich mineral deposits during their mapping and related studies, but they are happy merely to write about them, with no eye to profiting from the discovery. When they publish the discovery, people who read the report first are the ones who stake the claims and who develop the deposit by mining it. Publication of results allows scientists who come later to replicate or advance what the earlier geologist has done. If a geologist merely records stuff or works out problems on their own, with no written record that went through peer review or release in an objective, established journal, we would say that that geologist has a hobby or is a journalist, but she is not doing science.

Although I have published more than two hundred reports, chapters, and small books, almost all my writing has been for peers in my field, using a lingo that my peers will understand but the average citizen likely will not. This memoir, however, has a far more difficult writing task: to communicate my love of science to citizens.

Most scientists are employed by city, county, state, and federal governments. Whether working at a low level or a high level, they gather data, interpret it, and pass on to businesses, peers, and the public any advice that comes out of their findings. Scientists include many teachers in public schools, private colleges, and state universities. In other words, these scientists who assemble and interpret facts are mostly working for the taxpayer; they are public servants. However, significant scientific research is paid for by the private sector, such as pharmaceutical companies that develop drugs, oil companies that find oil and gas, mining companies that exploit mineral resources, etc. None of these are jobs that will allow a person to get rich, but then money rarely motivates scientists: the discovery and the information do. Many members of the taxpaying public—perhaps you too—are unaware that they pay for most science, not only that of public servants but also by the prices they pay for drugs, metallic objects, fuel for their car, etc. Most technologies we now enjoy, such as computers, software, fiber optics, satellite technology, and the internet, were developed during science projects in research and development (R&D) laboratories run by the federal government (see the book *Concrete Economics* by Stephen S. Cohen and J. Bradford DeLong, 2016). So too were vaccines (such as for COVID-19, influenza, and malaria). Such government-paid scientists are almost overwhelmingly competent, dedicated, and hard-working; they are proud of what they do, and they have every reason for this pride. Society could not function without them. Yet many persons today think that government workers are primarily bureaucrats, engaged merely in pushing papers or fomenting regulations, and that therefore they are not important and this type of work force should be shrunk to save money. Republicans have long peddled this tune, and it grew worse under Trump.

In late 2018 and early 2019, Trump ordered a 35-day shutdown of the federal government. Only so-called "essential" federal workers were allowed the privilege of working, but they were not paid until later. The whole fiasco—a political blackmail attempt by Trump against the Democrats—was a huge hardship on millions of people inside and outside the government, all of whom were innocent targets of Trump's wrath! A beautiful article ("Portrait of an inessential government worker") by Michael Lewis in the October 21, 2019 issue of *Bloomberg Opinion Today* (also summarized in Lewis' 2019 edition of his book *The Fifth Risk*) describes one such "nonessential" scientist, an oceanographer named Art Allen, who worked in the Search and Rescue Division (the lone scientist there) of the U.S. Coast Guard, reaching a grade of GS-14 before retiring recently. This person, unassuming and unheralded (except by many in the Coast Guard), whose only career research topic was analyzing winds and currents and their complicated effects on the routes of people and overturned boats in the water in order to rescue them, used his science to save the lives of many persons lost at sea, and he ended up spearheading the development of SAROPS (Search and Rescue Optimal Planning System), a software that analyzes many types of data to find and rescue people in the water. All government employees, including scientists, can and should identify with Art Allen, for he is the model of a public servant but hardly atypical from many I have known, some of whom I describe in what follows.

Ours is a time in which many people disparage science—and indeed truth—perhaps in part because we scientists did not try hard enough to reach members of the public, who after all pay our salaries. Scientists do more than describe things and accumulate facts: they are also responsible for interpreting why and what those facts mean (the fun part of science), based on their experience. Those interpretations may not always be correct (think of how astronomers like Nicolaus Copernicus, Galileo Galilei, and then Stephen Hawking increased understanding of the solar system, but only incrementally, over time, with more discoveries undoubtedly to come in the years ahead), but at least scientists make those interpretations honestly and impartially to explain things using the best evidence available to them. This evidence includes that of previous workers as well as what each scientist discovers on her own, and the conclusions are published to allow the next generation of scientists to come along to accept, modify, or render outdated what each scientist has done. To some non-scientists any criticism may seem to be an onerous price to pay for a scientific career. But for scientists it is not, even if one's conclusions turn out to be dead wrong. Some conclusions/interpretations are weak and may be scientifically controversial, but peer review and new data will eventually sort out the correct interpretation, if not in this generation, then in future ones. The strength of each scientific interpretation is directly proportional to the strength of evidence behind it.

Some important interpretations, including at times those that have become politically controversial, are based on evidence whose strength is huge. These include evolution, human-caused climate change, bad health consequences from smoking, acid rain, the ozone hole, and many others. The "controversy" of these, even though the evidence for them is overwhelming, arises because corrupt—typically meaning profit-driven—companies or politicians argue against them and commonly will pay equally corrupt scientists to side with them. To the non-scientist public, such a “controversy” thus becomes a contest between arguing scientists, even though the corrupt scientists are very much in the minority.

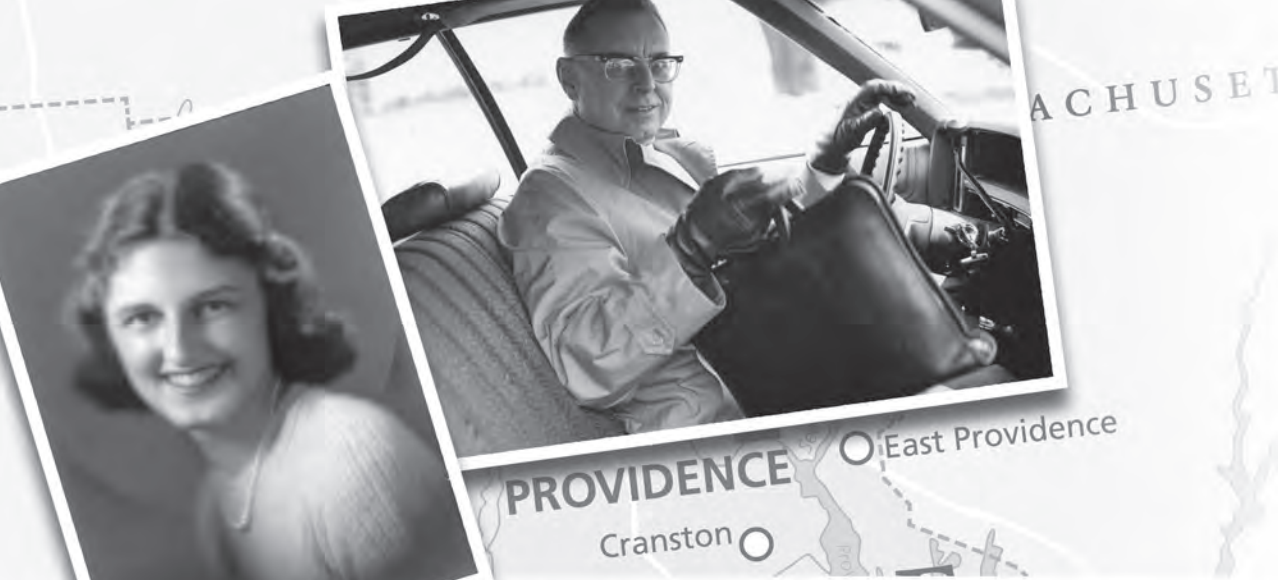
Another aspect of science upon which I will expand below is the practical nature of science. Most non-scientists know in their hearts that scientific discoveries have led to inventions, new drugs, behavior changes, etc., and that these have resulted in benefits to many lives. Geology, the most practical of the sciences, discovers potable and farmland groundwater, oil and other energy resources, metallic and non-metallic minerals, and information with the help of which we can counter natural hazards such as earthquakes, flooding, and landslides. Yet especially since President Reagan, some politicians with axes to grind or profits to make have told their public that all scientists are just a bunch of nerds with thick glasses living on the public’s dime and pursuing curiosity-based research that has no value to anybody, and worse, that many of their data and conclusions are wrong or falsified. These are lies that foster skepticism of science and truth—exactly as such politicians intended.

My story is one of a shy, introverted, yet curious kid who moved through life, seemingly effortlessly in retrospect, by way of lucky adventures that came from doing science out of doors. My talents have been field geology and a love of the outdoors, plus the enjoyment from writing reports and stories about them. Along the way, I have met and made many friends of extraordinary talents and accomplishments, and I tell many of their stories too. The one thing that we all have in common is a love of doing our craft. Certainly, my family had to endure my absence beyond the typical forty-hour work week while I enjoyed doing geology. My passion took place against the backdrop of the times in which we lived and worked, not all of them pleasant. These times included the rise and fall of the USGS, a formerly important federal agency that lost much of its usefulness largely due to its own actions and inactions, including its lack of courage in the face of our national ultra-partisan politics. We also witnessed a rise and fall of science in general. Partisan politics by the Republican political party has worsened, not least through its encouragement of formerly nascent right-wing religions, but also through its condoning if not glorifying the ignorance generally associated with fundamentalist members of these religions. Such ignorance is overwhelming in those who buy into the literal translation of the Bible, Quran, etc., because that buy-in also assumes rejection of data and objective science. Of course, Democrats have been inept in countering the onslaught, perhaps for the reason given by the poet Robert Frost, namely that “a liberal is a man too broadminded to take his own side in a quarrel.”

The Trump administration disparaged science, objectiveness, and the truth in the US, and it hired sycophants who went along with the Trump party line and refused to refute his lies. The people who elected

this emperor, Donald Trump, were blinded to the reality that he wore no clothes, to use the well-known parable. Thus, until the election of Joe Biden as President in November 2020 and the subsequent attempt to return to normalcy, the US slowly slid toward a corrupt autocracy that resembled classic banana republics. Before and since Trump, we also witnessed events of international significance, including increasing political turbulence, migration, diseases, and genocide in response not only to leaps in world population, but also to corrupt countries that survive by exploiting and dividing people, and to climate change. In the absence of global calamities, it might have been possible for an incompetent politician to muddle through a four-year presidency. But the accelerating effects of climate change have highlighted the hazards of electing a politician such as Trump, who preferred to turn back the scientific clock and to reject eleventh-hour realities. And as the year 2020 dawned, we also had COVID-19, an exceptionally contagious virus for which no cure existed (see chapter below).

A lyric in Bob Dylan’s song “Subterranean Homesick Blues” reminds us that “you don’t need a weatherman to know which way the wind blows.” The greatest change in the world is that of climate, and it does not take a scientist to detect climate change. Anyone who goes out of doors and can remember things just a decade ago can see differences in temperatures, storm frequency and strength, and other extremes of weather and the concomitant rise and fall of flora and fauna that, taken together, clearly show that something horrific in the climate, and hence life on our planet, is taking place and accelerating in strength. Because all these things are so interrelated, this book is therefore not only about geology, but about objective observations in climate, life, and the politics of science as well. But it’s also about how geology (and science more broadly) became part of my life, and to that I now turn, beginning with my beginnings—an abbreviated family tree. In the words of Louis Armstrong, let’s see how the red rose bloomed for you and me!



CHAPTER 1

EARLY AWAKENINGS

Peter DeWitt Rowley. The name Rowley came from my father's grandpa, William A. (Armstrong) Rowley (and of course from his forebears), born in Belfast, Northern Ireland. He was a man who "wore orange"—that is, he expressed loyalty to the British crown—and he was an educated son of a well-off family that made textiles, apparently linen. Presumably, the prospect of spending his life producing fabrics did not appeal to the young man, and he ran off to sea, eventually becoming a captain of a sailing ship. After a career on the high seas, at the turn of the twentieth century he settled in northeastern Massachusetts and married Sarah Hooper. They had six children, four of whom lived beyond infancy and one of whom was James H. (Henry) Rowley, my father's dad.

Now my father's grandpa William was a feisty guy who enjoyed the bars and got into fights with Irish Catholics who had settled in abundance in Massachusetts. My dad barely knew his grandpa William, for he died at 56, leaving Sarah not only penniless but having to return to work in one of the many textile mills powered by rivers in Lawrence. She married a second William—William Stansfield, a Welchman and a wonderful person ("a sainted man" according to my dad); they had one child. In the absence of his own grandfather, his step-grandfather William S. became a major influence on my dad's upbringing. Jim, my grandfather and Dad's dad, married Marian Carter, who had descended from the Hemenways, a family that reached America in the 1600s. Jim worked his way up from a teller in a bank in Lawrence to becoming a bank manager for twenty years, but I never knew him because he also died early, coincidentally also at age fifty-six. Jim and Marian had two kids, my dad, Arthur C. (Carroll) Rowley (born February 23, 1917), and sister Ruth, five years his junior. They lived in nearby Methuen, and our family often drove north to visit Grandma Rowley and Aunt Ruth. Though the family grew up as Quakers, later my dad observed that organized religion was not his life's priority, although he was always proud of one of the main credos that characterizes Quakers, that of honesty. His main reason for leaving the Quakers (now known as the Friends) took place when World War II broke out; Dad had no use for religious objectors to military service.

The name DeWitt, my middle name and that of my brother Clark, was my mother Barbara's maiden name (Barbara Jean DeWitt, born September 25, 1918). She grew up with her younger brother, Richard C. DeWitt (1922–2006) in Utica, New York, where my grandfather, Guy C. (Clark) DeWitt, was a civil engineer for the City of Utica. Guy married Angie Mae Humstone in 1916; both were born in 1893. We called them Gamie and Gampie, for we drove to visit them as often as we went to Methuen. Gampie, a quiet but loving, thin six-footer, majored in engineering at Cornell University, and early in their marriage they lived in New York City, where he worked on the tunnels beneath the city (Mom was born in nearby Yonkers). After a brief stint in a Buick plant in Flint, Michigan, Guy accepted the aforementioned engineering job in Utica, not far from where the two had grown up. They built a home in a suburb at the end of a trolley line from downtown, at 11 Bonnie Brae. Mom spent happy summers with her grandparents Humstone in the small town of Vernon, west of Utica, helping them with chores on their dairy farm. Her Grandpa DeWitt was a veterinarian in Oak Hill, a small community southwest of Albany, where he and his wife lived in a pre-Revolutionary War farmhouse and raised sheep and chickens.

Long, long before that, brothers Johan and Cornelis DeWitt were statesmen who dominated Dutch politics during the Dutch Golden Age, when the Netherlands was the main European sea power. But politics changed and both were lynched in 1672 by a mob loyal to the House of Orange, which had just gained power. I have a scrapbook put together by one of the DeWitts that traces the family name back into the early 1600s to the two brothers and others. Apparently, being on the wrong side of politics drove offshoots of this family to the Plymouth colonies in the New World after the voyage of the Mayflower. My mother and father lived in Rhode Island and then Connecticut, the states where Clark and I grew up. Clark was named after William Clark, of Lewis and Clark fame, a family friend of previous generations of DeWitts. The useless fact regarding the Mayflower was recognized early in Mom and Dad's marriage by busybodies at the Daughters of the American Revolution (DAR), who invited Mom and Dad to join their exclusive "club" made up of people who thought that those with ancestors who arrived earlier in America were progressively better than those whose ancestors arrived later. Mom ignored all such racist invitations (they came from time to time) and had nothing but contempt for people who thought this way. Because of similar examples of arrogance, commonly manifested by a lack of acceptance of newcomers to their town or state, my parents tended to paint most New Englanders with at least mild disdain, and they were happy to leave when they eventually retired to Tucson, Arizona, where they found people to be friendlier.

Art (Dad) got a bachelor's and master's degree in chemical engineering from the Massachusetts Institute of Technology (MIT), finishing the latter degree in 1939 (see Notes) as war clouds loomed across the world. Mom graduated from Laselle Junior College in Auburndale, Massachusetts, not far away. Both were members of a glee club in their colleges, and they met at some joint concerts by these schools. They got married in August 16, 1941. Mom was shy and introverted, but beautiful and mentally strong. Dad was not particularly good looking but more extroverted. And he was brilliant. As World War II approached, Dad specialized his studies in artificial-rubber technology, for the Japanese Empire was soon to conquer and annex the rubber plantations in Indonesia, where most commercial rubber trees were grown. Upon graduation, the U.S. Rubber Company in Providence, R.I. hired him. He was too valuable to serve as a soldier in the war, he noted with significant regret. He was in Research and Development there, helping invent artificial rubber. In short, he was a scientist, too.

We lived first in an apartment in Seekonk, a suburb of Providence. I was born there on December 6, 1942, just ahead of the "baby boomer" generation. I spent my first days ("little bitty baby") being rocked by mom in an old family cradle, as the old song "Cotton Fields", one of my favorites, brings home. One of my earliest memories is of Dad returning to MIT with me on weekends to borrow a two-man scull (rowing shell) to row so Dad could get some exercise; he plunked me down in the second seat while he rowed up and down the Charles River. He had rowed as a varsity collegiate sport while at MIT.

The postwar years brought prosperity to all. By about 1943, the three of us moved to the suburb of Barrington, seven miles southeast of Providence and on the eastern side of Narragansett Bay. Here Mom and Dad refinished a small farmhouse on a couple of acres, with a big garden out back. Clark was born there on August 3, 1944, and the first time he slept through the night coincided with the hurricane of 1944, which caused significant damage in other parts of Rhode Island. Our first new (!) car was a 1950 light-blue and white Chevrolet.

A couple of miles away from our new home, Mom found in Molly Nye Tobey a mentor and close friend. Mrs. Tobey was a thin, high-intensity and high-intelligence, no-nonsense grandmother and also a well-known artist with a studio in her house. (Some of her art is in the Metropolitan Museum of Art and the Smithsonian American Art Museum.) She did all types of paintings, but her specialty was another medium altogether: rug hooking. Her set of fifty "Statehood" rugs done between 1946 and 1961 to commemorate the states became famous and are now displayed in the Shelburne Museum in Vermont. One of her sons was the CEO of Amica Insurance Company, another the CEO of Chase Bank. Mom saved her letters from a correspondence that lasted decades until Mrs. Tobey died in 1984, and Molly gave Mom several hooked rugs, some woodcut prints, and a half-dozen watercolor paintings that depict floral designs and U.S. Navy sailing ships, plus a mobile of geese in flight, all of which decorate a guest bedroom in our present home.

We kids, however, found a less inspirational friend, Dutch Vetterlein, on the next block from us, where he and his wealthy parents rented a big Victorian house with a wraparound deck, adjacent to which were big shrubs. Somewhat of a spoiled hell-raiser, he inspired us to climb up on the deck railing and jump into the bushes, something we would not be allowed to do at home. Back then, we had a comfortable, middle-class life, although Mom was strict. Clark was better looking, a thin six-footer like Gampie, not so bookish (did not need glasses) or introverted, and with a better personality, so he got away with more trouble than I did. Newport, where really rich people had their estates, was another twenty-five miles to the south, as were many long stretches of empty beaches on Narragansett Bay. Our family spent many memorable hours walking those beaches, and if a storm came up on a weekend, we rushed down to a beach in the early morning to collect quahogs (round hard-shelled clams used for clam chowder) and oysters that washed up, and soft-shelled clams that we dug up at their "blow holes." We put them in gunny sacks, and Dad shucked oysters when we got home, to be eaten raw. The soft-shelled clams were steamed and served in butter, with a side dish of corn on the cob. I have memories of neighborhood clambakes on the beach that consisted of the same ingredients, some of the best food ever prepared!

While Clark and I were jumping into neighbors' bushes, Dad spent eleven years in research with U.S. Rubber, then in a similar capacity for three years with General Electric. He made inventions and patented them, and he wrote publications about some of his discoveries. But he left me no records of these, and I have been unable to turn up anything. I often wonder why I did not press him more about his career. He modestly noted once that he "made some contributions" to rubber technology, so I assume that his contributions were minor compared with those of many others. Nonetheless, artificial rubber was available for the war effort and perfected in subsequent years. He spent the remainder of his career employed by R.T. Vanderbilt, a large chemical supply company based in Norwalk, Connecticut, where he was a traveling consultant in wire and cable technology until retirement. Although Dad loved and was good at inventing things and doing research, he did not have a Ph.D., and there was a growing number of young people who got that degree after the War. So that was how he came to Vanderbilt, eventually to be put in jobs that involved solving problems (consulting for his employer) and even in sales. He was hardly thrilled to sell chemicals or chemical technology, but he was accommodating; Mom recognized the frustration. This later was an important lesson for me: if you want a career in research, make

sure you get the damned Ph.D.!

Mom and Dad put their primary life emphasis on Clark and me. But it was subtle, and we were not doted on or pampered, so it took me at least fifty years to realize their motivations. They were always supportive and they trusted us in our decisions, urged us to figure things out for ourselves. I do not remember them ever doing something without us, other than occasionally visiting neighbors and leaving us with a babysitter. They both—but particularly Dad—encouraged us to be curious, and they made sure we had ready access to interesting people, libraries, and ideas. Dinner conversation seemed to be centered on concepts rather than people, politics, or finances; and we knew to eat everything on our plates (a stay-at-home parent, Mom was a good cook)! We were never protected or urged not to do things that might be too dangerous. Exploring on our bicycles or on foot, to the library and occasionally going miles away from home, was a common pursuit of ours. Weekends and vacations consisted of visiting state or out-of-state parks or museums, camping with our German Shepherd dog Vera, and things that were educational or interesting. Studying and chores had to be done before fun, and fun included reading lots of books. We lived in various suburbs in Connecticut, including Stratford, Bridgeport, Woodmont, and New Haven, and later (after I left for college) Newtown. We stayed the longest in New Haven, not far from the Yale Bowl, where we attended private day schools in junior high and high school. Clark is smarter than I am, so he did not have to work as hard at his lessons as I did. At Newtown, my parents bought a small one-story house on two treed acres, which was the guest house that had been broken up from an estate owned by the actor Paul Muni; it also had a guest house (bedroom and bathroom), where Gampie spent his last years, cared for by Mom and Dad.

During several Christmas breaks, the family drove all the way from Connecticut to a beach at Clearwater, Florida, to escape the cold weather. My most enduring memory of these vacations was not the swimming but a disturbing incident in a small town in Georgia, where we had stopped for gas on a trip south. I recall walking down a narrow sidewalk adjacent to shops on the main street. An older black man was walking toward me and, as we got to within twenty feet of each other I was about to move off the sidewalk to let him pass. Instead, this adult got off the sidewalk to let me, a roughly nine-year-old white kid, go by. I was disturbed, and my consternation and questions precipitated a long conversation as we continued driving, a discussion about the Jim Crow South and the abuses and insults (and lynchings) that blacks still suffered then (and now, even at the hands of the police).

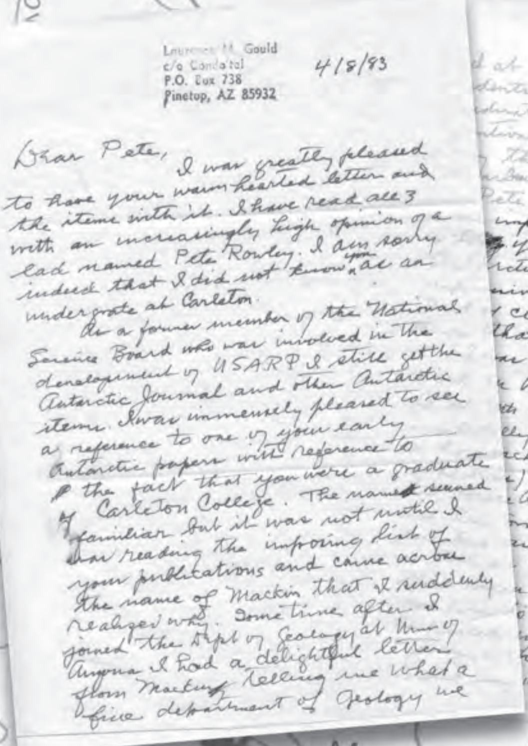
Both Clark and I had curious, adventurous spirits. During the summer between his junior and senior year of high school, Clark hitchhiked across Canada to Vancouver (I drove him up to Quebec, leaving him on a highway outside Montreal), then south through California and to Yosemite (he even climbed Mt. Lyle) and Sequoia national parks and other places, then east to Las Vegas, then southeast to Houston to visit Uncle Dick and Joyce, then New Orleans, and back to Connecticut. He said he lived on Oreo cookies and quarts of milk. An interesting lesson he took away from this, among many others, was that few friends or schoolmates wanted to quiz him during his senior year about the huge adventure, presumably because they could not relate to his experiences. Typically, the only persons who will participate in conversations about unique experiences are others who have had similar encounters. Military veterans will tell you the same. This was the case with my Antarctic adventures too. Many of my best friends are persons who have had similar experiences.

What sparked such early adventures, or the later Antarctic ones? Perhaps we were driven to it, for despite Clark's and my objections, for years our parents refused to own a TV. Later, while we were in high school, Mom and Dad relented and bought one, but they severely restricted our viewing, generally to Sunday nights and then only if our homework were done. One of our favorite shows was *Maverick*, with the actor James Garner. But that was the exception. Usually it was homework, chores, and outdoor play that occupied us.

Then, after a conversation Dad had with a colleague, we started a weekend hobby: collecting minerals. Connecticut and nearby states had pegmatite and other types of quarries that had been mined for abrasives and metals, and what we considered to be the beautiful minerals were now in the discard piles ("dumps'). Getting to the quarries or other spots required hikes, but all of us needed such exercise. This hobby was so much fun that the entire family commonly spent summer vacations visiting areas to look for minerals or fossils, plus we also visited nearby national parks and tourist spots in such places as Ontario, Michigan, Wyoming, Colorado, Utah, and South Dakota. By then we had a gray and white 1957 Chevrolet station wagon, and its tail end was dragging from boxes of rocks by the time we got home.

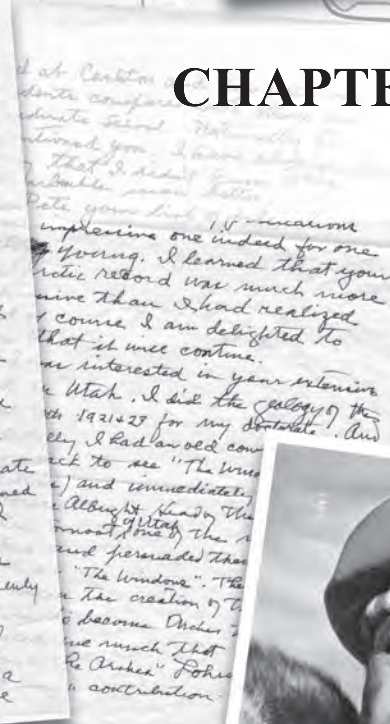
On one such weekend day while digging in a dump at a quarry, an adult fellow rock hunter nearby asked me the typical adult question of what I wanted to be when I grew up. I had not given much thought to a career, even though I was well into high school. While I hesitated, Dad volunteered: "Why, he's going to be a geologist!" Even though by then we had been collecting rocks for several years, for some reason it had never crossed my mind that I could make a profession out of this!

Decisions on college finally came around. Mom urged me to get out of evil New England, so that took the Ivy League off my list. Instead, our attention focused on small liberal-arts colleges in the Midwest. I was a dutiful child. On spring break of my junior year in high school, Mom and I drove the '57 station wagon around to visit colleges in Ohio and Minnesota that had a geology department. I remember that Oberlin College was ugly, but Carleton College was beautiful. Besides, its president was a guy named Laurence McKinley Gould, formerly a geologist. Two professors staffed its Geology Department, one a kindly older man named Duncan Stewart, who brought his large Airedale terrier, Bobby Marvel, with him to his office, and the other a fast-walking, dynamic young athlete (a wrestler who just missed making the Olympics once), Eiler L. Henrickson. Carleton was the clear favorite after the trip and, following a stressful application period and a worse wait, I was fortunate enough to be accepted to study there.


Laurence M. Gould
c/o Condo tel
P.O. Box 738
Pinetop, AZ 85932

4/18/83

Dear Pete,
I was greatly pleased to have your warm-hearted letter and the items with it. I have read all 3 with an increasingly high opinion of a lad named Pete Rowley. I am sorry indeed that I did not know you as an undergrate at Carleton.
As a former member of the National Science Board who was involved in the development of USARP I still get the Antarctic Journal and other Antarctic items. I was immensely pleased to see a reference to one of your early Antarctic papers with reference to the fact that you were a graduate of Carleton College. The name seemed familiar but it was not until I was reading the imposing list of your publications and came across the name of Mackin that I suddenly realized why. Some time after I joined the Dept of Geology at Univ of Arizona I had a delightful letter from Mackin telling me what a fine department of Geology we



CHAPTER 2

LARRY GOULD AND UNDERGRADUATE STUDIES

Carleton College, in Northfield, Minnesota, had/has an enrollment of about 1,300 to 1,800 students. Going there was a great decision, for it is an excellent college with a beautiful campus, in a bucolic rural setting; indeed, the sign marking the city limits noted that it was a place of "cows, colleges, and contentment." This farming town straddles the Cannon River and lies forty miles south of Minneapolis/St. Paul. The town had its five minutes of fame in 1876 when the James-Younger outlaw gang attempted to rob the First National Bank. The bank clerk on duty was killed when he refused to open the vault, the gunfire alerting townspeople who then fought back, although one died, as did two outlaws. Two weeks later a posse caught up with the gang, killed another of them, and captured the three Younger brothers. Frank and Jesse James had escaped but the Youngers were convicted of murder and sentenced to life in prison. The bullet holes in the bank were still visible when I enrolled at Carleton. The college is on a hill on the eastern edge of town. Another excellent college, St. Olaf, on a hill about a mile to the west of town, was our major rival in football, basketball, and other sports, but it was a close partner in spirit and in some shared classes.

I was a decent student, although my sophomore year was hardly stellar. My main memory was that I studied day and night to keep up. I was still shy and introverted, so did not date for nearly the entire four years. The constant study and shyness meant that I did not particularly enjoy college, and I was certainly ready to get it over with, to invoke the same spirit of future longing in Emmylou Harris' lyric line "one of these days" in her wonderful song of the same name. My sport was soccer, and working out, making friendships, and the camaraderie of the varsity training table resulted in some added muscle and friends. In the first game of my senior year, however, during a tackle for the ball, I blew out the ligaments and cartilage of my right knee, ending my soccer career. The ligaments came back by the end of the year through rehabilitation and jogging, but the cartilage was never operated on and bothered me from then on. But it became an incentive to walk distances and to exercise every day, so the