Profile of a Department:

Geological Sciences

University of Colorado at Boulder

L. A. Warner

Second Edition to Commemorate the Dedication of the Benson Earth Sciences Building

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Forword to the Commemorative Edition

Larry Warner finished "Profile of a Department: Geological Sciences, University of Colorado" in November of 1986. He died of cancer in December, 1991, and was not to see the many changes since he wrote the book. We are forever grateful to him for providing us with this wonderful inheritance and to Robin, his wife, for her patience in supporting him in this effort. The casual reader, who might not think a history of a department to be interesting or relevant, is guided to page 11 "Between the Wars (1914-1945)" where Larry describes a particularly volatile era for the University. The very survival of the University was threatened from outside. Strong leadership and faculty and staff support allowed it to not only survive, but become stronger after the legislature had refused to give any funding in 1924..... read on! This courage and dedication is just as relevant today as it was then.

Our persuasive talents were not great enough to find a successor to Larry Warner as the departmental historian. In republishing and updating his book, we thus left his part of the book untouched and simply added sections in which we complement the book with individual contributions detailing events of the last twelve years. It is the dedication of our new building which prompted us to provide an update to the departmental history. We are thankful to all those who contributed directly or helped in roundabout ways to make the reissuing of this book possible. Special thanks are due Mrs. Sue Long in the front office for her diligent work in getting the book into camera ready form. Professor Emeritus Al Bartlett of Physics has been a friend of the department over the years and has actively supported our path to our new home as well as helped us with many tips on getting the book republished. He has co-authored an extensive book on the history of the Physics department: "The Department of Physics at the University of Colorado at Boulder, 1876-1996, by Albert A. Bartlett and Jack J. Kraushaar." It contains many jewels about the history of the University and as such is highly recommended for the reader whose interest goes deeper. The book is available from the Physics Department or from the archives in the Norlin Library.

A wonderful little, longer range perspective of the department can be found in Don Eicher's "A Recollection" on page 118. Don't miss it.

Hartmut Spetzler
October 1997

Preface to the First Edition

When I was asked more than four years ago by Erle Kauffman, then department chair, to undertake writing a history of the Department of Geological Sciences, I accepted with an erroneous expectation that the project would be wrapped up within six months. Except for two factors, the writing would have been completed somewhat earlier. First, I inherited during the interim other obligations, some of which consumed much of my time. Second, in searching for historical material, I became involved in lines of inquiry which, though fascinating, led off into the hinterland and caused me to stray from the central theme.

Early on, it became clear that the history of the Department cannot be separated from that of the University, which in turn has been influenced by local, national, and international events that have occurred during the past century. Accordingly, I have included segments of University history, together with sketches of events and personalities, that have been connected with the Department's evolution.

Organization of the mass of material that came to light presented problems that I had not anticipated. Several schemes were tried and abandoned before arriving at the format adopted. Following a brief outline of the development of geology as a science and an account of the University's early years, during which departments as such did not exist, the succeeding five chapters are devoted mainly to the faculty and the roles they played in building the Department. Chapters 8 through 10 trace the development of academic programs, growth of support facilities, contributions of students and alumni, and the Department's role in University affairs. I have included in a final chapter some thoughts on what society may expect of geoscientists in the future and how these expectations may affect the Department's role in training future students. Much of what is contained there has been borrowed from the recorded wisdom of distinguished members of the profession who have assumed the cloaks of eider statesmen.

Much of the source information for this narrative was derived from departmental files and records. I am deeply indebted to Edith Ellis, Paulina Franz, and Kay Fox for the many times they have helped me to track down details and for searching out material that would otherwise have been overlooked. Interesting insights into the Department's past were obtained from early University *Bulletins* housed in the archives of Norlin Library. Pertinent segments of University history were abstracted from two excellent books (Davis, *Glory Colorado*; Allen et al, *The University of Colorado*, 1876-1976) and from back issues of the Silver and Gold Record. Many of the missing links were bridged through conversation and correspondence with former students and colleagues. I acknowledge with gratitude their help and encouragement. I am indebted especially to Ted Walker, Bill Bradley, Ed Larson, and Hartmut Spetzler for reviewing the manuscript and making helpful suggestions for its improvement.

It is my hope that any who read what follows may extract from it some of the pleasure I have experienced in putting it together.

Larry Warner
November 1986

PROFILE OF A DEPARTMENT: GEOLOGICAL SCIENCES

UNIVERSITY OF COLORADO AT BOULDER

L. A. WARNER

Professor Warner has given freely of his talents and time to produce this chronicle for all of us. Larry, all alumni, faculty, students, and friends of the Department of Geological Sciences of the University of Colorado at Boulder thank you for this wonderful and lasting gift.

And Robin, we appreciate your patience in putting up with Larry's heavy schedule in spite of his supposed retirement.

Hartmut Spetzler, Chairman
Department of Geological Sciences

Omer Raup, Chairman
Alumni Advisory Council

Geology in the Twentieth Century

Development of the geological sciences at the University of Colorado paralleled the development of geology from a set of loosely coordinated principles inherited from earlier times into an integrated discipline that merits a position among the natural sciences. When the Department was born at the turn of the century, four fundamental themes that formed a foundation for growth of the science had been well established. The first was the principle of uniformity; the second concerned rules for reading the record in the rocks; a third embraced rudimentary ideas concerning the origin of mountains; and the fourth accounted for surface relief in terms of a balance of masses in the outer earth.

The principle of uniformity was set forth eloquently by James Hutton of the University of Edinburgh in his book, *Theory of the Earth*, published in 1795. It proclaimed that the present is the key to the past and that to understand the past one must learn what is going on now. Since earth processes can be observed to take place very slowly, the concept led to the belief that the earth is very old.

A clue to interpreting the rock record was established by William Smith, a civil engineer who supervised excavation of canal routes in England. By 1815, he had demonstrated that fossils in the rocks can be used to correlate strata between two or more localities and that younger layers are always deposited in sequence on older ones. Darwin's *Origin of Species*, published in 1859, supplied a powerful confirmation to Smith's observations.

Meanwhile, James Hall of the New York Geological Survey discerned that strata in the folded Appalachian Mountains are enormously thick. He reasoned that they must have accumulated gradually in an elongate marine trough and were later crumpled into folded mountain ridges. In 1857, he christened the trough a "geosyncline" and advanced the premise that all folded mountain systems emerge from geosynclinal accumulations. J. D. Dana, the noted mineralogist at Yale, embraced the principle of the geosyncline and added the concept that conversion of geosynclines into folded mountains led to growth of the continents by accretion. These concepts were subsequently modified by European workers, but the geosynclinal theory persisted. E. Suess, an Austrian, is credited with having noted in 1885 the association of island arcs and ocean trenches with folded mountain systems, suggesting that they might be related to a common cause.

Isostasy, meaning equal standing, grew out of studies by two Britons, Pratt, a clergyman, and Airy, an astronomer, concerning geodetic work in the Himalayas during the 1840s. They reasoned that some means to compensate the excess masses of mountains at the earth's surface by mass deficiencies at depth was required to account for discrepancies in geodetic measurements. The principle was later formulated by Dutton, an American, in 1889 and subsequently refined by Bowie of the U. S. Coast and Geodetic Survey.

All of these concepts fit readily into the notion of a long time scale for the history of the earth. This view was challenged in 1861 by a famous British physicist and mathematician, Lord Kelvin, who proved that, based on an assumed cooling rate from an initial molten state the earth could not be more than 100 million years old and was probably much younger. Discovery of radioactivity by Becquerel at the turn of the century laid the foundation for radiogenic age determinations of rocks that soon vindicated the uniformitarian belief in an ancient earth.

Concurrently with Becquerel's discovery of radioactivity, Roentgen found that X-rays could penetrate opaque solids. In 1912, von Laue in Germany used X-rays to prove what had long been suspected, that crystal lattices of minerals consist of an orderly arrangement of atomic particles. By 1915, techniques for X-ray determination of crystal structures had been refined by W. H. and W. L. Bragg in England.

The use of radiogenic isotopes to determine rock ages and of X-rays to study crystal structures focused attention on a need for quantitative laboratory data to substantiate qualitative concepts that emerge from field observations. In this regard, a foundation for experimental earth science, laid early in the century, marked a turning point in the history of geology.

The notion of continental drift, although suggested much earlier, was first given serious consideration by Taylor (U.S.A.,1910) and later given scientific respectability by Wegner (Germany, 1915). A vocal advocate in the years that followed was A. du Toit of South Africa. The hypothesis was opposed vigorously by proponents of continental permanence, including R. T. Chamberlain and B. Willis in America and H. Jeffries in Great Britain. E. W. Berry of Johns Hopkins remarked that continental drift created more problems than it solved. C. Schuchert of Yale invented continental borderlands and land bridges to account for the migrations of faunas and floras explained by drift.

In 1931 an Englishman, H. Holmes, proposed mantle convection as a mechanism for moving the continents. The idea had been advocated by another Briton, 0. Fisher, in 1909. A Dutchman, Vening-Meinesz, expanded the concept to account for ocean trenches and the origin of arcuate mountain systems.

Shortly after World War II, an Englishman, Blackett, developed techniques for measuring paleomagnetism, which were soon used to demonstrate wandering of the earth's poles of rotation. In 1957 another Englishman, K. Runcorn, tied polar wandering to continental drift by showing that ancient pole positions could be matched by reassembling the continents. Meanwhile, Ewing, Dietz, Menard and others in America had mapped the mid-oceanic ridges and noted the transverse fracture zones that offset them. The relative youth of sea floor sedimentary deposits was noted in connection with these investigations.

It remained for H. Hess of Princeton in 1960 to propose sea floor spreading to account for the observed oceanic structures and sea floor youth. Soon after, Vine and Matthews in Great Britain tied sea floor spreading to magnetic pole reversals in order to explain the linear magnetic anomalies observed in the oceanic crust. They demonstrated that the magnetic lines increase in age away from the ocean ridges, which they parallel. In 1966 J. T. Wilson, Toronto University, proposed the term "transform fault" to apply to the oceanic fracture zones.

The sum of these observations led to development of the modern plate tectonic model, which ties together all of the subdisciplines of the earth sciences. In the two decades that have followed its initial presentation, the model has undergone testing and refinement to bring it to its present status. Although it explains many things that were once mysteries, there remains much that is poorly understood. Whether it will stand the test of future discoveries or will be pushed aside in favor of a better model remains to be decided.

The Department's efforts to remain abreast of developments in the earth sciences and its present role in promoting new discoveries are traced in the chapters that follow.

Birth of the University (1876-1891)

A department cannot be separated entirely from the university of which it is a part. In a state university, a department's fate is also linked to that of the political establishment it serves. It is considered appropriate, therefore, to review briefly the origins of the state of Colorado and the University in order to trace the development of what is now the Department of Geological Sciences. Virtually from its inception the University and the Department have shared a parent-child relationship, the basis for which was established in the first 15-year interval of the University's life, at a time when it was ill-equipped to assume the responsibilities of parenthood.

The legal foundation for the University was laid in 1861, the year in which the territory of Colorado was organized. During the first session of the territorial legislature in that year, a bill was introduced to establish a public university at Denver, the only town of consequence in the territory. The bill, signed by Governor William Gilpin, also provided for establishment of a Board of Trustees. However, there was no provision to finance the fledgling institution, and much debate ensued regarding its location. These matters were not settled until 1874. The town of Boulder was founded in 1859 as "Boulder City" to provide a supply base for mining activity in the hills to the west. As more settlers arrived, agriculture was developed on the plains to the east, gradually supplementing, and eventually replacing, mining as the major source of income for the community. The desirability of linking the economy of Boulder with that of Denver more firmly than could be provided by stagecoach led to construction of a rail line connecting the two cities, which was completed in 1873.

The Legislature was bombarded with proposals to change the proposed location of the University from Denver to other frontier towns, including Colorado Springs, Greeley, Boulder, and Burlington, later a part of Longmont. Largely through the efforts of Charles F. Holly, representative from Boulder County, together with those of Boulder merchants and civic leaders, the location at Boulder finally was secured.

In 1874, the Board of Trustees managed to obtain from the Legislature an appropriation of $15,000 to begin construction, contingent upon receipt of matching funds through private subscriptions. The funds were quickly secured by Boulder merchants and citizens, construction plans were furnished by a local architect, and ground was broken for a main building in late July, 1875. An additional appropriation of $15,000 was provided subsequently for plumbing, lighting, furniture, and equipment. Thus, the original University building, now known as Old Main, came into being.

The territorial legislature petitioned Congress in 1872 for statehood on the grounds that the population, then less than 50,000, was increasing rapidly, and that mining and agriculture were prospering. Congressional approval was delayed until 1875. Late in that year a constitutional convention met in Denver. The constitution was ratified by Colorado voters, and on August 1, 1876, President U. S. Grant proclaimed Colorado a state. The state constitution contained two important provisions regarding the University:

1) The state was required to set aside 72 sections (approximately 18,000 acres) of land for use and support of the University, as required in the Statehood Enabling Act.

2) A six-member Board of Regents, to be chosen by the voters, would act as a governing board for the University, replacing the Board of Trustees.

Once elected, the Board of Regents set about drawing up criteria for a curriculum. They wisely recognized that an institution of higher learning depending upon support from a frontier state would have to emphasize "practical training" in order to survive. However, they regarded the Jeffersonian ideal of a citizenry "educated to understand the human condition" as a respectable goal. They sought a leader for the University who would combine these two objectives and chose as the first president Dr. J. A. Sewall, who held both M.D. and Ph.D. degrees from Harvard and had taught chemistry at Illinois Normal University. They also appointed J.

E. Dow, former principal of Boulder High School, as the first full-time faculty member.

Classes began in September 1877 with 44 students and two faculty (Dr. Sewall and Mr. Dow). The curriculum was split between two departments, a normal department for training of teachers and a preparatory department to accommodate students who lacked an adequate background for college work. Sewall was anxious to establish a college department, including courses in languages, mathematics, and science as a focal point for the University's development. However, for lack of students and faculty, the addition of this program was delayed. Improvement came with the arrival in 1878 of a third faculty member, Mary Rippon, who was hired to "teach French and German languages and to give some instruction in the branches of mathematics and English grammar." Another faculty position was added in 1879. Even so, it was only by Herculean efforts on the part of the faculty, each teaching four or five courses per semester, that a curriculum leading to a bachelor's degree was possible.

Although the instruction did not include great variety, it was provided at low cost. A matriculation fee of $10 entitled a student to membership in the University for the duration of his studies. Fees per term were $15, and living expenses (board, fuel, light and laundry) ranged from $103 to $235 per term, depending upon the accommodations chosen. In 1879, a tuition fee of $15 per year was added.

From the outset, Dr. Sewall's administration was plagued with difficulties, chief among which was lack of funds. In 1877 the Legislature passed a bill setting aside one-fifth mill of the state property tax for University support, intending this to take the place of a biennial appropriation, as well as student tuition. The annual receipts from the mill levy were $16,000-20,000 per year, depending on the economy. By 1885, 16,000 acres of the land provided by the state constitution to support the University had been set aside, but most of it was in areas unsuitable for mining or agriculture and, at the time, valueless. The state leased 3,680 acres for an annual rental of $239.

Responding to local interests, the Legislature established three other institutions of higher learning during the formative years of the University: the School of Mines at Golden in 1874, the Agricultural College at Fort Collins in 1879, and the Teacher's College at Greeley in 1890. All were in competition for meager funds provided by an infant state. The Legislature was also under pressure to provide funds for a state capitol building and appropriated $400,000 in 1885 for initial construction while granting nothing to any of the state colleges.

A second difficulty, stemming largely from the first, was the slow growth of the University. Although elements of what were to become schools and colleges of liberal arts, law, engineering, medicine, and music were established during the initial decade, the programs were poorly enrolled. There were no dormitories until 1884, when cottages were constructed to provide limited housing. Most students were required to find housing in Boulder, which at the time was ill-prepared to meet the demand. Consequently, most of the students attending the University were drawn from Boulder County. They had received primary and secondary education in primitive frontier schools and were not prepared for advanced work. At the end of the first decade, the University enrollment was only 120 students, three-fourths of which were in the preparatory program. The Legislature was not enthusiastic about spending money on what many regarded as a failure.

Dr. Sewall became the brunt of open criticism for the University's shortcomings, and he resigned in June of 1886. Suffering a fate that was to haunt several of his successors he learned first-hand what a distinguished faculty member (J. D. Ogilvy) was to note half a century later: The president of a state university must be willing to "forego nirvana for the common good" and "be rash enough for an undertaking which combines the attractions of a bath in a cement mixer with those of a trip through hell in a paper shirt."

Sewall was replaced in 1887 by Horace M. Hale, who had served as a regent of the University and as territorial superintendent of schools. Hale had no illusions about the task that he assumed, but he regarded it as a challenge. Noted for his vigor and administrative ability, he was able to remedy most of the problems he inherited and to place the University on a sound footing. He increased student enrollment, attracted new faculty and added substantially to the physical facilities. Too exhausted to continue, he retired in 1891, feeling that he had accomplished his mission.

That the University survived these early years is nothing short of miraculous. The frontier environment in which it was spawned was not conducive to the prosperity of an institution of higher learning. The miracle was achieved through the dedication and personal sacrifices of its first two presidents and the missionary zeal of the faculty members they were able to assemble.

What was to be a Department of Geology was not yet born, although it may be said to have been conceived out of wedlock. Dr. Sewall, apart from conducting the business of the University, taught six classes and lectured throughout the state on a variety of subjects. Included in his repertoire was a course on Mineralogy and Assaying, presumably taught in deference to the thriving mining industry in Colorado. In 1880, a cabinet containing a collection of ores and metallurgical products was donated to the University by J. Alden Smith, the State Geologist. This collection became a valuable adjunct to Dr. Sewall's course. Early catalogues list other courses in the earth sciences, presumably taught by part-time personnel or as an overload by other faculty. However, two decades were to pass before the Department was officially organized.

The Department's Early Years (1902-1913)

Dr. James A. Baker became the third president of the University in 1892. During the 22 years of his administration, the University grew to include most of its present academic units, and the faculty increased from 32 to more than 200. A graduate department, established in 1893, became the Graduate School in 1909. Earlier programs in law, medicine, and engineering developed into a school of law, a medical school, and a college of engineering. A department of philosophy and pedagogy, organized when Baker arrived, became the College of Education in 1908. The Department of Liberal Arts achieved college status in 1903, with E. B. Hellems as its first dean, and furnished a home for the Department of Geology, organized a year earlier.

Baker was able to accomplish the transition from what had been a preparatory school to an institution resembling a true university, despite a major economic depression in the mid-nineties. He encountered strong competition from the University of Denver and from the other state schools of higher learning. All depended on meager appropriations by the Legislature, which had meanwhile committed itself to construction of a capitol building with a gold leaf dome. Former President Hale noted that the dome alone cost more than the entire University plant in Boulder and regarded the expenditure as disgraceful.

The Department got underway officially in 1902 with the arrival of N. M. Fenneman as its first full-time faculty. Fenneman, the son of a Lutheran minister, had taken a baccalaureate degree at Heidelberg College, Tiffin, Ohio, at the age of 17. He taught in the secondary schools and became principal of the high school at Greensburg, Pennsylvania before his twenty-first birthday. Prior to his arrival in Boulder, Fenneman had served as Professor of Physical Sciences in 1892 at Colorado State Normal School in Greeley, studied under William Morris Davis at Harvard in 1895, and completed a Ph.D. in geology at the University of Chicago in 1901.

Although his special field of interest was physiography, Dr. Fenneman taught courses in general geology, historical geology, geometrical crystallography, optical crystallography, systematic and determinative mineralogy, petrology, paleontology, and physical geography of the United States. At the time of his appointment, the University *Bulletin* advertised teaching equipment for geology to include a Wollaston model goniometer, a Bausch and Lomb microscope "with rotating stage and polarizer, mechanical stage, condenser, triple nose piece with objective lenses, together with accessories . . . "; a lapidary's lathe, and a diamond saw. Fenneman greatly broadened the scope of the curriculum and added work in geography, which the Department was to retain for half a century. Unfortunately, he departed for greener pastures at the end of one year, suffering from exhaustion, to join a well-established department at the University of Wisconsin.

One is tempted to wonder what might have happened had Fenneman remained with the Department. Following a four-year stint at the University of Wisconsin, he was appointed head of the newly established Department of Geology and Geography at the University of Cincinnati, where he remained until his retirement in 1937. He succeeded in building a strong faculty at Cincinnati, including Walter H. Bucher, Charles Behre, and John Rich, among other notables. He served as Chairman of the Division of Geology and Geography of the National Research Council (1922-1923), Vice President of AAAS (1923), and President of the Geological Society of America (1935).

Despite an arduous schedule of teaching and administrative duties, Fenneman managed to publish more than 50 scientific papers and books. In his spare time, he wrote a similar number of essays on a variety of subjects, including "The Case for Latin," "Why Dickens?" Railroads of Australia, Sex, Thomas Paine, and Science and Religion. He is best remembered for his two volume work on *Physiography of the United States*. Of more interest locally is his *US Geological Survey Bulletin 265*, "Geology of the Boulder District, Colorado."

He remained a staunch friend of the Department until his death in 1945, being a frequent summer visitor and lecturer on campus and at Science Lodge, the summer field camp.

With Fenneman's departure, the task of nurturing the infant Department fell to Russell D. George, who arrived in the fall of 1903. George had taken an M.A. degree at McMaster University, Toronto, and had been one of Fenneman's fellow doctoral students at the University of Chicago. Dr. George served as department head until his retirement in 1933. Under his direction the Department grew in terms of faculty, student body, physical facilities, and research and service activities. Initially, George taught a great variety of courses, but ultimately, he became primarily responsible for those related to economic geology and public relations. He developed a laboratory for teaching fire assaying, resurrecting a subject that had been abandoned upon the departure of President Sewall. In addition to his work as department head, he served for many years as State Geologist and involved faculty and students in the work of the Colorado Geological Survey until it became dormant during the early years of the Great Depression.

In 1904, Dr. George recruited a promising student, R. D. Crawford, as a teaching assistant. Trained at Northern Indiana Normal School, he had taught at public schools in Illinois, Texas, and Colorado before deciding to enroll at the University to study geology. Crawford completed a B.A. degree in 1905 and an M.A. in 1907, in which year he was appointed to an instructorship. He took leave of absence to enter a doctoral program at Yale in 1911 and completed the Ph.D. in 1913. In 1914, he became professor of mineralogy and petrology, a post he retained until his retirement in 1940. His course load included crystallography, mineralogy, petrology, ore deposits, and field methods. Dr. Crawford was admired and respected by his students and professional peers as a teacher, a scientist, and a person of impeccable integrity.

Growing out of his work with the Colorado Geological Survey, which began in 1906 and continued through most of his career, Crawford conceived the notion of a northeast-trending Colorado Mineral Belt related to an alignment of Tertiary intrusives extending from the Four Corners region to the mountain front at Jamestown. His work in the vicinity of Mt. Princeton led to his concept of a central Colorado batholith (*Am. Jour. Sci.*, v. 7, p. 365-388). Many of Crawford's ideas regarding central Colorado geology have been proven correct by more recent geological and geophysical studies performed mainly by the U.S. Geological Survey.

When Crawford joined the faculty, the Geology Department was housed on the fourth floor of the Hale Science Building, which had been completed in 1893 and named for the second president. Several tons of rocks, minerals, and fossils, housed in huge oak cases, had been transported up three flights of winding stairs. Soon after his appointment Crawford began to work long hours with George on plans for a new geology building. The building was completed for occupation in 1911 and still houses the Department.

A third faculty member arrived in 1912 in the person of Philip G. Worcester, beginning an association that was to last for half a century. Born and reared in Vermont, Worcester attended the University of Michigan for a brief period before transferring to Colorado to major in geology. He received a B.A. degree in 1909 and an M.A. in 1911. The following year, he became an instructor. He completed a Ph.D. at the University of Chicago in 1924, the year in which he became a full professor.

Dr. Worcester's specialty was geomorphology, and his teaching and research were built upon the foundation established by Fenneman a decade before his arrival. He was best known for his textbook on the subject, first published in 1939 and periodically reprinted and revised. However, his professional interests were numerous and varied. He served as a geologist with the Colorado Geological Survey from 1912 to 1927 and as a consultant for the Canadian Exploration Company for many summers. He was Dean of Men from 1920 to 1930 and head of the Department from 1934 to

1949. Named Acting Dean of the Graduate School in 1943, he was appointed Dean in 1946 serving in this capacity until his retirement in 1953, meanwhile continuing to teach two advanced courses. Worcester's forthrightness is reflected in his comment to a new faculty member: "We trust that you will be able to handle the work required of you; if not, we trust you will not remain."

Aside from Worcester's University duties, he found time to serve on the Boulder Board of Education, as a director of the Boulder Savings and Loan, and on the board of the Chicago Theological Seminary. His University honors include the Norlin Distinguished Achievement Medal in 1946 and the Faculty Research Lectureship in 1952. He was active in numerous academic and professional societies, including Phi Beta Kappa, Sigma Xi, Geological Society of America, and American Association for the Advancement of Science.

Phil Worcester was admired by his students, colleagues, and professional peers. A fitting tribute to his stature as a teacher is contained in a letter to the Department from an alumnus, Dr. David Harris (Ph.D. 1959), who taught for many years at Colorado State University: "He always considered his students first, and by doing so had little time to do the things that would bring recognition. My main regret is that I didn't tell him how much his courses have done for me."

Worcester was dedicated to espousing the role of the earth sciences in human affairs. Following retirement, he continued to teach courses through the Extension Division for nonmajors, conducting weekend field trips to places of interest. Not only did the students profit from his wealth of experience, but they also marveled at his agility in rugged terrain and often had difficulty in keeping up with his pace. Up to the time of his death in 1970, at the age of 86, Phil was at home to returning students and visiting firemen, many of whom took time to call on him in passing through the area. A memorial fund was established by the Department in his honor.

Although not a member of the Department, a person who contributed much to its welfare was Junius Henderson, first curator of the University Museum and a man of many parts. Born and reared in Iowa following the Civil War, he became interested in journalism and moved to La Conner, Washington, where he edited the *Puget Sound Mail* from 1887-1892. In his spare time he read law and, following a move to Colorado, was admitted to the Colorado Bar in 1894. He practiced law in Boulder and was elected to the office of County Judge, serving from 1898 to 1902. During the academic year 1901-1902 he was an instructor in the University Law School.

Early in life, Henderson had developed an interest in rocks, minerals, fossils, and modern flora and fauna. By the turn of the century, he was recognized as a proficient naturalist. In 1902, President Baker persuaded Henderson to serve without pay as an interim curator for the modest collection of specimens housed in Hale Science Building. In 1909, the Museum was established as a separate unit, and Henderson was named Curator. A year earlier, he had completed a B.A. degree at the University, the only earned degree he held, and had been appointed Professor of Natural History.

After his appointment to the faculty, Henderson abandoned the practice of law and devoted full attention to improving the Museum, a task he pursued until his retirement in 1933. He established cooperative relationships with the Departments of Geology, Biology, and Anthropology, securing appointments for faculty members from these departments as curators for collections in their fields of interest. He in turn lectured in the departments on a variety of subjects in which he had expertise. To expand the museum collections for teaching and research purposes, he acquired support from industry and government agencies as well as from the University. During his tenure, he published more than 170 scientific papers and books, dealing with subjects in ornithology, mammology, perpetology, geology, geography, and anthropology. A major contribution in geology resulted from his study of Front Range glaciers. The present Museum building was designed under his direction and built with PWA funds during the depression. It opened in November 1937, two weeks after his death. It was dedicated as the Henderson Museum in 1938. A close association of the Department with the Museum, which began with Junius Henderson, has continued to the present.

The Department's formative period ended with the beginning of World War I. The initial emphasis on mineralogy, provided by President Sewall in 1878, was borne out in its first title, the Department of Geology and Mineralogy. From the single-term course offered by Dr. Sewall, the program grew to include three tenured faculty, with part-time assistance from other professionals, offering what then amounted to a balanced curriculum leading to the Master's degree.

It is of interest to note that the founders of the Department, each a remarkable person in his own right, were contemporaries of Francis Ramaley (Biology), J. B. Eckley (Chemistry), George Norlin (Greek), F. B. Hellems (Latin), Mary Rippon (German and French), M. S. Ketchum (Engineering), J. F. Willard (History), and F. G. Folsom (Law), names that were subsequently memorialized in structures on the campus. The roots of the Department are closely intertwined with those of the University.

Between the Wars (1914-1945)

Dr. Baker resigned as President of the University just prior to the onset of World War I. He was succeeded by Dr. Livingston Farrand, the second medical doctor to hold the office, who had taught psychology and anthropology at Columbia. President Farrand's tenure was brief. He took leave of absence to head the Rockefeller Foundation's medical mission in Paris in 1917 and resigned in 1919 to become president of Cornell University. During his leave of absence, Dr. George Norlin, Professor of Greek, served as acting president and was named president following Farrand's resignation. In addition to his achievements as a Greek scholar, Norlin was noted for his love of trout fishing, gardening, and poker. Like Baker, Norlin was to enjoy a long and distinguished term, extending from 1919 to 1939. During this period, student enrollment increased from 1,300 to 4,400 and the physical facilities were greatly expanded, despite a depressed economy. The Department shared in this growth, increasing its permanent faculty from three to seven and more than doubling its student body.

Dr. Norlin's strength of character, not widely appreciated while he was a mere Professor of Greek, came to light in an encounter with the Ku Klux Klan during the mid-twenties. The Klan had wide support in Colorado and had gained control of the Governor's office and both houses of the Legislature. The Klan leadership ordered Norlin to fire all Jews and Catholics on the University faculty. He flatly refused. As a result the University received not one cent of state funds in 1924. It might not have survived this incident without Norlin's strong leadership and the support of his faculty and staff.

World War I

Between the outbreak of hostilities in Europe in 1914 and United States involvement in the war in 1917, activities on the campus were clouded in uncertainty. In June of 1916, Congress passed an act providing for a Reserve Officer's Training Corps at institutions of higher learning. The University was among the first in the country to acquire an ROTC unit, and khaki soon became a standard mode of campus dress. The curriculum was modified to include airplane and automobile construction, operation, and maintenance, wireless telegraphy, and military mapping. Also included were courses on international law and on the history and causes of war. The Department adapted its courses to conform with the wartime curriculum of the University. As its population was largely male, it suffered somewhat more than other segments of the University from the military draft and enlistments.

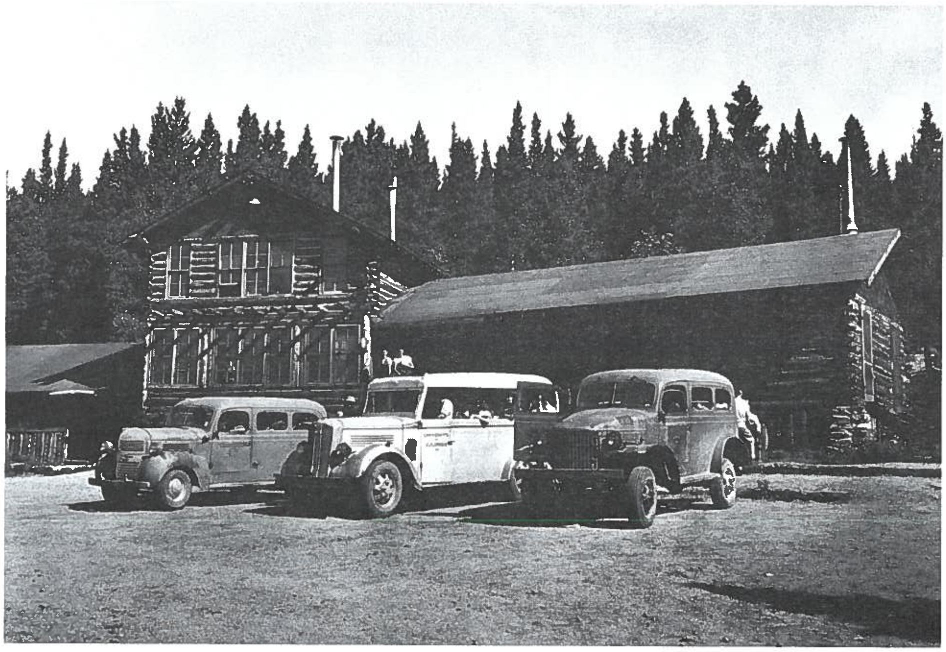
At the height of wartime activity, more than a third of the University faculty and about half of the students were involved in military service. After the armistice in 1918, the University promptly divested itself of a military image in a rush to return to normalcy. The tent city that had housed ROTC units was dismantled, and a flavor that was to characterize college campuses during the twenties soon took over.

The Department emerged from World War I essentially intact, with Professors George, Crawford, and Worcester forming the core of the faculty. They were supported from time-to-time by Professor Henderson of the Museum and by part-time instructors and student assistants. The decade following the war was a period of growth, followed by a period of retrenchment during the Great Depression.

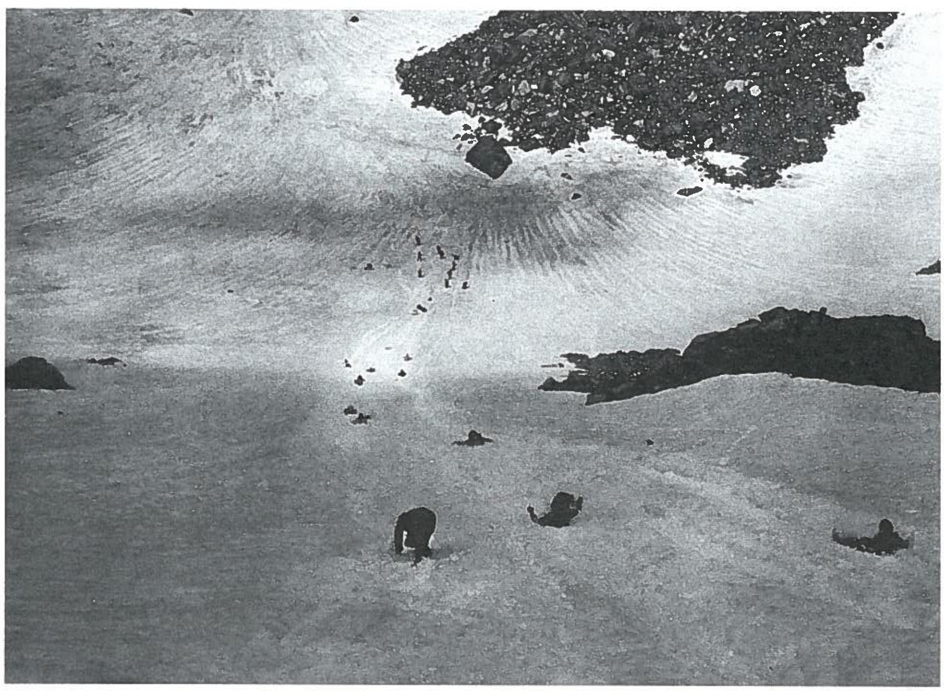
The Roaring Twenties

Like their counterparts at other universities across the nation, students at the University of Colorado adapted with enthusiasm to the stereotypes of the postwar era. "Sheiks" and "flappers," along with raccoon coats, roadsters, and hip flasks were much in evidence. Fraternities were accused of sponsoring sex orgies and consuming copious quantities of bathtub gin. Football, which had been around in a quiet way since the early years of the University, suddenly became a matter of great importance and took precedence over more prosaic academic endeavors.

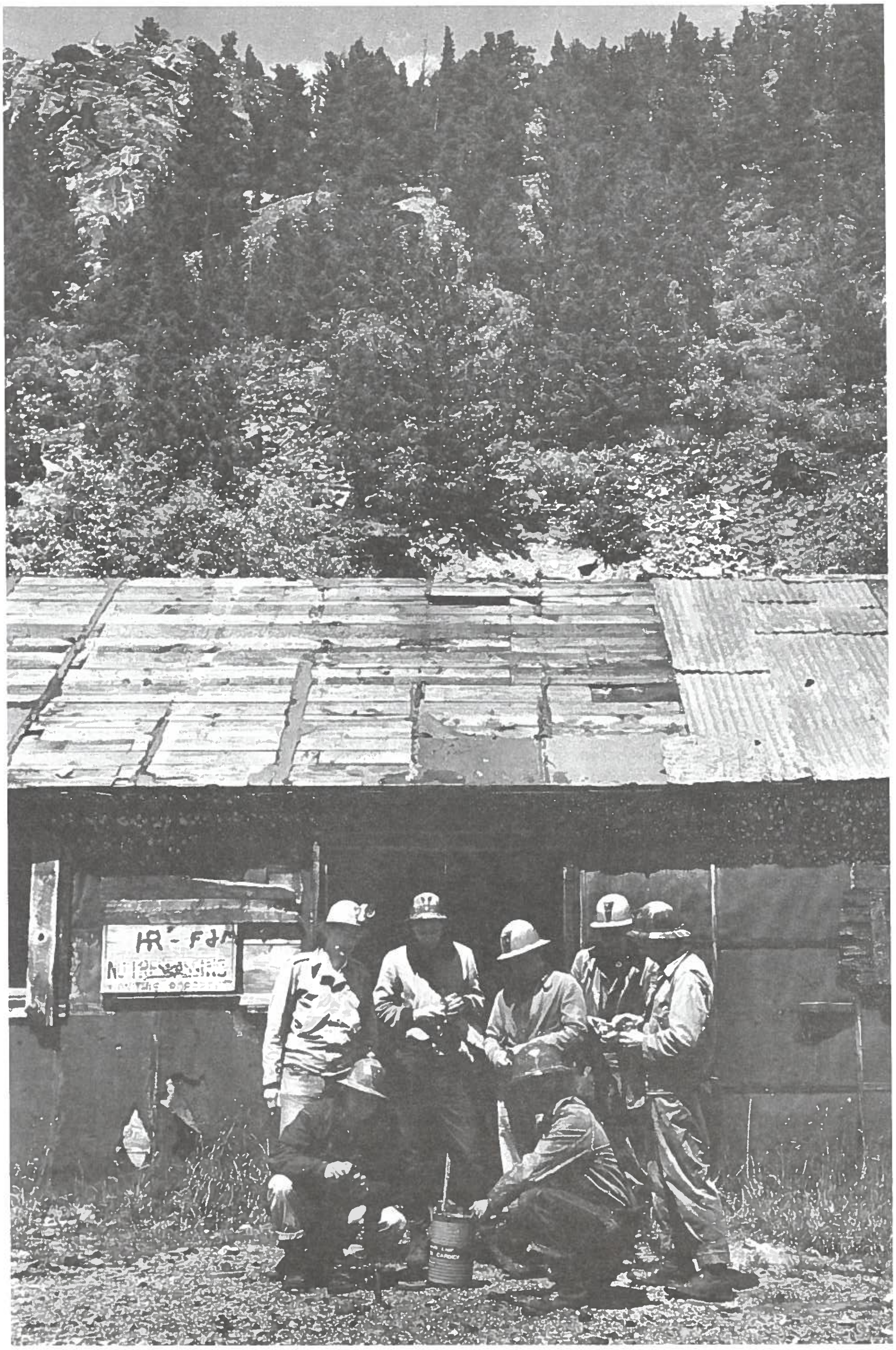
Legislators from ranch communities throughout the state were not favorably impressed with the campus activities, and



Science Lodge, summer of 1947.



Science Lodge Students at Arapahoe Glacier.



Science Lodge class in mining geology at White Raven Mine near Ward.

the Denver press was periodically critical of the atmosphere of permissiveness that appeared to prevail. As on previous and future occasions when the public image of the University was at low ebb, the effect was translated into lack of appropriation dollars. President Norlin found that appeals for support of programs he was trying to initiate often fell on deaf ears. A winning football squad, competing with some of the nation's name teams in the late twenties, removed some of the tarnish.

There is no record that geology students were involved in the prevailing episodes of misbehavior, nor is there any proof that they were not. In any event, the Department suffered with the rest of the University during the economic dry spell, and new faculty positions sought at the end of the war were not forthcoming immediately. However, substantial progress was achieved later in the decade.

One of the major achievements during the twenties was the establishment of Science Lodge as a summer field camp for geology and biology, beginning in 1922. The original log building, or "lodge," for which the camp was named, came to be surrounded in time with other general purpose buildings and a cluster of cabins for students and faculty. The camp was located on land inherited by the University, a mile west of the Peak-to-Peak Highway on the Rainbow Lakes Road at an elevation of 9,000 feet. It continued to be used for summer field instruction, mainly for undergraduates, for nearly 30 years. During the latter part of this period, Harvard University became affiliated with the operation, sending undergraduate geology students to the camp for summer field instruction as a part of their training. Subsequently, the camp was taken over by the Institute for Arctic and Alpine Research as a mountain research station for graduate students and faculty in biology and Quaternary geology. It continues to function in that capacity.

A second achievement during this period was the development of a program in geography, building on a foundation initiated by Fenneman and continued by Worcester. Clarence A. Newman was appointed Assistant Professor of Geography in 1923, the first professional geographer to come to the campus. He shortly resigned and was succeeded by Ralph D. Brown in 1925, who remained for a similarly brief period. In that same year, Harold A. Hoffmeister, a recent graduate of the Department was appointed Instructor in Geology. Following Brown's departure, Hoffmeister was called upon to teach courses in geography. He became absorbed in the subject and shortly took leave of absence to embark on a Ph.D. program at the University of Chicago. Returning as an Assistant Professor in 1929, he devoted his major effort to building a geography curriculum. As a result of his work, the program grew, and the Department of Geology and Mineralogy became the Department of Geology and Geography, a title it retained until Geography became a separate department in 1957.

A third achievement during the twenties was in permanent additions to the faculty and in broadening the curriculum to include programs in paleontology and sedimentation. The nucleus of a program in paleontology, begun by Junius Henderson through the Museum, was supported from time to time by interim appointees, none of whom chose to remain. In 1922, Walter C. Toepelman was appointed to develop a curriculum. "Toep," as he was known to his friends and colleagues, was born of German immigrants in Madison, Wisconsin. He attended the university there but transferred to the University of Oklahoma, where he completed a B.A. degree in 1916 and in the same year embarked on a doctoral program in paleontology at the University of Chicago. His studies were interrupted by military service in World War I, but he subsequently completed the Ph.D. in 1925. Following his return from the war, Toep spent much of his time for two years on thesis work in the Dakota Badlands. It was there that R. D. George tracked him down and persuaded him to join the staff at Colorado. Thus began an association that continued until he was incapacitated by a stroke in 1957. His premature death came a year later, soon after his sixty-fourth birthday.

Toep took over the teaching of courses in invertebrate and vertebrate paleontology and established for the first time a course in micropaleontology. Soon after his appointment as a full professor in 1928, he elected to teach the introductory courses in physical and historical geology. During the decade that followed, he came to be regarded by his students as a spellbinder. Many of the Department's distinguished alumni were persuaded by Toep's eloquence to follow geology as a career. Growing out of his work in the general courses, Toep became interested in acquainting public school teachers and students in other disciplines with the role of geology in human affairs, an interest he shared with Phil Worcester. He developed courses entitled "Geology and Man" and "Minerals in Modern Industry," which he offered in the summer session beginning a trend that continues to the present.

A second addition to the permanent staff was Warren O. Thompson, who originated in California. The family moved to Boulder when his father was appointed Professor of Education at the University. He grew up in Boulder and, following a two-year stint as an infantry officer in the U.S. Army, enrolled at the University, completing a B.A. degree in geology cum laude in 1922. He taught for two years at Washington University in St. Louis and served as a geologist for the Midwest Refining Company before accepting an appointment as instructor at his alma mater in 1926. Once established in teaching, he embarked on a doctoral program at Stanford University, which he pursued on an interim basis, completing the Ph.D. in 1935. His doctoral thesis concerned the original structures of beaches, bars, and dunes, an interest he was to pursue throughout his professional career. The theme furnished a basis for his selection as an AAPG Distinguished Lecturer in 1958; his topic, "Ancient Beaches and the Search for Oil."

"Doc" Thompson, as he came to be known to his students and colleagues, added new dimensions to the Department's curriculum in the areas of sedimentation, stratigraphy, and petroleum geology, which had been largely lacking prior to his arrival. He also developed courses in field and structural geology, which he taught on the campus during the academic year and at Science Lodge during the summer session, where he served as Director from 1934 to 1947. He was employed intermittently as a field geologist and consultant by major oil companies, including Shell, Phillips, Pan American, Midwest, Stanolind, and the California Company, forming contacts that furnished scholarship funds and employment for his students, many of whom came to hold high positions in the petroleum industry. After World War II, he served for more than a decade as Head of the Department and played a major role in its development. After his retirement in 1967, he and wife Jane planned to travel and to pursue a variety of interests that they had long neglected. Unfortunately, their hopes were largely unrealized. Following a brief illness, Warren died in November 1968.

Aside from his professional contributions, two things stand out to mark the memory of Warren Thompson in the minds of those who knew him well. One was a charismatic personality that placed him at ease with strangers and accounted for his wide circle of friends. The other was his innate sense of humor and love of a good story. (The ones he liked best tended to be a bit earthy, but they were always funny.) These qualities endeared him to students and alumni in ways that few of his peers or successors have been able to equal. He was largely responsible for organizing a Denver-based alumni organization which still exists and over the years has furnished valuable support for the Department.

Other than those of Toepelman and Thompson, faculty appointments during the twenties proved to be ephemeral, either because the openings were temporary or the appointees chose not to remain. The list includes Clarence Newman, Russell Gibson, Arthur Tieje, John Vanderwilt, and Tom Hendricks, all of whom went on to notable achievements elsewhere.

Some details regarding the brief sojourn of Arthur J. Tieje, who was Toepelman's predecessor as the Department's paleontologist, are of interest. He began his career as professor of English after completing a Ph.D. in that subject at the University of Illinois in 1912. Because of poor health, he became attracted to geology as a means of getting out of doors. The interest led to a second Ph.D. at the University of Minnesota in 1920. He was appointed an assistant professor at Colorado in that year and remained until 1922, when he departed for Los Angeles, ultimately to become the department chairman at the University of Southern California.

Although Tieje's term with the Department was brief, he recruited a student, George Gaylord Simpson, whose name was to become enshrined among the world's immortals in paleontology. Fifty years later, Simpson, in accepting a medal awarded by the Paleontology Society, paid tribute to Tieje for launching him in his career while he was an undergraduate at the University of Colorado.

> I entered the University with the vague notion of becoming a poet or something. Following a beginning course in geology, I went on field trips with Tieje, and one evening after a hard day in the mountains, he and I staggered into the dining room of a resort hotel without taking sufficient time to spruce up. A child at the next table asked, "Mama, who are those bums?" Mama replied, "Shush; they are a strange kind of gentleman." Tieje's example and encouragement decided me that a paleontologist was the strange kind of gentleman I wanted to be.

The Dismal Thirties

The impact of the Great Depression on the University was severe due to a marked decrease in both public funds and student tuition as sources of operating income. Appointments to new faculty positions and replacements to fill vacancies were held to a bare minimum. However, the depression had the salutory effect of uniting students, faculty, and administration in a common effort. Although the faculty suffered wage cuts averaging 10 percent, they voted to set aside an additional percentage of their salaries to create student employment in the form of research assistantships and clerical and custodial help, paying an average of 30 cents per hour. Despite a tight budget, the administration increased the sum available for student loans and grants. It also provided a clearing house for distribution of clothing for needy students, donated by more affluent students and faculty.

The effect on the Department was not without a brighter side, as young geologists who found themselves without employment and graduates who had no prospect of obtaining jobs returned to school for further training, despite a lack of ready cash. As a consequence, the Department was able to retain existing programs and its faculty of six members, albeit on a limited budget. A major blow was the demise of the Colorado Geological Survey in 1930; the State Legislature decided that this was one of the tax supported services that had a low priority at the time. R. D. George, who had guided the course of the Department from its inception, retired to a well-earned rest in 1933, and P. G. Worcester was chosen to assume the headship during this difficult period.

During the twenties, Warren Thompson had organized a summer course in advanced field geology to provide additional training in field mapping for graduate students. By the summer of 1931, the $50 fee for the course ($30 for tuition, $20 for food and transportation) loomed as a major obstacle to enrollment. Warren recounted the situation, in characteristic Thompson prose, in a piece which he wrote for the Alumni Newsletter of January 1964. It is worth repeating, with minor editing in the interest of brevity.

"This is the story of a small group of intrepid students of geology at the University of Colorado who rose from obscurity to positions of prominence in industry and public service. It is the summer of 1931. We still suffer from the big crash of 1929. The Colorado Geological Survey has folded for lack of funds, and there seems to be no way for these budding geologists to get practical experience.

"Dean Durham, then Dean of the Summer Session, insists that we cannot have a class in Advanced Field Geology to provide such experience unless we have six students. We have Robert E. (Squatlow) Murphy (M.A. '32), Edwin (Roundy) Kimball (M.A. '32), Walter (MacHosenose) Nygren (M.A. '35), George (Fuzzy) Worden (A.B. '33), and a ready and willing instructor who needs a summer teaching job. We are two men short of the minimum requirement for paying the instructor's salary. Julian (Virgie) Low (A.B. '35) at this time is working 18 hours a day, sleeping 5 (nobody ever found out what he did with the other hour). He is janitor at the Geology Building, washes dishes at a local cafe, and goes to school. We try him. No money. I lend him $50, which he paid back at the end of the summer. Now we have five. In desperation we resort to sharp practice. Louie (Curly) Quam (M.A. '32) and Howard (Howdy) Stagner (M.A. '33) each put up half of the $30 tuition fee, and Louie signed up. Louie never did go and neither did Howard, but both felt that they had helped to make the course possible. I had a '27 four-cylinder Chevy touring car, and Julian had a vintage Model T roadster. This was our transportation.

"We stayed in Boulder for 10 days and mapped the Haystack Anticline; then we took off. We spent three days in Coal Creek Canyon looking at the metamorphics. Later we mapped the Alaska Mine near Ward and went to Box Elder Creek in northern Colorado, where we mapped and measured sections. Murphy spent a lot of time chasing young rabbits to save on the meat bill. After several days camping, we made a wild goose chase to Alcova, Wyoming to look at a dinosaur skeleton and take in some Wyoming geology. Five and a half weeks from the start, we left Casper for Boulder. Each car was full of gas, and jointly we raised $1.26 for the trip home. In Cheyenne we had a cup of coffee for dinner and spent the rest on gas. We got to Boulder at midnight with 5-1/2 weeks of practical experience under our belts.

"Where are these guys today? Virgie Low is Senior Research Geologist and Technical Specialist in New Orleans for the California Company. Along the way he worked for the Park Service, for the USGS, and for the State Engineer in Utah. He has written two well-known books, *Plane Table Mapping* and *Geologic Field Methods*, plus numerous additional articles on a variety of subjects. Squatlow Murphy is no less than Division Geologist for Magnolia (Mobil) in Roswell, New Mexico. Roundy Kimball, when last heard from, was Division Geologist with Continental Oil Company in Shreveport. MacHosenose Nygren went back to the ranch at Nucla and finally migrated into foreign work, spending many years in various parts of South America. Fuzzy Worden went back to his ranch near Colorado Springs and has not been heard from since. Lou Quam, one of the guys who put up $15 to help make the course possible, is now Director of all Earth Science Research for the Office of Naval Research, having acquired a Ph.D. at Clark University along the line. Howard Stagner spent many years as a Ranger-Naturalist in various national parks and ended up in Washington, D.C., as Head Ranger Naturalist for the Park Service."

Despite the state of the economy, the University managed to provide funds for employment of graduate assistants. One such position was awarded to Ernest E. Wahlstrom in 1932 to assist R. D. Crawford on the condition that he return to school for graduate work, having completed requirements for the B.A. degree in geology a year earlier. Thus began an association between Ernie Wahlstrom and the University that was to last for nearly half a century until his retirement in 1978.

Following completion of a Master's degree, Wahlstrom embarked on a Ph.D. program at Harvard. A measure of Professor Crawford's magnanimity is indicated by the fact that, although himself a Yale man, he urged Wahlstrom to attend Harvard and recommended him for financial aid. After a year at Harvard, Ernie was offered an instructorship at Colorado to teach economic geology and geophysics. The $1,800 stipend was too much to turn down. His new boss was Phil Worcester who had just acceded to the headship. For the next two years, Ernie combined his teaching assignments with work on a doctoral thesis, completing the Ph.D. in 1939, after which he returned to the Department for good.

In the years that followed, Wahlstrom rose through the ranks to a full professorship, ultimately to become Department Chairman and later Dean of Faculties and Vice Provost of the University. In his spare time, he managed to publish six books and more than 30 major articles. In one of the articles (*GSA Bull.*, 1947), he took issue with the then prevailing hypothesis of multiple Cenozoic erosion surfaces in the Colorado Rockies, citing evidence for a single widespread surface, which he presumed to be of late Tertiary age. Although his assumption of age proved to be incorrect, the concept of a single surface was upheld by detailed work performed a quarter of a century later. In a second article (*GSA Bull.*, 1948), he showed that the altered zone beneath the Fountain formation west of Boulder is a remnant of the widespread early Carboniferous regolith in central Colorado. Chemical analyses of the altered rocks, which he performed in his laboratory, indicated laterization, supporting a warm, moist climate for the time.

Ernie's extracurricular activities over the years included consulting work with local mining companies and the Denver Board of Water Commissioners. Although now a resident of Redmond, Washington, he continues to serve as a geotechnical consultant to the Denver Water Department.

Warren W. Longley, another long-term addition to the faculty, was persuaded to join the Department in 1939 and arrived in 1940. This followed his acquiring a B.S. degree at Acadia University in his native Nova Scotia, a Ph.D. at the University of Minnesota, and five years teaching experience at Dartmouth. Warren's background in math and physics and his field experience in searching for mineral deposits in the Canadian bush made him well suited to teach courses in economic geology and geophysics. Ultimately, he was to teach a variety of courses, including hydrogeology, air photo interpretation, metamorphic petrology, engineering geology, and structural geology. During World War II, he was drafted to teach courses in physics and general physical science. In later years, he devoted his considerable talents to courses designed to acquaint the general public and students in other disciplines with the role of geology in human affairs. In addition to his duties in Boulder, he taught for many years at the CU Denver Center, making the 50-mile round trip on two or more evenings a week and conducting field trips on weekends.

Despite his teaching load, Longley found time for research and consulting activities. Beginning in his student days and extending into the early fifties, he spent his summers on the Canadian Shield conducting geologic investigations for the Canadian Geological Survey and the Quebec Department of Mines. He also consulted intermittently for the Kennecott Copper Company and its Canadian subsidiary, Kennco Exploration Ltd. His interest in geophysics led him to acquire a seismometer, which he mounted in the basement of the Geology Building, and to negotiate having the Department named a regional seismic station. In his later years Warren became involved in work with the U.S. Justice Department as an expert witness in federal court proceedings to determine the value of mineral lands.

In the mid-fifties, Longley acquired a few acres of land southeast of Boulder and set about building a house in his spare time. Although he had had no prior experience in construction, he sketched a design and for the next three years became a weekend carpenter, electrician, plumber, cement contractor, and painter. On the adjacent land, he developed a small dahlia and iris farm, indulging in a love of flowers he had acquired in early youth. Over the years he developed many new varieties, winning numerous prizes at local flower shows.

Warren hung up his cap and gown in 1977 and retired to devote more time to his flowers, consulting work, and research on stereo projection equipment and a process for improving ground water quality by precipitating compounds of iron and other metals in the aquifer. Although he sustained a heart attack a few years ago, and wife Betty keeps him on a short leash, he remains active and alert.

Two other faculty members who were recruited in the late thirties but did not remain beyond the war were Robert W. Wilson and Louis O. Quam. Wilson, a vertebrate paleontologist with a Ph.D. from Cal Tech, was appointed in 1939 and remained until 1946, when he moved to the University of Kansas. Quam, whose field was geomorphology and physical geography, received an M.S. degree from the Department in 1932 and a Ph.D. from Clark University in 1938. He served as an assistant professor from 1938 to 1941, leaving for service in the Navy. He subsequently became Head of the Geographic Branch of the U.S. Office of Naval Research and later Chief Scientist in the Office of Polar Programs of the National Science Foundation.

The Second World War 1941-1945

The role of the University in World War II was considerably greater than in the prior conflict a quarter of a century earlier. The normal student population, both male and female, was depleted by military recruitment. However, the impact on enrollment was modified by the University's being chosen to host a Navy V-12 program for officer training and by a marked expansion of ROTC activities. Beginning in 1942, the University organized a year-round operation to meet commitments to the military. The schedule of three academic quarters, plus a 10-week summer session that had been followed between the wars, was changed to a trimester system of three 16-week terms, beginning July 1, November 1, and March 2, plus an eight-week summer session beginning July 1 and running concurrently with the summer/fall trimester. Classes and laboratory sessions were scheduled for six days each week, during which faculty and staff members were expected to remain on duty. The expanded schedule enabled the University to function effectively, despite a substantial reduction in teaching and support personnel due to departure of faculty and staff for military service.

The Department's role in this enterprise was to modify its curriculum to accommodate the training of military personnel while continuing to train geologists and geographers for ultimate civilian service. Courses in map reading, air photo interpretation, meteorology, and military geology were added to an already crowded agenda. Some of these were continued into the postwar period.

At the close of World War II, the Department retained a tenured faculty of six (Worcester, Thompson, Toepelman, Hoffmeister, Wahlstrom, and Longley), R. E. Crawford having been lost to retirement in 1940. Between the wars, the student body increased substantially and the Department became noted for producing graduates well-trained in fundamentals at the Bachelor's and Master's levels, most of whom found employment in the petroleum industry. Few Ph.D's were awarded during this period, the recipients being employed mainly in government agencies and academic positions.

The Postwar Period (1946-1960)

The years following World War II were a period of trial and transition for the University. An immediate problem was created by the rapid increase in student population from 4,500 in 1945 to 10,500 in 1947. More than half of the new students were veterans who took advantage of Public Law 346 (the G.I. Bill) passed by Congress in 1944. Administrators had anticipated an enrollment increase but not of this magnitude and were unprepared to meet the requirements. Vetsville, a housing facility for married veteran students, consisting of barracks and Quonset huts obtained from military surplus, was hastily constructed on the Boulder Creek flood plain below the campus. A crash program was adopted to round up additional faculty, many of whom were housed in "winterized" summer cottages in Chautauqua Park, leased from the city for this purpose.

The population problems were exacerbated by uncooperative weather conditions. A succession of early snow storms in November 1946 dumped 42 inches of snow on the Boulder area. Meanwhile, a coal strike resulted in closure of the University power plant and forced suspension of classes for the fall semester following the Thanksgiving recess.

The problems of crowding and inclement weather were tempered by the attitudes of the students and the new faculty. Contrary to the prediction of R. M. Hutchins (then President of the University of Chicago) that the G.I. Bill would result in colleges being beset by hordes of "educational hobos," the veterans who descended on the University of Colorado were eager to learn and a joy to teach. For the most part, they were mature beyond their years and leavened the student body in a way that has not been equalled since. As the G.I. students graduated, they were replaced by other students from out-of-state. By the early fifties, more than half of the students were nonresidents, and many were from foreign countries, the mixture providing a cosmopolitan flavor that had been lacking in earlier times.

In addition to pressures resulting from rapid growth and ever-present financial concerns, the late forties and early fifties were fraught with problems stemming from the Korean conflict, communist "witch hunts" during the McCarthy era, and efforts to stamp out racial discrimination among campus organizations. Robert L. Stearns resigned as President in 1953, having succeeded George Norlin in 1939. He was followed by Dr. Ward Darley, the third M.D. to serve as President, who was succeeded in 1956 by Quigg Newton, a former mayor of Denver.

The Newton administration of the late fifties and early sixties was a time of comparative prosperity and tranquility. Faculty salaries doubled, and the University became the fifth largest educational institution west of the Mississippi. The tranquility was short lived, however, as clouds of the Vietnam War began to gather, leading to widespread student unrest in the decade that followed.

Against the background of rapid growth, political instability, and economic uncertainties that haunted the University, the Department prospered beyond its expectations. Many of the returning veterans chose geology as a career, and within a few years the number of student majors in the Department more than doubled. The building erected in 1911 and equipment inherited from the teens and twenties were wholly inadequate to accommodate the burgeoning family. These conditions led to an extensive renovation in 1951. For a brief period, the Department became one of the better housed and equipped departments of earth science in the central United States. The large enrollment required additional faculty, and in the 15 years following the war, the geology faculty increased from 5 to 13. The geography contingent which had increased to four, organized a separate department in 1957.

Among the new faculty were two females, the first to grace the Department's roster in its initial half century. Mary O. Oswald, one of the Department's own Ph.D.'s (the first awarded to a woman) who had completed a doctorate in 1944 and taught at the

University of Illinois for a year, joined the faculty in 1946, soon after her marriage to W. R. Griffitts of the USGS, to teach invertebrate paleontology and stratigraphy. Zena M. Hunter, also a Department Ph.D. (the second female doctorate), was hired in 1947 to direct the burgeoning introductory program. Both women ultimately resigned to assume domestic responsibilities, Griffitts in 1950 and Hunter in 1960. However, they pioneered a trend that has continued with regard to the hiring of female faculty.

During her nearly 15 years of service, Dr. Hunter left a lasting mark on the Department. A former high school teacher of chemistry and physics, she established a rapport with beginning students that became a hard act to follow. Although her classes were large, by the end of the second week she knew all of her proteges by first and last names. Her doctoral thesis, which involved a compilation of the structure and stratigraphy of the northern Front Range foothills, became a reference work widely used by industries and academic institutions in the region. During the academic year 1955-1956, she was a Fulbright lecturer at the University of Mandalay, Burma. In 1960, she resigned to become the wife of Philip Andrews, an alumnus of the Department (B.A. 1921) and a Boulder consulting geologist.

Two male members of the early postwar faculty, Harrison Murray and Russell Honea, are no longer with the Department. Murray was appointed as an instructor to assist with the student overload after completing a Master's degree in 1949. His plans to take a doctorate and remain in academic life were interrupted when he became involved in the uranium boom of the early fifties and later in petroleum exploration. He left to join the Lyon Oil Company and subsequently rose to an executive rank.

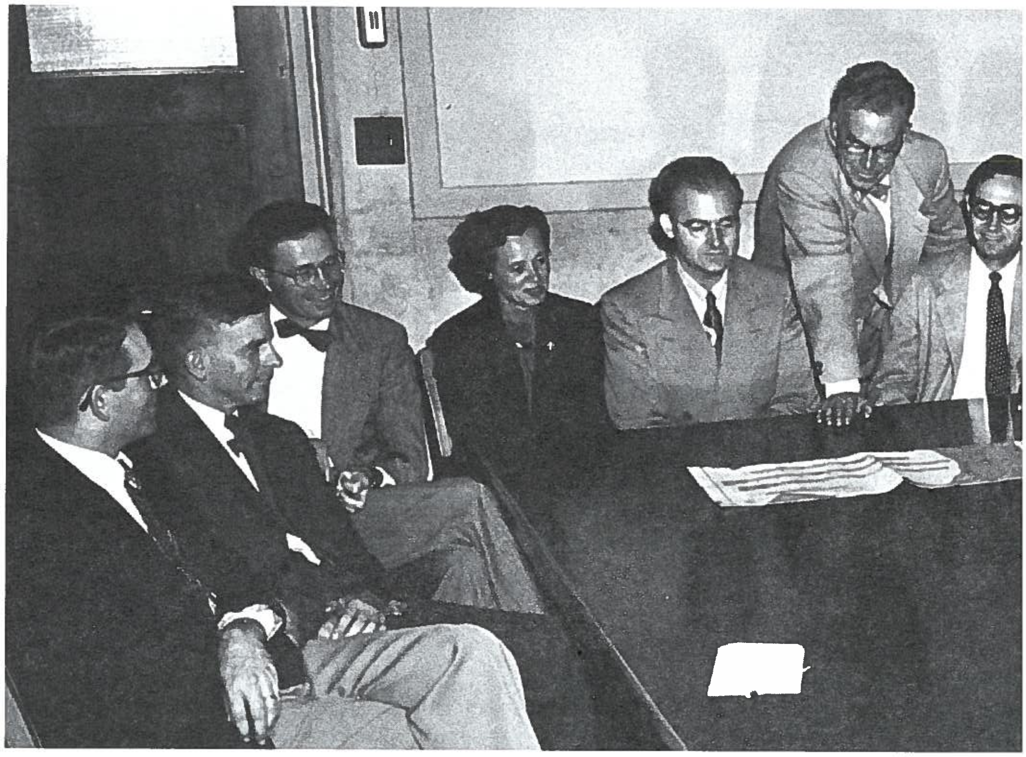
Honea (Colorado B.A., 1953, M.S., 1955; Harvard Ph.D., 1958) joined the teaching staff in 1958 to organize a program in geochemistry, a new field of endeavor for the Department. His courses in sulfide geochemistry, crystal structure, and X-ray analysis were popular with graduate students and advanced undergraduates. He required his students to build structural models of many of the common minerals. Most of the models are still in use or on display as teaching aids in several courses. Honea resigned in 1968 to establish a consulting practice in the minerals industry, which he still pursues from his office in nearby Broomfield. His work with major mining companies has taken him to the far corners of the planet.

During the period 1946-1958, eight permanent members were recruited to the Department faculty. Four of these (Chronic, Curtis, Koerner, Warner) are now retired; the other four (Braddock, Bradley, Eicher, Walker) remain at their posts. Together with three carry-overs from the prewar era (Longley, Thompson, Wahlstrom) and Zena Hunter, they formed the core of the Department's professional staff until the early sixties.

Among the first of the postwar recruits was Larry Warner (Ph.D., Johns Hopkins, 1942), fresh from two years in the Antarctic Service (1939-1941) and four field seasons with the USGS in the wilds of Alaska (1942-1945). He was looking for a place with lots of sunshine, reasonably dry and free of bugs, in close proximity to interesting geology. Colorado seemed to qualify on all counts. At the time he applied, the Department was desperately in need of help, and he got the job beginning in the fall of 1946.

Trained as a generalist during the Great Depression, when one had to be prepared for any available employment opportunities (on the premise that if you knew a little about a subject, you could fake it until you learned the ropes), Larry taught a variety of courses during his first decade on the campus. Ultimately, he alighted upon a combination of mineralogy, tectonics, and field geology, which made little sense to professional peers but was not out of keeping with his early interest in the structural control of ore deposits.

Early on, Ernie Wahlstrom got Warner involved in geotechnical work with the Denver Water Department. In the late fifties, Denver finalized plans to drive the 23-mile Harold D. Roberts Tunnel through the central Front Range. Detailed surface and underground mapping along the route of the tunnel provided Larry with fascinating insights into Rocky Mountain geology. He came to recognize the Rocky Mountains, of which the Front Range is the largest unit,



Geology-geography faculty in the early fifties. From left to right: Smith, Koerner, Loeffler,

as probably unique among mountain systems of the world and devoted much of his later career to a search for ways to unravel the kinematics and dynamics of their formation.

Larry retired in December 1981 after 35 years with the Department. He continues to serve from time to time as a geotechnical consultant to the Denver Water Department and to work on projects related to Rocky Mountain tectonics.

Another early recruit was Harold E. Koerner, who arrived in 1947, having taught at Lafayette College, Pennsylvania after receiving a Ph.D. at Yale in 1939. During his 25 years with the Department, Harold taught courses mainly in vertebrate paleontology and historical geology. Graduate students who included Harold in their examining committees had to be prepared to answer questions about fishes, dinosaurs, and pterodactyls in relation to their origins, habitats, and roles in geologic history. Although relatively few students chose to specialize in vertebrate paleontology during this period, Harold's courses were always popular. He was adept at making his subject interesting and pertinent, regardless of the student's field of specialization.

Koerner had served in his early years as a collector of fossil vertebrates for the Denver Museum of Natural History and the Peabody Museum at Yale. His summer activity included stratigraphic field work and collecting fossil vertebrates in the Rocky Mountain region from New Mexico to Montana and in parts of the Colorado Plateau. His work led to important conclusions regarding stratigraphic correlations and paleoenvironments.

Harold retired in 1971 and has continued to live quietly in Boulder in a manner consistent with his long and fruitful professional career.

Next to arrive on the scene was John Chronic, who was recruited in 1950 from the University of Michigan faculty, which

Hunter, Longley, Thompson (standing), Walker, Wahlstrom, Kelly, Toepelman, Hoffmeister, Murray, Warner, Chronic

he had joined following completion of a Ph.D. at Columbia. Starting out with a degree in petroleum engineering from the University of Tulsa, John's field of specialization shifted at the graduate level to invertebrate paleontology. He took over the duties relinquished by Mary Griffitts at the time of her resignation.

John's research led to publications on a variety of subjects. Among his more interesting discoveries was a segment of limestone containing Silurian fossils lodged in a diatreme near the Colorado-Wyoming border. Prior to this discovery, Silurian strata were unknown in Colorado and were assumed to be absent.

John's travels in connection with his teaching and research activities read like a sea captain's journal. Although many of the more recent faculty have outdone him in this regard, he stands out as a pioneer in representing the Department in faraway places. His foreign service included an exchange professorship at the University of Edinburgh in 1958-1959, a visiting professorship at the University of Addis Ababa, Ethiopia (1965-1966), a sabbatical year (1969-1970) of travel and study in Australia, the South Pacific, and India, and an exchange professorship at the University of Puerto Rico (1978-1979). There were also some just-for-the-helluvit trips to North Africa, Europe, and the Orient.

John retired in 1980 after 30 years of service. He remains active with a consulting firm based in Houston.

The last of the retirees to join the faculty during the early postwar era is Bruce F. Curtis, who was recruited from a promising career in the petroleum industry. Bruce is a Colorado native, having been dropped off in Denver by the stork during the flu epidemic in 1918. Following baccalaureate work at Oberlin College, he took an M.A. degree at Colorado in 1942. After service in the Army Air Corps during World War II and a stint with the Continental Oil Company, he enrolled for doctoral work at

Harvard, completing the Ph.D. in 1949. Returning to Conoco, he rose rapidly to become Regional Geologist for the Rocky Mountains. At that point, he began to have second thoughts about what he wanted to do with his life. In 1957, he was invited to fill an opening in the Department and, perhaps with some misgivings, elected to join the Ivory Tower in a position that promised twice as much work for half as much pay.

Bruce's teaching had to do mainly with the training of petroleum geologists, environmental geologists, and civil engineers. He is widely recognized for his contributions in editing, having served as Associate Editor of the *Mountain Geologist*, Associate Editor of the *GSA Bulletin*, and Acting Publications Editor for *GSA*. Among the better known volumes that bear the mark of his work are "Natural Gases of North America" (*AAPG Mem. 9,* 1968), "Geologic Atlas of the Rocky Mountain Region" (*RMAG*, 1972), and "Cenozoic History of the Southern Rocky Mountains" (*GSA Mem. 144*, 1975).

When Warren Thompson resigned as Head of the Department in 1960, the faculty voted to join other departments in adopting a rotating chairmanship. The following year, Bruce became the first chairman, a position he held until 1967. He shortly found himself involved in numerous other assignments at the college and university levels. The breadth of his talents and interests is reflected in the fact that he served for nearly two decades on the Artist Series Committee, struggling with limited budgets to bring world renowned performers to the campus.

Bruce retired in 1983 after 26 years of service to the Department and the University. He has busied himself with part-time teaching and consulting work, while continuing intermittent trips to interesting parts of the earth with his wife Ruth.

Turning to the four postwar recruits who still retain faculty status, T. R. Walker was the first to arrive, joining the Department in 1953. Walker grew up in Madison, Wisconsin and was educated at the university there, completing a Ph.D. in 1952, following service in the Navy. He was employed briefly with the Illinois Geological Survey as a ground water geologist, while negotiating for an appointment in Boulder. The Department decided it needed a ground water person, and Ted got the job. However, it was soon apparent that Walker did not plan to follow a career in ground water, his first love being sedimentology, a field he was forced to share for a time with Warren Thompson. As Thompson tapered off on work with advanced students and approached retirement, the entire program in sedimentology fell to Walker. His courses in sedimentation and sedimentary petrology were highly rated by students for effective presentation and authoritative coverage. He was chosen for a University Teaching Excellence Award in 1982. His colleagues chose him to chair the Department for the period 1972-1975.

Although he disavowed a major interest in ground water, one of his principal contributions in the late fifties had to do with a ground water contamination problem related to waste disposal by the Rocky Mountain Arsenal. The Arsenal attempted to dispose of liquid waste remaining from nerve-gas experiments conducted during the war by pooling the liquid in evaporation ponds. However, the ponds leaked, contaminating the ground water regime in the area and resulting in damage to crops and livestock on nearby ranches. Ted was able to show from detailed studies that the contamination was traceable to the ponds. As a result of his studies, the Arsenal abandoned the evaporation method in favor of a deep disposal well, drilled to the basement complex near Derby. Injection of the fluid under pressure ultimately resulted in the Denver earthquakes, which received wide attention during the middle and late sixties. The three largest shocks occurred in 1967-1968, ranging in magnitude from 5.0 to 5.5. One might argue that Ted was indirectly responsible for inducing the earthquakes, although he has never been credited officially with that achievement.

Walker's major research activity has been in regard to the origin and significance of red beds, an effort which has earned him the title of "Red Bed Ted," as well as international renown. His interest in the subject was kindled during the mid-fifties while he and Larry Warner ran the summer field camp for Advanced Field Geology near McCoy. Studies conducted by Ted and his students on red strata in the Minturn formation led him to conclude that the contained hematite pigment was not a detrital product derived from an iron-rich regolithic provenance, as had long been supposed, but resulted from complex post-depositional reactions in which the iron was derived from mafic minerals contained in the original sediment. During the following two decades, financed mainly by grants from the National Science Foundation, Ted pursued his investigations in many parts of the world, including North Africa, the Middle East, western Europe, Mexico, and South America, as well as in various parts of the United States and Canada An important aspect of his work, on which he collaborated recently with Ed Larson, involves dating paleomagnetism in red sedimentary rocks. Since the magnetism relates to the iron pigment, which may have formed long after deposition of the sediment, the magnetic age may not correspond to the age of the stratum, as tacitly assumed by most investigators.

Ted's work has resulted in his being recognized as one of the world's leading authorities in his field. Resulting from this recognition, he has received numerous awards and special appointments. He was a Visiting Research Professor at Scripps Institute of Oceanography (1962-1963), at the Swiss Federal Institute of Technology (1968-1969), and at the Scott Polar Research Institute, England (1969). On more than 100 occasions he has been invited to lecture and to participate in seminars, symposia, and conferences in the United States, Canada, England, Switzerland, West Germany, and the Netherlands. He has served in a variety of posts at the regional and national levels in a half dozen professional societies, most recently as President of the Society of Economic Paleontologists and Mineralogists (1982-1983).

As Walker approaches ultimate retirement a few years down the line, his pace is more relaxed. Although he has reduced his teaching schedule to half time, he continues to refine his courses and to indulge in petrologic and geochemical studies of the effects of post-depositional mineral alteration on the properties of sandstones.

After Worcester's retirement in 1953, the Department was without a geomorphologist. The vacancy was filled by the appointment of William C. Bradley as Instructor in 1955, a year prior to his receiving a Ph.D. at Stanford. Bill straightway set about building a program of course work and research in geomorphology and Quaternary geology that served as a foundation for what has become, with addition of other faculty, one of the outstanding programs of its kind in the United States.

Over the years, Bradley has served the University and the city of Boulder in a variety of assignments. His sound judgment, quiet demeanor, and sense of humor rendered him effective in problem situations. He was Chairman of the Department for the term 1968-1972. He served on the Citizen's Advisory Committee in 1978-1979 when the city was confronted with the problem of whether to modify the channel of Boulder Creek as a flood control measure. His effectiveness as a teacher earned him the Faculty Assembly Teaching Award in 1981.

Over a period of more than two decades, Bill's research was financed by grants from the National Science Foundation and the U.S. Geological Survey. His work included a study of marine terraces in California, fluvial processes of the Knik River, Alaska, flood deposits at Lake Missoula, Montana, incised meanders on the Colorado Plateau, late Quaternary fault displacements in Utah, and Quaternary weathering and soil erosion in the Front Range. One of his recent projects dealt with a study of large boulders at the mouth of Boulder Canyon. The discharge required to transport them was calculated to be 22,000 cubic feet per second, with a flow velocity of about 20 feet per second and a water depth of about 15 feet. The discharge was estimated to correspond to a 500-year flood.

Bill's accomplishments have been recognized by his appointment to important professional posts. He was chairman of the local committee for the 7th Congress of the International Union for Quaternary Research, which met in Boulder in 1965, and was Vice President and President of the Colorado Scientific Society in 1967-1969. His assignments for the Geological Society of America include Chairman of the Rocky Mountain Section, 1972-1973, Chairman of the Division of Quaternary Geology and Geomorphology, 1976-1977, Chairman of the Headquarters Advisory Committee, 1977, and Councilor, 1978-1980.

Periodically, Bradley took leave of absence from the Department to try the climate and broaden his perspective in other regions. He was a Research Scientist Associate at the University of Texas, Austin, 1965-1966, a Visiting Lecturer at the University of Adelaide, South Australia, 1973-1974, and a Visiting Lecturer at the University College of Wales, Aberystwyth, 1982-1983.

A year after Bradley's appointment, a third person who retains a tenured faculty position was added to the Department roster. William A. Braddock, who had completed a B.A. degree with the Department in 1951, worked for two years (1952-1954) with the U.S. Geological Survey, and embarked on a doctoral program at Princeton, was appointed as Instructor in 1956. He achieved professorial status upon completing the Ph.D. in 1959.

Bill's teaching has centered mainly on courses in field and structural geology. His undergraduate courses have been designed mainly to acquaint students with geologic mapping techniques and the geometric analysis of rock structures. Advanced courses have dealt with physical and chemical processes of rock deformation and with microtectonic and petrofabric studies.

Braddock retained his association with the U.S. Geological Survey and managed to sell the agency on the desirability of working out the structure and petrology of the basement complex in the northern Front Range, a project that has occupied most of his summers from 1956 to the present. He was able to fund student assistants through this work, and some two dozen graduate theses have emerged from his effort. In collaboration with USGS colleagues, Bill was able to show that the Front Range basement has had a long and complex history involving three, and perhaps four, periods of deformation extending over a time interval comparable to the entire Phanerozoic.

Beginning in 1968, Braddock developed a laboratory for experimental deformation of fine-grained sedimentary rocks. The equipment is capable of deforming samples at temperatures to 500°C at confining pressures to 2 kb. for strain rates in the range 10^{-5} to 10^{-8} per second. It also can be used to perform creep tests at constant axial stress. This work has been supported by the Engineering Geology and Tectonics Branch of the U.S. Geological Survey with a view to obtaining data needed to evaluate the possibility of using shales as repositories for toxic wastes. Braddock and his students have carried out experiments, mainly low temperature creep tests, during intervals between field seasons in the Front Range Precambrian.

The last early postwar appointee who remains on the faculty is Don L. Eicher, who arrived in 1958, soon after completing a Ph.D. at Yale. Don was no stranger to the department, having taken B.A. (1954) and M.S. (1955) degrees at Colorado. His appointment filled a gap left by the loss of Walter Toepelman, who taught a course in micropaleontology, Don's special field of interest. Since his arrival on the scene, Eicher has worked steadily through his teaching and research to expand and improve the Department's offerings in paleontology, stratigraphy, and historical geology. The success of his effort is attested by the impressive list of his students who are now well-known paleontologists.

Don's research, supported in part by grants from government and industry, has centered primarily on problems related to micropaleontology and stratigraphy of Cretaceous formations in the Rocky Mountain region and adjacent parts of the Cordillera and Great Plains. His publications include three books. One, *History of the Earth*, which he coauthored with Lee McAlister in 1980, has become a widely used text and reference work.

Eicher's professional competence has been recognized by his appointment to offices in well-known professional societies and research groups. Among these are: Editor, *Journal of Foraminiferal Research* 1970-1973, Chairman, Committee for Advanced Geology Exam, Educational Testing Service, 1975-1978, Director of the Cushman Foundation, 1973-present (President, 1977-1978), member, JOIDES Planning Panel for Ocean Margin Drilling Program for the 1980's, and member, National Science Foundation Review Panel for Deep Sea Drilling Project, 1982. Foreign assignments include a stint as Lecturer in the Geology Department at the University of Edinburgh, 1968, participant in International Micropaleontological Congress, Geneva, 1967, and participant in Sixth African Micropaleontological Colloquium, Tunis, 1974.

Don served as Department Chairman during the period 1975-1980, which was a trying time for the University. Faced with a depressed economy, the Colorado Legislature cut the University's appropriation to the bone, forcing a substantial reduction in expenditures for personnel and teaching facilities. Eicher was able to steer a course that minimized losses to the Department during this period.

In terms of the Department's history, the postwar era may be said to have ended in the late fifties. At that time there was a rostered faculty of 14 members, plus 28 teaching fellows and graduate assistants. The number of declared undergraduate majors had risen to 169, and graduate enrollment reached 95. The faculty voted to tighten graduate entrance requirements in order to limit the number of advanced degree candidates to that which could be given proper attention with the facilities at hand. By the end of the decade, a marked reduction in undergraduate major enrollment resulted from collapse of the employment market.

Departure of the geographers to form a separate department in 1957 resulted in a temporary respite from crowded conditions in classrooms, laboratories, and offices. It also necessitated a change in title from Department of Geology and Geography to Department of Geology.

Other than for growth in numbers and change in name, by 1960 the Department had retained much of the structure and philosophy that had characterized its activities in the late forties. Its image was to change markedly in the years that followed.

A Time of Transition (1961-1979)

The decades of the sixties and seventies were times of change for both the Department and the University. Following Quigg Newton's resignation in 1962, the destiny of the University was guided during this period by three presidents: Joseph R. Smiley (1963-1969), Frederick I. Thieme (1970-1974), and Roland E. Rautenstraus (1975-1980). Their administrations were beset with the usual difficulties in addition to some different ones that presented new challenges.

The decade from the mid-sixties through the early seventies is recalled as one of widespread student unrest and activism, sometimes resulting in violence. Passage of the Civil Rights Act by Congress in 1964, followed shortly by the assassination of John F. Kennedy, inaugurated a period of militancy and confrontation. Escalation of the Vietnam War under President Johnson and assassination of Martin Luther King and Robert Kennedy in 1968 resulted in a further alienation of college youth toward traditional values. Respite from student unrest came in the mid-seventies, following the conclusion of the Vietnam conflict.

Despite the generally unfavorable climate for academic achievement, the interval of unrest was marked by substantial accomplishments. In 1965, the University was awarded a Center of Excellence grant by the National Science Foundation to strengthen programs in science and engineering. This was followed in 1967 by its election to the Association of American Universities. During the Thieme years, the University administration was reorganized, the president becoming the executive officer for all four campuses (Boulder, Denver, Health Science, and Colorado Springs), each campus being administered by a chancellor. Lawson Crowe of the Philosophy Department, who had served as a Vice President, became the first Chancellor for the Boulder campus.

During the time of student unrest and financial uncertainties, the Department underwent significant changes that were to alter its course for the future. Prior to the late fifties, its effort had been directed primarily toward training students at the baccalaureate and masters levels for employment with industry and government agencies. Teaching loads were heavy, and research, largely field-oriented, was left to the initiative of the individual faculty as a secondary pursuit. Over the two decades that followed, teaching loads were reduced and more emphasis was placed on research. The curriculum became more specialized and included training in the use of sophisticated equipment and laboratory techniques as a means to supplement field observations.

The seeds of change were sown in 1958 when the Department decided to launch a program in geochemistry, resulting in the appointment of R. M. Honea. When Zena Hunter resigned two years later, the decision was to replace her with a person trained in geophysics to initiate a program in that discipline. David Strangway, with a doctorate from University of Toronto and a special interest in paleomagnetism, was selected in 1961 to fill the post. Although neither Honea or Strangway remained to reap the rewards of their early labor, both were able to lay foundations for future work in their fields and to procure grant funds for graduate research and basic equipment.

Strangway departed in 1964 to join the faculty at Massachusetts Institute of Technology. His replacement was J. C. Harrison, a native of Great Britain and a Cambridge Ph.D., whose special interest was in gravity and geodesy. Chris was persuaded to leave the Institute of Geophysics at University of California, Los Angeles, and come to Boulder in 1965. A year later, Edwin E. Larson (Ph.D. University of Colorado, 1965) was appointed to carry on work in paleomagnetism begun by Strangway. The course work and research support developed by Harrison and Larson provided a firm foundation for a future program in solid earth geophysics.

Soon after his arrival on the campus, Chris developed a liaison with persons in physics and engineering whom he perceived to have teaching and research interests that would supplement the geophysics program. These relationships led to the founding of CIRES (Cooperative Institute for Research in Environmental Sciences) in 1967 as a joint venture between the University and NOAA (National Oceanic and Atmospheric Administration), which had established headquarters in Boulder with the National Bureau of Standards. In addition to Geology, the institute was organized to include the Departments of Aerospace Engineering, Astrogeophysics, Chemistry, Civil Engineering, Electrical Engineering, Mechanical Engineering, and Physics-Astrophysics. Harrison served as acting director of the institute from 1967 to 1972 while the search for a director was in progress.

Harrison resigned his faculty post in 1983 to return to California where he accepted a position with private industry in Santa Barbara. During his nearly two decades with the Department, he made substantial contributions to its development. His courses in solid earth geophysics and exploration geophysics became important elements in the curriculum. He installed a recording drum, attached to the Department's seismograph, which permits students to observe at first-hand the records of major earthquakes from around the world. Although directed primarily toward his interests in gravity and geodesy, his research covered a spectrum of activities, including participation in the CIRES Aleutian project in the mid-seventies. An interesting aspect of his work in the local area grew out of data gathered from a tilt meter system which he installed in the Poor Man Mine west of Boulder. Over a period of time, Chris was able to correlate sensitive tilt measurements with seasonal accumulation and melting of snow along the crest of the Front Range.

Concurrently with the establishment of CIRES, the University decided in 1966 to reorganize and expand INSTAAR (Institute for Arctic and Alpine Research), which had been founded in 1951 with J. W. Marr of Biology as its director. Bill Bradley, the Department's representative on the governing board of INSTAAR, played a part in the reorganization. Four men who were involved in Arctic research for the Canadian government were recruited to the new institute in 1967. One of them, John T. Andrews, became a member of the Department in 1968. These events coincided with the arrival of Peter W. Birkeland, who was imported from the University of California, Berkeley, to develop a program in soil geology and Pleistocene stratigraphy. The team of Bradley, Andrews, and Birkeland, together with other INSTAAR personnel, formed a base for what was to become an internationally recognized group in Quaternary geology.

By the late sixties, programs in geochemistry, geophysics, and Quaternary geology had been firmly established as components of the Department's structure, the latter two being augmented by its affiliation with CIRES and INSTAAR. Birth of the new programs was not accomplished without labor pains. Increasing the size of the family required establishing priorities for allocation of limited resources, and the choices arrived at were not always universally popular. However, a pattern of change evolved that continued without major interruption into the mid-seventies. The pattern was reflected particularly in the composition of the faculty. Between 1960 and 1975, the roster increased from 14 to 19 and acquired a cosmopolitan flavor that had been mostly lacking previously. Short biographical sketches are given for those faculty who arrived during this interval and remain with the Department.

Edwin E. Larson (B.A., 1954, M.A., 1958, University of California, Los Angeles; Ph.D., 1965, University of Colorado) joined the faculty in the fall of 1966, following postdoctoral work at Massachusetts Institute of Technology and the University of Tokyo. Ed's major training is in geology, but his background in physics and mathematics enables him to bridge the gap between geology and geophysics in ways that few of his contemporaries have achieved. This background was a major factor in his being selected for the position from a large field of candidates. His courses in rock physics and paleomagnetism, built upon foundations laid by Strangway, were immediately popular. Because volcanic rocks tend to be important paleomagnetic markers, he acquired an interest in them that led to his offering a course in volcanology. In the spring of 1986, Ed was named for a teaching award by the Boulder Faculty Assembly.

In the two decades that he has been affiliated with the Department, Larson's research activities have included improvements in application of paleomagnetic techniques to geologic problems, studies of lunar and deep sea samples, magnetism of meteorites, ages of paleomagnetic events ranging from the Precambrian to the Pleistocene, development of chemical remnant magnetization during the formation of red beds (in collaboration with T. R. Walker), and timing of continental breakup around the Atlantic. With P. W. Birkeland, he has co-authored two editions of *Putnam's Geology*, a widely used text for beginning students. During the early seventies, Ed participated with Japanese colleagues in an investigation of the petrochemistry of extrusive rocks in the Mariana Islands, a project sponsored by the U.S.–Japan Scientific Cooperation Study Group.

Peter W. Birkeland (B.S., University of Washington, 1958; Ph.D., Stanford, 1962) taught in the Department of Soils and Plant Nutrition at the University of California at Berkeley prior to joining the Boulder faculty in 1967. Pete was chosen to supplement the work in Quaternary geology initiated by Bill Bradley. His courses have dealt mainly with weathering and soil development in relation to dating structural and geomorphic events of the Quaternary. They have led to the publication of three books, two at advanced level dealing with soils and geomorphology, the third (in collaboration with Larson) an elementary text. Peter's research projects have taken him to various parts of the United States, particularly Nevada, California, and the Rocky Mountain states, as well as to New Zealand, Australia, Israel, and a dozen countries in Europe. He has served two terms as a counselor of the American Quaternary Association and is presently a member of the U.S. National Committee of the International Union for Quaternary Research. He was a visiting lecturer at Lincoln College, New Zealand (1977-1978).

For the academic year 1984-85, Peter was granted a Faculty Fellowship by the University Council on Research and Creative Work to conduct studies on soil profiles and Quaternary stratigraphy in contrasting climatic zones. Parts of his work were carried out at Lincoln College, New Zealand; University of Tasmania, Hobart; and Hebrew University, Jerusalem. He also conducted field studies on the island of Corsica.

John T. Andrews, a native of England, holds an M.S. degree from McGill University (1961), and a Ph.D. (1965) and D.Sc. (1978) from the University of Nottingham. Prior to joining INSTAAR and the Department in 1968, he was employed by the Canadian Department of Energy, Mines, and Resources. Since his arrival in Boulder, John has taught courses in glacial geology, geomorphology, and geostatistics and has conducted seminars in a variety of Quaternary subjects.

During his years at the University, Andrews has continued to pursue research growing out of his earlier work for the Canadian government. Much of his effort has been focused on Quaternary studies in Baffin Island, in which he has involved many of his students. However, he has also studied Quaternary events in other parts of the Canadian Arctic as well as in western Europe, Antarctica, Alaska, and the Rocky Mountain region. The gamut of subjects he has investigated includes lichonometry and radiocarbon dating, chronology of glacial advances and retreats, measurements of post-glacial uplift, and late Quaternary paleoclimatology. Paleotemperature reconstructions for the past few thousand years, based on his studies of pollen contained in Holocene deposits in Arctic Canada, appear to show a pronounced warming trend during the past two centuries, perhaps resulting from a marked increase in atmospheric carbon dioxide that began with the Industrial Revolution.

John is a prolific writer and has been honored for his work by several professional societies, government agencies, and universities. In 1973 he received the prestigious Kirk Bryan Award of the Geological Society of America. He served as Associate Director of INSTAAR (1968-1976), President, INQUA Subcommission on American Shorelines (1977-1982), President, Division of Quaternary Geology and Geomorphology, GSA (1982-1983), and member of the National Research Council Committee to evaluate the Arctic Program of DOE (1980-present).

Having launched programs in geophysics and Quaternary geology through affiliation with CIRES and INSTAAR, the Department chose to strengthen its program in geochemistry to include studies of high temperature-pressure reactions related to igneous and metamorphic petrology and the formation of ore deposits. The person selected for the task was James L. Munoz (B.A. in chemistry, Princeton, 1957; Ph.D. in geology, Johns Hopkins, 1966), who was a postdoctoral fellow at the Geophysical Laboratory, Carnegie Institute, Washington. Arriving in Boulder in the fall of 1968, he began immediately to equip a laboratory for teaching and research in experimental mineralogy and petrology. Jim's major teaching effort has been in developing courses in thermodynamics, phase relationships, and hydrothermal geochemistry for advanced students. With an alumnus, D. K. Nordstrom (M.S., 1971), he recently co-authored an advanced text on geochemical thermodynamics.

Jim's research interests center mainly upon halogen geochemistry in relation to the stability fields of micas and the mineralogy of hydrothermal alteration assemblages. His efforts have led to the development of prospecting criteria that have potential application to a search for ore deposits. His work has been financed by the National Science Foundation and other government agencies. He is presently serving a term as Editor of the *American Mineralogist*.

During the same year in which Munoz joined the faculty, R. M. Honea resigned to go into private practice. Search for a replacement led to the appointment of Donald D. Runnells in 1969. Following completion of a Ph.D. at Harvard, Don was employed as a geochemist with the Shell Development Company (1963-1967) and taught at the University of California, Santa Barbara (1967-1969) before coming to Boulder. His teaching has dealt mainly with the geochemistry of natural reactions under near-surface conditions. His effectiveness as a teacher is indicated by the fact that his students have twice nominated him for an outstanding professor award.

Don's research has been mainly in the field of environmental geochemistry, financed by grants from the National Science Foundation, the U.S. Department of Energy, the U.S. Bureau of Mines, and the U.S. Geological Survey. During the early seventies (1971-1975), he was associate director of the Molybdenum Project, which was designed to study the impact of molybdenum mining on the environment in central Colorado, where more than half of the world's supply of molybdenum is produced in an average year. Since molybdenum is known to play a role in the nitrogen cycle of plants and, at high concentration, to cause illness in ruminant animals, the project was felt to be in the public interest. Similar studies, conducted by Don with students and colleagues in the late seventies and early eighties, include contamination of ground- and surface waters by uranium mining and milling, the mobility of trace elements in oil shale leachate, and geochemistry of the water-sediment system of the Orinoco River, Venezuela. Investigations pending approval include studies of the hydrology and chemistry of interstitial fluids at the Nevada Test Site and modeling the chemical behavior of nuclear wastes in geologic repositories.

Don's work has led to his appointment to important offices, including: Regional Editor, *Journal of Geochemical Exploration* (1971-1975), Committee on Public Policy, Geological Society of America (1976-1979), Council, Society of Environmental Geochemistry and Health (1977-1980), Council, Association of Exploration Geochemists (1980-present), Colorado Governor's Council on Science and Technology (1980), Legislative Advisory Committee, Colorado Ground water Association (1983-1984), Chairman, Workshop on Hydrogeochemical Exploration for Mineral Deposits, Helsinki, Finland (1983), and Materials Review Board, Argonne National Laboratory (1980-1984).

The search for a director for CIRES ended with the appointment of Carl Kisslinger in

1972, who retained the position until 1979. Carl's academic training was at St. Louis University, where he completed a Ph.D. in geophysics in 1952. He taught at his alma mater prior to joining the Boulder Department. His field of interest is seismology, and his teaching includes general courses in solid earth physics and planetary physics and advanced courses in seismology.

Kisslinger is a true citizen of the planet having served in a variety of important assignments both at home and abroad. His appointments on the domestic scene include: President, American Geophysical Union (1971-1972), President, Seismological Society of America (1972-1973), Colorado Governor's Scientific Advisory Council (1973-1977), NSF Advisory Group on Earthquake Prediction and Hazard Mitigation (1976), USGS Earthquake Studies Advisory Panel (1977), NAS-NRC U.S. Geodynamics Committee (1975-1978), NAS-NRC Committee on Scholarly Communications with the Peoples Republic of China (1977-1981), and NAS-NRC Committee on Opportunities for Research in the Geological Sciences (1982).

Carl's foreign assignments began in 1966-1967 with service as a UNESCO expert in seismology and chief technical adviser for the International Institute of Seismology and Earthquake Engineering, Tokyo. Since then, he has served as a member of a technical exchange delegation in earthquake engineering to the USSR (1969), as consultant on seismology to the government of the Marche Region, Italy (1972), and as a member of a seismological exchange delegation to the People's Republic of China (1974). Carl was the recipient of an Alexander von Humboldt Foundation Senior U.S. Scientist Award, given by the Federal Republic of Germany, and served as a guest professor at the University of Karlsruhe in 1979-1980. Over the years, he has been an invited speaker at international symposia and scientific meetings in the USSR, Chile, Austria, Romania, France, and Sweden.

Kisslinger's research in seismology has dealt mainly with refinements in seismic techniques and model studies of phenomena associated with natural and induced seismic activity, including underground nuclear explosions. In recent years, he has devoted attention to developing criteria for earthquake prediction, a project he championed as Director of CIRES.

Carl accepted the CIRES directorship in 1972 with the understanding that the University would provide support to build a strong program in seismology as a part of the institute. He also obtained from the Department tacit approval to house new personnel, including himself, on its faculty. Carl's first recruit, who joined the Department in late 1972, was Max Wyss, a native of Switzerland, who completed undergraduate training in geophysics at the Federal Institute of Technology, Zurich (1964) and M.S. (1967) and Ph.D. (1970) degrees at the California Institute of Technology. Since his arrival in Boulder, Max has taught mainly courses in introductory seismology and the geophysical aspects of plate tectonics. His broad experience with seismic activity in many parts of the world has provided him with a wealth of information on modern tectonism.

Wyss' research activities have dealt with studies of earthquake source parameters, earth stresses, tectonic strain release mechanisms, earthquake frequency distribution, and criteria for earthquake prediction. In connection with the last, he has directed his attention to seismicity in California, South America, Japan, New Zealand, India, and the Hellenic Arc. His work has been supported by more than two dozen grants from the National Science Foundation, U.S. Geological Survey, U.S. Air Force, and Smithsonian Institution.

Max's teaching and research have taken him to many parts of the globe. Included are service as a research scientist at the University of Mainz, Germany (1965), research scientist at Lamont-Doherty Geological Observatory, Columbia University (1970-1971), visiting professor at the National University of Mexico (1972), visiting professor, University of Karlsruhe, Germany (1975), and visiting professor, Federal Institute of Technology, Zurich (1979-1980). He has also acted as a consultant on seismic hazards and earthquake prediction to NASA and UNESCO.

In 1974, a third member of the geophysics team, Hartmut Spetzler, was recruited to CIRES and the Department faculty. A native of Germany, Hartmut completed his early training there before coming to the United States in the late fifties. He took B.S. (1961) and M.S. (1962) degrees in mathematics at Trinity University, San Antonio, Texas, and M.S. in geology (1966) and Ph.D. in geophysics (1969) degrees at California Institute of Technology. Prior to coming to Boulder, he taught geophysics at the State University of New York, Binghamton. Spetzler's teaching schedule includes both introductory and advanced courses in geophysics. He was largely responsible for developing a popular three-semester sequence entitled "Our Dynamic Earth" for nonmajor undergraduates, in which he shares teaching responsibilities with other members of the faculty.

Hartmut's research interests are concerned mainly with earthquake prediction and the physics of planetary interiors. He has developed experimental approaches to evaluate the properties of earth materials at high temperature and pressure. Among them is the use of optical holography to measure small strain fields in laboratory samples. Much of his work has been supported by the National Science Foundation and other federal agencies.

Spetzler's research on planetary interiors made him a logical choice as a consultant to NASA regarding lunar samples returned from the Apollo missions. He served first as a member of the Lunar Science Review Panel (1974-1977) and later as a member of the Lunar Sample Allocation Planning Team (1977-1979). Other important assignments include: consultant to Sandia Laboratories, Livermore, California (1969-1973); member U.S. Geodynamics Committee, NAS-NRC (1977-1981); coordinator (with a Russian colleague), US-USSR Cooperative Earthquake Prediction Program (1978-present); and member, Commission on Physical Properties of the Earth's Interior, International Association of Seismology (1979-present). He received an Alexander von Humboldt award for research at the University of Bokum, Federal Republic of Germany, during the academic year 1979-1980. At the time of this writing, Hartmut is serving a term as Department Chair, a chore that has added a fourth dimension to his activities.

A second appointment to the faculty via INSTAAR during the transition period was Gifford H. Miller. Giff completed a B.A. in geology with the Department in 1970 and served as a research assistant at INSTAAR while enrolled in a doctoral program. He received the Ph.D. in 1975 after completing a year at the Geophysical Laboratory, Carnegie Institute, Washington, where he studied amino acid diagenesis as a technique for dating Quaternary events. Upon returning to Boulder, he was appointed a Research Associate at INSTAAR and Assistant Professor of Geology. His teaching duties have included courses in amino acid geochronology and other Quaternary dating methods, as well as seminars in geomorphology and Quaternary history.

Miller has established on the campus a laboratory for amino acid geochronology, which he now directs. Since 1981, he has also served as Associate Director of INSTAAR. His research has taken him on summer excursions for field studies in Baffin Island, Spitzbergen, and Tunisia. During the academic year 1979-1980, he was a visiting professor at the University of Bergen, Norway. He has served as a member of the International Geological Correlation Program, a corresponding member of the INQUA Subcommission on Mediterranean Shorelines, and a member of the Scientific Advisory Board, Division of Polar Studies, NSF.

The late seventies proved to be a time of stress for the University and the Department. A nationwide decline in university enrollments, brought on by a shrinkage in the population group of college age, introduced the specter of competition for students into University planning, an element not considered since the thirties. Public institutions were hard hit by double digit inflation that climaxed in the late seventies. A taxpayer's revolt, formalized in California by Proposition 13, had its counterpart in Colorado. A bill sponsored by State Senator Kadlecek of Greeley in 1977 established a seven percent limit on the annual increase in state appropriations. The combined impact of these factors on the University reached a crisis level during the period 1977-1980.

Another dimension of the problem had been brewing for more than a decade. In response to local pressures, the Legislature approved in 1965 a plan to establish a system of two-year community colleges and technical schools throughout the state. For the most part, they proved to be poorly enrolled, resulting in high per-student costs that sapped the state's resources. In 1971, the Legislature. placed an enrollment cap on the University, hoping that Colorado students who could not gain admission in Boulder would be diverted to the community colleges. The plan did not achieve the desired result, but the pressures continued.

Faced with declining tax revenues and increased expenditures, the Legislature sought to reduce appropriations to state institutions. The "fat cat" image that the University had unwittingly acquired made it a major target. Its spendable allowance was cut by more than three million dollars in 1975. Because of appropriation cuts, the Boulder libraries were unable to purchase any new books, except for required reserve copies, between November 1977 and June 1978 and were forced to cancel subscriptions to many periodicals. During that academic year, the faculty was reduced by 27 FTE positions, and the long appropriations bill included a cut of 20 staff positions for the following year. Convinced that the University was over-staffed, the Joint Budget Committee of the Legislature announced in 1979 a plan to reduce the Boulder faculty by 132 positions, together with a comparable reduction in supporting staff. Although these numbers were modified during ensuing debate, the impact was serious, particularly in the College of Arts and Sciences, the Department's home. Further cuts were included in the long bill for 1980.

The budget cuts and reductions in faculty and staff had a demoralizing effect on the campus community. President Roland Rautenstraus, who succeeded Frederick Thieme in 1975, weary of battling against formidable odds, resigned in 1979 to resume his post as Professor of Civil Engineering. Shortly thereafter, Chancellor J. R. Nelson resigned to accept an attractive appointment elsewhere. William E. Briggs, Dean of the College of Arts and Sciences since 1963, frustrated in attempts to maintain a superior faculty while threatened with further position cuts, returned to his position as Professor of Mathematics. Some of the better-known faculty accepted other employment offers, and the threat of position cuts frightened away potential replacements. Elections to organize the faculty for collective bargaining were held in 1974-1975 and again in 1979. The first failed to select a bargaining agent, and the second was narrowly defeated.

As in most adverse situations, there were some hidden assets. The University undertook a rigorous self-examination, unit by unit, to determine ways to improve its programs and to eliminate waste in human and material resources. The Department's participation in the self-analysis brought on by hardship resulted in substantial benefits.

Despite the budget restrictions of the late seventies, the Department was able to add new members to its faculty, and in this respect it was more fortunate than others. Wahlstrom's retirement in 1978 created a void in two dimensions. First, the courses he had taught in optical mineralogy and petrology throughout much of his career required a replacement in that area. Secondly, although not trained specifically as an economic geologist, his experience with mining companies and engineering firms had led him to develop courses in mineral deposits and mining geology during parts of his tour of duty. His departure created an opportunity to launch a more extensive program in economic geology. To guide the latter program, the Department sought a person with training and experience in ore deposits who had close contacts with industry. Bill Atkinson, having completed 12 years as a mining geologist with the Anaconda Company, seemed ideally suited for the position and was persuaded to leave industry for academia in 1978. A search then ensued for a petrologist whose training and interests would supplement programs in mineralogy, economic geology, and geochemistry. Chuck Stern was recruited from the faculty of Cornell University in 1979 to assume this responsibility.

William W. Atkinson (B.A., M.S., University of New Mexico, 1957, 1960; Ph.D., Harvard, 1973) had studied at the University of Hamburg, Germany and had acquired experience with mining companies in the interim between advanced degrees. He chose to follow mining geology as a profession, joining the Anaconda organization in 1966 for work in Utah, Nevada, and Montana. He completed a doctorate while on leave from his regular duties and returned to the company for an assignment in Iran, following which he decided to seek a university position.

Bill has worked with other faculty, chiefly Munoz and Stern, to put together a teaching and research program in the geology of ore deposits that has attracted a large number of students. His connections with mining companies has provided research and employment opportunities for students that were not available before his arrival. He has devoted his summers to research and consulting in Mexico, Chile, Alaska, and the western United States, out of which has evolved thesis support for his graduate students.

Bill's research activities, supported mainly by industry, are concerned chiefly with processes involved in the formation of porphyry copper and contact metasomatic deposits related to emplacement of igneous plutons. Included are investigations of zoning and mineral paragenesis, movement of hydrothermal solutions, formation of skarn in contact zones, and interpretation of fluid inclusions.

Charles R. Stern took his training at University of Chicago (B.S., 1967; M.S., 1971; Ph.D., 1973) in mathematics and geological sciences. He was a Visiting Lecturer at the University of Chile, Santiago, in 1976 and a Research Scientist at Lamont-Doherty Geological Observatory, Columbia University, from 1973 to 1977. Prior to joining the faculty in Boulder, he taught at Cornell during the academic year 1978-1979. In addition to courses in optical mineralogy and petrology, Chuck has developed a course in natural catastrophes and geologic hazards that is open to interested students in other disciplines. He also teaches an advanced course in planetary geochemistry that concerns the role of radiogenic isotopes and trace elements in the formation and magmatic evolution of planets in the solar system.

Stern's course offerings reflect his major research interests, which include the relation of igneous activity to tectonism, isotope chemistry of igneous rocks, hydrothermal and metallogenic processes associated with igneous activity, structure and composition of the earth's interior, and the role of volcanism in the evolution of planets. His doctoral dissertation was based on an investigation of high-pressure formation of hydrous magma and implications for magma formation in subduction zones. During the past decade, he has investigated subduction processes and magma formation in the Chilean Andes, the Himalayas of Nepal, and the Archean greenstone belt of South Africa. His research has been financed by more than a dozen grants from the National Science Foundation. As was hoped at the time he was hired, his interests overlap with those of his colleagues in geochemistry, volcanic petrology, geotectonics, and economic geology. At the time of this writing, Chuck is on leave from the University, having been granted a Faculty Fellowship and a Fulbright Fellowship to participate in the American Republic Research Program during the academic year 1985-86.

By the close of the seventies, the Department's period of transition was complete. The stage was set for its rise to national prominence during the eighties. The setting was enhanced by the fact that the University had gone through a similar transition, providing a climate that was favorable for new development.

Shaping the Present (1980-1986)

Arnold Weber succeeded Roland Rautenstraus as President of the University in 1980. His administration, in contrast to those of most of his predecessors, was marked by a period of relative tranquillity. The calm has continued under the leadership of his successor, Gordon Gee, who arrived on the scene in 1985, following Weber's departure to assume the helm at Northwestern University. There is hope that the decade of the eighties may be a golden age for the University of Colorado. The long struggle that began with James Sewall and continued with blood, sweat, and tears on the part of those who followed him may have begun to pay dividends.

Growing out of state appropriation cuts in the late seventies, all segments of the academic community were urged to undertake rigorous self-examination. The Department chose this opportunity to decide not only where it was at the time but where it wanted to be and to map a plan for getting there. The effort culminated in a three volume work, completed in 1982, which set forth details for reorganization of its structure and curriculum, as well as a plan for growth. A rostered faculty of 25 to 30 resident scientists was foreseen as a requirement for the proposed curriculum to provide an appropriate balance between teaching and graduate-faculty research. Preliminary plans for a new building to house the Department, INSTAAR, and CIRES were outlined, and a date for completion of construction was set for March 1986.

Except for the new building, substantial progress has been made in activating proposals set forth in the self- study. The framework of the Department has been restructured, and new elements have been introduced into the curriculum, some of the old ones having been discarded in the process. By 1985, the faculty roster included 7 new faces, bringing the total to 22, all of whom are at the cutting edges of their special fields, many having established themselves as authorities of national and international renown.

The first of the new faculty was Erle G. Kauffman, who arrived in 1980 and played a major role in drafting the three volume self-study. Erle left a career appointment as Curator of the Department of Paleobiology at the U.S. National Museum, Smithsonian Institution, Washington to join the Department as its chairman. Prior to employment with the Museum, he had completed academic training at the University of Michigan (B.S., 1955; M.S., 1956; Ph.D., 1961). In conjunction with his museum work, he also served as Adjunct Professor at George Washington University and as a lecturer for Smithsonian Associates and the American Geological Institute. He was a Visiting Professor at Oxford University, England (1970-1972), University of Tübingen, Germany (1974), and the University of Colorado (1977-1979).

Retirement of John Chronic in 1980 created a vacancy in invertebrate paleontology, making it possible to bring Erle to the campus on a permanent basis. Since his arrival, he has revamped the course offerings in paleobiology to include, beyond the basic courses, seminars on a variety of subjects, taught by himself or by experts of his acquaintance from government, industry, and professional societies. Student interest in paleontology has increased markedly as a result of his efforts.

Kauffman's research interests cover a wide range of topics related to paleobiology. Included are studies of evolutionary theory, rates, and patterns, systematics of late Paleozoic-Cenozoic mollusca, geochemical analysis of molluscan environments, studies of sedimentary cycles, refinements in Cretaceous-Paleocene geochronology, basin analysis of epicontinental seas, and research on the influence of extra terrestrial forces and events on geologic systems. In connection with the last, he has contributed paleontological arguments to the debate concerning the causes of mass extinctions. A prolific writer, he has been an invited lecturer at more than 50 colleges and universities throughout the world. In 1984, he was sponsored as a Distinguished Lecturer by the American Association of Petroleum Geologists. He has served as President of the Paleontological Society (1982) and

Vice President of the International Paleontological Union (1986).

During his term as Department Chair (1980-1984), Erle spearheaded the self-study and provided leadership for curriculum changes, expansion of faculty and staff, increases in funding for research and student aid, more efficient use of building space, and a plan to raise funds for a new Earth and Environmental Sciences Center on the main campus.

Larry Warner's retirement in 1981 provided a means to add two new members to the faculty in that his duties involved two major subjects, tectonics and mineralogy. Roy Kligfield was recruited in 1981 to fill and expand the tectonics position and Joe Smyth in 1982 to build a program in mineralogy.

Kligfield received his academic training at Columbia University (B.A., 1972; M.Ph., 1976; Ph.D., 1978) and did postdoctoral work as a Research Associate at the Swiss Federal Institute of Technology (1978-1981), where he worked with W. Alvarez, I. W. Dalziel, and John Ramsay on problems in Alpine tectonics. As a result of his Swiss experience, he became fluent in Italian, German, and French and also acquired some Spanish. Since arriving in Boulder, he has established courses in displacement and strain theory, geology of fold and thrust belts, and global tectonics.

Roy's research interests cover a range of topics on a global basis. Included are studies of finite strain and deformation styles in thrust belts and continental collision zones (Alps, Appenines, Scottish Caledonides, New England, North American Cordillera, the Andes, and Antarctica) and the tectonics of extensional orogens in metamorphic core complexes (Arizona). His interests supplement those of Bill Braddock, Chuck Stern, Ed Larson, and Max Wyss, leading to his collaboration with them on teaching and research projects since his arrival.

Joseph R. Smyth (B.S., 1966, Virginia Polytechnic Institute; M.S., 1968, Ph.D., 1970, University of Chicago) served in several professional capacities before joining the Department. He was a Research Fellow at Harvard (1970-1972), a Staff Scientist at the Lunar Science Institute, Houston (1972-1976), a Senior Lecturer at the University of Capetown, South Africa (1975-1976), a Visiting Scientist at Philipps University at Marburg, Germany (1976), and a staff member of Los Alamos National Laboratory, New Mexico (1976-1981). Since joining the faculty in Boulder, Joe has taught courses in introductory mineralogy, undergraduate petrology, X-ray crystallography, crystal chemistry, and advanced mineralogy. His interests supplement those of Munoz, Larson, Stern, and Atkinson, and they have collaborated in some of their course offerings.

Joe's research has focused mainly on the structure and crystal chemistry of ferromagnesian silicates, with emphasis on their occurrence in lunar rocks and the earth's lower crust and outer mantle. Samples of the latter are obtained from eclogite inclusions in kimberlite pipes, mainly from South Africa. His work includes studies of high temperature-pressure polymorphic transitions that are presumed to occur at moderate depths. The results of such studies are of interest to the CIRES seismologists in attempts to correlate seismic data with the composition, structure, and properties of rocks in the outer earth. Smyth has also studied the potential for storing radioactive wastes in pyroclastic rocks and other materials under near-surface conditions. He has lectured at more than two dozen universities and research institutes throughout the United States and several in western Europe, South Africa, Australia, and Japan.

During the seventies, Ted Walker, recognizing that there were aspects of sedimentology that he could not hope to cover without diluting his efforts, mentioned repeatedly the desirability of adding to the faculty a process sedimentologist with a special interest in continental clastic deposits. However, the climate on the campus at the time offered little hope for such an appointment, and the suggestion was placed on a back burner. The upbeat atmosphere of the early eighties provided an opportunity for a renewed effort, and by 1982 the Department had obtained permission to proceed with an appointment. A thorough search for an appropriate candidate demonstrated that the best qualified among the large group of applicants was one of Ted's own doctoral students, Mary Kraus. Meanwhile, Mary had received an attractive offer from Massachusetts Institute of Technology and a tug of war ensued between the two departments. The decision was not an easy one for Mary, but to the Department's delight, she elected to remain in Colorado and joined the faculty in 1983.

Mary began her academic training at Yale in biology (B.S., 1973) and taught mathematics and physics at Morristown, New Jersey high school before deciding to switch to geology and come west. She completed an M.S. degree at the University of Wyoming in 1979 prior to enrolling in a doctoral program at Boulder. She was supported in her doctoral studies by two University fellowships (1980-81; 1981-82), a Penrose grant from the Geological Society of America, and a Sigma Xi research grant-in-aid. In her final year of study, she received the Graduate School Award for Excellence in Research and Creative Work and was elected to *Who's Who Among Students in American Universities and Colleges*.

Mary's teaching duties include basic and advanced courses in sedimentation and a course dealing with continental depositional systems and sedimentary tectonics, her major field of interest. In this connection, she served as a consultant to the Duke University Geological Survey of Egypt Expedition in the western Egyptian desert.

Another late addition to the faculty, G. Lang Farmer (B.A., University of California, San Diego, 1977; Ph.D., University of Calif., Los Angeles, 1983), is also a CIRES Fellow, having been recruited jointly by the Department and CIRES. Prior to his arrival on the campus in January 1985, he held a postdoctoral appointment at Los Alamos National Laboratory where he was engaged in research on Nd and Sr isotopes. Lang has not as yet had time to put down roots on the campus. However, his expertise in isotope geochemistry in relation to the origin of granitic intrusives and related mineral deposits adds an important component to the Department's program in geochemistry-petrology-economic geology. He regularly teaches courses in isotope geology and contributes to team efforts in other courses. His research efforts with CIRES are directed toward refining models concerning the evolution and structure of the earth's crust and related problems in terms of information provided by stable isotopes.

Two recent additions to the Department, Alexander Goetz and Mark Meier, were acquired through CIRES and INSTAAR, respectively, in the fall of 1985. Both are seasoned professionals and eminent authorities in their fields. Alex Goetz was on the technical staff of Bell Telephone Laboratories in the late sixties and was involved in systems studies for the Apollo lunar missions. He has since been associated with the Jet Propulsion Laboratory at Cal Tech. As a CIRES fellow, he will direct the Center for Earth Observations and Remote Sensing (CEORS). His major interest is in the application of remote sensing techniques to geologic problems. Mark Meier has been associated with the University of Washington since 1964, where he was a Research Professor of Geophysics and Project Chief for Glaciology. He also has served as a Research Geologist for the USGS since 1956 and has been a visiting professor at several universities. His major interests are in glacier dynamics and the physics of geomorphic processes. His principal assignment at the University will be as Director of INSTAAR. Both men will participate in teaching and in supervising student research.

Another recent addition to the faculty is Roger Bilham, who joined the Department in September 1986 as Professor of Geophysics. Born in England, he completed a Ph.D. at Cambridge in 1970 and occupied several posts in the United Kingdom and western Europe before accepting an appointment to Lamont Doherty Geological Observatory at Columbia University in 1975. He was a Visiting Fellow at CIRES and JILA on the Colorado campus in 1984-1986 and remained to fill a vacancy in the Department.

Roger's research interests are in applications of new technologies to stress and strain, space geodesy, sea-level studies, volcano monitoring, and earthquake prediction; his work has taken him to many parts of the world and has resulted in an impressive list of publications. He will teach courses in crustal deformation, plate tectonics, and applied geophysics and will contribute to the Department's offerings for nonscience majors. Presently, he is designing and building classroom demonstration models to illustrate processes and concepts for beginning students.

Due to arrive in January 1987 as an Assistant Professor is David A. Budd, a carbonate petrologist. David completed a Ph.D. at University of Texas, Austin in December 1984. He has been employed as a research geologist with ARCO in Plano, Texas since 1983. His major interest is in diagenesis of carbonate sediments and rocks. He has also been involved in computer modeling of lateral and vertical faces changes in carbonate sequences.

Two other persons, David A. Yuen and Janell D. Edman, who were appointed to the faculty in the recent past, have left to take positions elsewhere. Yuen (Ph.D., UCLA, 1978), whose specialty is mathematical geophysics, remained for only one semester (Spring 1985). Edman (Ph.D., University of Wyoming, 1982), whose principal interest is sedimentary tectonics and basin analysis as applied to petroleum geology, was hired to fill the vacancy left by the retirement of Bruce Curtis. She arrived in the fall of 1983 and left in the spring of 1985. Search for a replacement to fill the position remains on the agenda.

By the mid-eighties, the Department had achieved some of the goals set forth in the self-study of 1982. Although much remains to be done, not the least of which is to provide adequate housing for its operation, a new sense of accomplishment prevails. Recently, it was ranked the third largest geoscience department in the country in terms of student enrollment, and the quality of its faculty and programs has gained for it national recognition. The struggle from a humble beginning at the turn of the century has paralleled that of the University, and the Department has kept pace with the development of its parent institution. The efforts of faculty, students, alumni, and friends have brought it to the forefront of the profession.

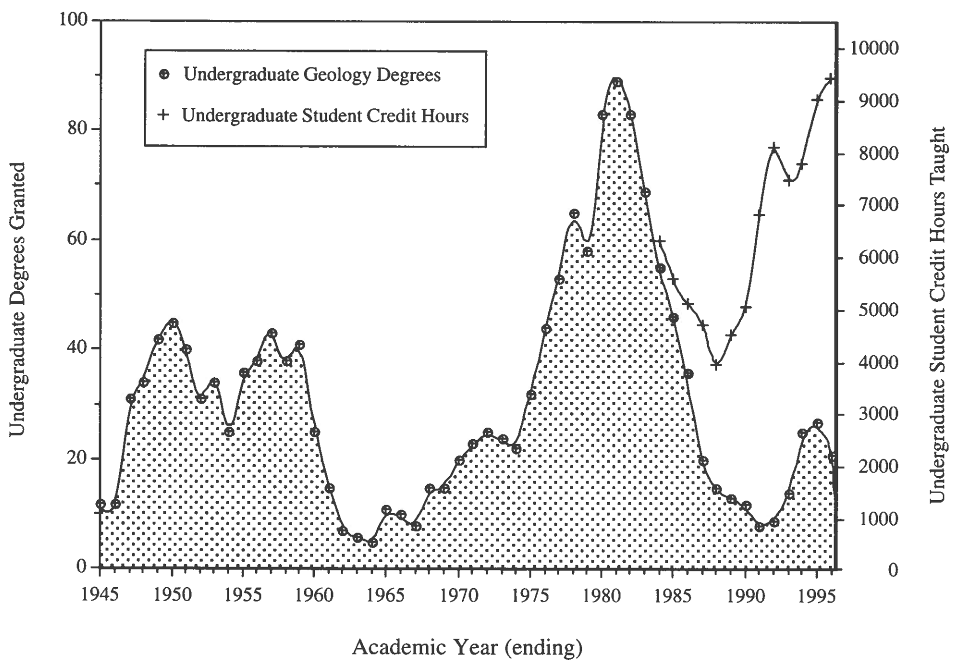
Development of Department Programs

The Student Body

Students constitute an essential component of any educational enterprise. Without them there would be little need for the faculty or support facilities that comprise the framework of a university. The Department's programs in teaching and research have evolved largely in response to student enrollment trends that have been influenced by a variety of factors. Included are changes in economic and political conditions, as well as in technology, that have affected the contributions required of geoscience professionals by society.

The accompanying chart traces the number of degrees awarded annually in the Department during the 51-year period from World War II to 1996. The curve reflects enrollment changes that have occurred in degree programs during this period. Data for earlier years are incomplete or unavailable. Although the general trend of enrollment has been upward, there are peaks and valleys in the curve that reflect the impacts of national and international events. During periods when employment opportunities for trained geoscientists are high, enrollments accelerate; when opportunities are curtailed, enrollments decline. Student demands at the graduate level for particular types of training reflect demands for such training by government and industry.

Undergraduates are also sensitive to economic and political factors that they perceive to affect their lives. During the years of the Vietnam conflict, a period of tumult on college campuses extending from the mid-sixties through the early seventies, students in general became disenchanted with the establishment. Undergraduate major enrollments in engineering and the sciences, including geology, declined and were replaced by enrollment increases in the social sciences and humanities. This shift in student interest contrasted markedly with attitudes in the post-Sputnik era of the late



fifties, when public attention was directed toward science and technology as providing the best prospects for salvation.

The decade from the late forties to the late fifties was one of rapidly rising demand for trained geoscientists. Diversion of youth into military service during the war years curtailed enrollments in geoscience departments, and the number of graduates that emerged to enter the profession fell sharply. The war had drained the nation's stockpiles of minerals and energy resources and had diverted industrial production mainly to military purposes. Return to peacetime unleashed pent-up demands for consumer products and the raw materials needed to produce them. Creation of the Atomic Energy Commission, with the intent to accelerate production of uranium from domestic sources, added a new dimension to the imbalance of supply and demand for trained personnel. The word spread quickly that employment for even modestly trained geoscientists was virtually assured. Student response was immediate and positive. Many returning veterans whose prewar interests were in other fields, chose to become geologists and were joined by new recruits fresh from high school. Overnight, the Department had more students than it was prepared to handle. Throughout the first postwar decade, recruitment of faculty and procurement of equipment and facilities lagged behind the increase in student enrollment.

The seller's market in employment opportunities during this period was not entirely beneficent. Competition among companies and government agencies for trained personnel led to hiring practices that later were regretted by both employers and employees. To a student living on the edge of poverty, overloaded with course hours and forced to take on extracurricular chores to help pay expenses, the offer of a job that paid twice the prewar salary for the same work was irresistible. The result was that many students were persuaded to leave their training for employment prior to completing a degree. They were encouraged to hope that they would find an opportunity to return in a few years with a sizable nest egg that would enable them to finish in style.

The picture changed sharply in 1958. By that time, thermonuclear techniques had been perfected to a point where reliance entirely on U^{235} by the military for building a nuclear arsenal was no longer a requirement. Geoscientists employed by the Atomic Energy Commission to promote exploration for uranium were suddenly without jobs. Meanwhile, oil companies decided that their exploration departments were over-staffed in relation to domestic and foreign petroleum markets; accordingly, they unloaded many of their junior personnel. Quite suddenly, the advantage in employment shifted from the seller to the buyer. For the first time since the Great Depression, geology students at all degree levels were hard-pressed to find any market for their talents, and many forsook the profession for other fields of endeavor. The dearth of opportunity was reflected shortly by a marked drop in enrollment. In 1957, more than 100 students were enrolled in mineralogy, a core course required of all undergraduate majors. Less than four years later, the number had dropped to fewer than a dozen. Other courses suffered a similar attrition.

The enrollment increases that culminated in the late fifties, followed by a sharp decline during the sixties, illustrates a matter of major concern in higher education, particularly in disciplines such as the geosciences that are ultrasensitive to economic conditions. The problem lies in trying to develop a high quality training program that can adjust to the peaks and valleys of student enrollment and course preferences. One way to promote enrollment stability is to stiffen degree requirements when the swing is upward and to relax them when it is downward, within a range permissible for quality training. The Department resorted to this procedure in the late seventies when enrollments approached an all-time high. Students were retained in a premajor category until they had completed specified courses in general geology and allied sciences, following which they became eligible to apply for major status. Applicants were then selected on the basis of their performance in pre-major courses. These requirements were relaxed as enrollments declined in the early eighties.

Peri-curricular and extracurricular activities of the student body have sparked an esprit de corps that has characterized the

DECEMBER 1955

THE
GEOLOGY
GEOGRAPHY
DEPARTMENT

NEWSLETTER

UNIVERSITY
OF
COLORADO

THE PROBLEM

THE
GEOLOGY
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DEPARTMENT

DECEMBER 1956

NEWSLETTER

UNIVERSITY
OF
COLORADO

TIME TO GO HOME


GEOLOGY DEPARTMENT
NEWSLETTER
UNIVERSITY OF COLORADO
THE GEOLOGIST
JANUARY 1966


JANUARY 1965
GEOLOGY DEPARTMENT
NEWSLETTER
UNIVERSITY OF COLORADO

Department throughout its history. Beginning in the twenties, such activity centered in a local chapter of the national student honorary, Sigma Gamma Epsilon. Each year, promising sophomore-junior students were tapped as pledges. They were required to wear hard hats and carbide lamps to classes and to perform mundane chores for the general welfare of the Department, such as removing trash from the attic and the basement. A faculty adviser was selected to assist the students in their endeavors.

In 1968, the students voted to divorce themselves from Sigma Gamma Epsilon and to form their own organization, called simply the "Geology Club." One of the reasons for abandoning the honorary was that it was not open to women, who by the late sixties comprised a substantial part of the student body. It also excluded students who could not qualify academically for membership. The Club was open to everyone, the intent being to foster cohesiveness among the students and to cultivate student-faculty relationships.

Leadership in the Club has been provided mainly by graduate students, but undergraduates have played an important role. The Club has selected members to represent the student body at weekly faculty meetings when occasions for student input arose. On a daily basis, it has supervised an honor system coffee-donut-bagel facility for students, faculty, and visitors. It has also assisted in organizing and conducting a series of annual student-faculty events, including one or more field trips, a fall picnic, and in past years a spring banquet. Because of inflation and other factors, the spring event has been modified in recent years to provide for a bring-your-own type gathering in less formal surroundings. Through the Geology Club, students have assisted over the years in preparation of the annual Department "Newsletter," commonly having furnished original artwork for the front cover.

The Teaching Function: Curricula and Degree Requirements

From its earliest years, the University strove to uphold high academic standards for its students and faculty. During the first decade, applicants for admission were required to pass examinations in English grammar, geography, reading, history of the United States, arithmetic, and algebra up to quadratics. Students enrolled in the classical curriculum were required to include studies in Latin, Greek, analytical geometry, political economy, German or French, history, chemistry, geology, astronomy, and mental and moral science. Students who chose the scientific curriculum were obliged to include classical and modern languages, chemistry, physics, calculus, mineralogy and assaying, geology, and surveying. Those not interested in either of the above could enroll in the Normal Department, if they proposed to become teachers. Those lacking entrance requirements could enroll in the Preparatory Department until they became qualified. The curricula were designed, of course, to provide an equitable distribution of students and courses among the limited faculty of the time. Considering the frontier environment in which he operated, one can understand how President Sewall came under fire from the Legislature for failure to enroll more students during the 10 years of his administration.

University course bulletins for the middle and late eighties include courses in general geology, paleontology, stratigraphy, mineralogy, crystallography, and petrography. Students enrolled in these courses were required to read selected passages from Dana, LeConte, and Lyell, as well as from the recently published USGS Hayden and Wheeler reports. Until N. M. Fenneman arrived in 1901, teaching of the courses fell to interested (or drafted) parties whose fields were in chemistry, physics, and biology. Students were expected to have had basic training in these disciplines. The nature and extent of the course materials depended on the individuals who taught them, and the courses appeared sporadically with little attempt to establish continuity. They did not lead to a degree in geology but were intended as general information or to supplement requirements in other sciences.

Fenneman laid the groundwork for a major in geology-geography, which was further developed by R. D. George, beginning in 1903, and came to full fruition with the appointment of R. D. Crawford in 1907 and

P. G. Worcester in 1912. In the decade following Fenneman, the curriculum grew to include courses in physical and historical geology, crystallography, mineralogy, optical crystallography, petrography and petrology, economic geology, engineering geology paleontology and stratigraphy, geological surveying, fire assaying, and courses of local and cultural interest. In addition were courses in geography, as well as advanced courses to foster an embryonic graduate program.

The record regarding degree requirements during this period is vague, except for those established by the College of Arts and Sciences. At the beginning of World War I, entrance requirements for work in the College stipulated graduation from a standard high (or preparatory) school with 15 acceptable units, including English, a foreign language, history, mathematics, and science, as well as satisfactory scores on the entrance exams. Graduation requirements designated 120 semester hours, 50 in a scheduled group and an additional 70 to include some choice of courses in classics, mathematics, or science, as well as in history or economics. Requirements at the graduate level were mainly those imposed by the student's department.

Following World War I, the University changed from a semester to a quarter system, which was maintained throughout the period between the wars. College requirements for graduation became 186 quarter hours, with 75 in a major-minor group. Additional requirements permitted choices among several groups, including mathematics, laboratory science, and Latin or Greek. In 1938, the College classified courses as lower or upper division, requiring 60 quarter hours in the latter. In addition, a "C" average was adopted as a requirement for graduation.

For a time the Department did not add to the college requirements for the B.A. degree, except to stipulate course prerequisites. However, by the late twenties, at which time 41 courses were listed in geology, geography, and mineralogy, the Department drew up requirements for admission to its graduate programs. Candidates in geology and mineralogy were expected to have no less than six hours in basic math (algebra and trigonometry) and no less than 10 hours each in physics and chemistry, as well as 12 hours each in general geology and mineralogy. Candidates in paleontology were permitted to substitute biology for mineralogy. It was anticipated that the requirements would encourage undergraduates to include such courses in their schedules. By the late thirties, the courses had come to be required for the B.A. in geology.

In 1948, the University returned to the semester system to minimize registration costs, and the Department was obliged to change its course structure. In the process, some course requirements that had been tacitly assumed for undergraduates were formalized as such. These included, beyond general geology, courses in mineralogy, paleontology, stratigraphy, and field and structural geology. The requirements established earlier in allied sciences were extended to include a minimum of two semesters each of mathematics, physics, and chemistry. A course in report writing, initiated in the prewar era by Walter Toepelman to assist students in preparation of term reports and theses, also became a requirement for baccalaureate candidates.

Graduate requirements changed rather dramatically during the same period. In the late forties, Dean Worcester established a committee to recommend a revision of requirements for the Ph.D. degree. Up to that time the degree had been based mainly upon satisfactory completion of a stipulated number of course credits, plus the thesis and examinations. The revision subsequently adopted focused mainly on the candidate's capacity for research and critical evaluation of concepts in a major field of interest. A residence requirement of six semesters was substituted for the prior hour credit requirement, except for a minimum of 30 semester hours of advanced work. Residence credit was to be granted by the student's department, with approval of the Graduate Dean, for course work completed with distinction, participation in seminars, and scholarly research. Other rules of the Graduate School adopted in the prewar era were retained. These included a requirement that all entering students pass qualifying examinations given by each department to determine fitness to pursue a degree program. Permission was added to permit substituting the Graduate Record Exam for the qualifying examination. Requirements for the Master's degrees remained largely a matter of course work, with or without a thesis.

During the decade following World War II, the Department came to require entering graduate students to have completed essentially the same course work as that required for its undergraduate majors. In 1954, Advanced Field Geology was stipulated as a course requirement for all graduate students. The requirement was abandoned a decade later. Doctoral candidates were required by the Graduate School to pass a comprehensive examination as a condition for admission to candidacy. In the early postwar years, the geology exam might include any topics chosen by the student's examining committee. By the late fifties, students were permitted to choose four fields of interest in which to be examined. Subsequently, the number of fields was reduced, and examinations were related more closely to the student's field of research.

Major changes in the curriculum and degree requirements began to take place in the mid-sixties, due partly to the Department's affiliation with INSTAAR and CIRES and largely to evolutionary trends in the profession. It came to be recognized that, because of explosive developments in geochemistry, geophysics, paleontology, Quaternary geology, and virtually all other subdisciplines of the science, students could not be expected to jump through the same hoops at the conclusion of their training, but that broad training in fundamentals was required at the outset. This realization led to broadening the base of requirements for undergraduates and providing greater latitude for specialization at the graduate level. The changes that ensued over a period of two decades, some of which were hotly debated, led to the adoption of current practices. By the late sixties, both undergraduate and graduate students were provided with brochures outlining requirements and procedures stipulated by the University and the Department for completing degree programs.

Beginning in 1973, Department undergraduates were presented with a choice of five curriculum options under the headings: 1) general geology, 2) geophysics, 3) paleontology, 4) petrology-geochemistry, and 5) cultural. Course requirements in the geosciences, mathematics, and allied sciences were designed to fit the needs of students for graduate work or employment in the chosen option. The cultural option was provided for students who desired a broad background in geology but did not intend to follow it as a profession, their ultimate interest being in law, business, anthropology, or land use planning. The option was abandoned a few years later when it became apparent that it was not serving its intended purpose. Since the course requirements in this option were loosely defined, students were using it as a device to obtain a B.A. degree in geology while bypassing the more stringent requirements in the other options. An option in engineering geology was adopted in its place. The curriculum included courses in civil engineering, as well as appropriate courses in math, physics, chemistry, and geology. In the early eighties, the five options were reduced to two, one in geology and the other in geophysics. Both require at least one year each of chemistry, physics, and calculus. The geology option provides a broader background in the geosciences, including some course work in geophysics; the geophysics option includes work in geology and substantially more in physics and mathematics than the geology option.

Changes in the mid-seventies also affected graduate programs, particularly at the doctoral level. The preliminary examination, given at the end of the first year of residence to determine the student's fitness to pursue a doctoral program, previously amounted to a test of background knowledge. The new practice requires the student to submit a formal report outlining in detail a research project that normally becomes a basis for the doctoral thesis. An oral examination tests the candidate's background in relation to the proposed research.

Courses for nonmajor students, designed to inform the layman regarding constraints and benefits that the geosciences bring to human society, always have been a part of the curriculum. Two developments during the sixties focused attention on a need for increasing this effort. One was the Apollo space program, which succeeded in landing a man on the moon in 1969. The other was the growth of environmental concerns regarding the impact of human activity on natural processes. In response to these developments, courses entitled "Environmental Geology," "Man and His Physical Environment," and "Man, Evolution, and the Universe" began to appear in the course bulletin in 1969. The Department also became involved in a course entitled "Environment and Public Policy," in collaboration with other departments in the physical, biological, and social sciences. Although the titles and contents of such courses have changed to meet new demands, they remain an important part of the teaching effort.

The use of seminars as a teaching device has become a common practice in recent years. They range widely in subject matter and duration, some are with credit and some without. The recent trend grows out of a loosely arranged seminar, called "Journal Club" that began in 1950, meeting for one hour weekly at noon or in late afternoon or evening. All graduate students were expected to participate, and undergraduates were invited to attend. The practice still continues in modified form. Initially, papers were presented mainly by students, based on thesis research or reviews of literature on subjects of interest. In recent years, The Journal Club has been replaced by a weekly colloquium at which the talks are given mainly by local professionals and visiting dignitaries. A discussion period follows, during which students and faculty belabor the speaker with questions and comments. Students who present papers at regional or national meetings commonly use the colloquium for a trial run.

Through seminars and scheduled lectures, the Department has been able to expose its students to personal contacts with many of the great minds of the profession. The location in Denver of a regional headquarters complex for the U.S. Geological Survey at the close of World War II and transfer of the headquarters of the Geological Society of America from New York City to Boulder in 1972 have brought prominent geoscientists from all over the world to the Boulder-Denver area for meetings, conferences, and professional visits. In recent years, INSTAAR and CIRES have attracted scores of well-known domestic and foreign scientists to the campus as visiting lecturers and fellows. Major mining and energy companies, most of whom maintain regional offices in the area, have been generous in supplying well-known persons on their technical staffs for lectures and informal meetings with students. A list of prominent visiting geoscientists who have contributed their expertise to the Department would constitute a *Who's Who* of the profession.

Incidents surrounding visits in the early fifties of two distinguished lecturers give eloquent testimony to the human qualities that characterize most of those who have risen to the top of the profession. One was J. Tuzo Wilson of Toronto University, who at the time was renowned for his work on the origin of the continents and who later played a leading role in the development of plate tectonics. Wilson came to the campus at the Department's request in connection with a lecture series sponsored by the Summer Session. However, the timing was such that many of the advanced students who could profit most from his instruction were at the summer field camp near McCoy. Warren Longley, who knew Wilson through Canadian work in which they had been engaged earlier, offered to transport him to McCoy and made arrangements for him to stay at the old hotel and boarding house where the students came for dinner. The only available place for an evening lecture was in a tin-roofed shed that had once served as a meeting place for the local Grange. There was one electrical outlet and a single light bulb dangling from the ceiling to furnish illumination. Longley had brought a projector for Wilson's slides, and a sheet was rigged as a screen. The students sat on logs and wooden benches in a mosquito-infested atmosphere, enthralled by Wilson's two-hour presentation of ideas concerning diastrophism and continental accretion. Tuzo Wilson has since returned to the campus on several occasions to lecture under more favorable circumstances on a variety of subjects, but he still recalls with good humor his visit to McCoy.

The other speaker who lectured to an enthusiastic audience under primitive conditions was Chester Longwell of Yale.

Field transportation in the late twenties. Some of these vehicles were still being used in the late forties.

Chester was invited by the Department to discuss his work in the Muddy Mountain thrust belt of Nevada, still regarded as a monumental achievement. Through some mix-up in room assignments, the lecture room turned out to be in the little theatre of Old Main, recently refurbished as a show place on the campus but at the time a veritable shambles. A portable screen was rigged on what served as a stage, and a projector was propped up on an abandoned lecturn at the rear of the room. The rickety seats were packed with students and visitors. Early in the lecture Longwell asked if a pointer were available. Warren Thompson stumbled around backstage in the dark and came up with a broken piece of two-by-four about six feet long. The lecture then proceeded uninterrupted, the sordidness of the surroundings forgotten while the speaker captivated his audience with his superb photography and the thrill of his discoveries.

The natural environment of Boulder has provided the Department with teaching advantages not enjoyed by its competition in the mid-continent region. Close at hand are rock exposures ranging in age through half of geologic time, in combination with structural features and land forms that provide textbook examples of a great variety of natural phenomena. The Department has taken pride in making certain that its students have seen the results of natural processes in a field context. Field trips have been an important part of student training at all levels of instruction.

In the early days, horse-drawn vehicles were used to transport students to nearby exposures, and longer trips were made into the mountains by narrow-gauge railroad. By 1915, the University had acquired a fleet of Stanley Steamers, and geology classes roared up Boulder canyon in comparative comfort. In the twenties, the steamers gave way to internal combustion cars. Following World War II, the University acquired various war surplus vehicles, including jeeps and power wagons, that were used to get students to places that previously had been inaccessible. These have since been replaced by modern four-wheel drive vehicles for use in the back country and by cars, station wagons, carryalls, and buses for use on the highways.

The use of professional drivers for student field trips has never been practical. Initially, the driving responsibility fell mainly to the faculty, but as classes grew larger and more numerous, student drivers were selected and paid a minimal hourly wage for their services. They were not always fastidious in their care of the vehicles, and the University motor pool has looked upon geology field trips as a high-risk operation. The Department has been charged frequently for nicks, scratches, and dents incurred in off-highway excursions.

An incident that occurred in the summer of 1947 illustrates a perennial problem that the University and the Department have faced with regard to field transportation. At that time, a few of the vehicles dating from the twenties were still in service. Among them were touring-car type buses that could carry eight people comfortably and as many as a dozen if the occupants were friendly. A trip to Rocky Mountain Park involved one of these vehicles, a great favorite with the students, who loved to ride with the top folded back. Coming down off the tundra, the brakes failed on the heavily loaded bus, and under stress from taking the curves too fast, a tie rod broke. Fortunately, the bus veered into the ditch and came to a jolting stop. As the student driver later pointed out, it could just as well have gone the other way and come to rest at the bottom of the canyon a thousand feet below. Although no serious injuries or fatalities have ever occurred on a Department field trip, the potential for such is an ever-present concern.

Student field trip in mid sixties to Permian reef complex, west Texas. Leader is Dr. Lloyd Pray, University of Wisconsin.

In addition to field trips related to course work, more extensive excursions of several days duration to localities in central and western Colorado and adjacent parts of Wyoming, New Mexico, and Utah have been in vogue for many years. Trips were scheduled mainly in the spring, commonly to include part of the spring break, but partly in the fall, the latter including a day trip to acquaint new students with the local geology. In general students have planned the trips in consultation with assorted faculty. They also worked out menus, assembled provisions, and did the cooking. Transportation and camping equipment have been furnished mostly by the Department, supplemented by private sources. In recent years, field excursions have become more extended and diversified. They have included a boat trip down the Grand Canyon and highway trips to Death Valley, Baja California, Texas, and the north central United States.

Not only have field trips served as an important means of instruction, they also have contributed to esprit de corps by bringing students and faculty together in ways not possible in the classroom. A common topic of conversation at alumni gatherings centers on field trip experiences. The rainy days, soggy or frozen sleeping bags, watery soup, and other hardships seem insignificant when the good times are recalled.

Research Programs

Although the University had given lip service to research and scholarly pursuits from early in its history, until recently, professors were expected to be teachers and counselors of students first; research was a secondary concern. In 1919, Professor Cockerell of the Biology Department, who had acquired an impressive list of publications in respectable journals, complained bitterly about the lack of recognition for faculty with proven research abilities. He ventured the suggestion that this lack probably accounted for the dearth of people on the faculty who were seriously interested in, or capable of, scholarly research. Part of the problem was, of course, economic. At the time of Cockerell's remark, sponsored research was virtually unknown, and the University was in position to give no more than token support to research activities. During one of the latter years of President Baker's administration, a nominal item for research was included in the budget request submitted by the University to the Legislature. In examining the request, one legislator allegedly asked, "What the hell is research?" Another replied, "Damned if I know; move the item be stricken."

During this early period, the Department necessarily adapted to the pattern imposed upon the University. However, it enjoyed some advantages not available to other departments. Its connection with the Colorado Geological Survey provided limited research opportunities for faculty and students. Its location also contributed an asset in terms of what characterized research activity in the earth sciences at the time.

Prior to World War II, emphasis in geoscience departments across the nation had been on training generalists skilled mainly in ability to adapt to a restricted job market. The rationale for such training was that knowing a little about a lot of things was better than knowing a lot about one thing only. The philosophy stemmed in part from a lesson borrowed from paleontology: in a world of harsh reality, the brachiopod Lingula has enjoyed an enormously longer generic existence than did any of the dinosaurs.

Except for a few well-healed institutions engaged in training research oriented doctoral students, most departments lacked equipment for specialized training. Standard items included the Brunton compass, aneroid altimeter, Jacob's staff, and telescopic alidade. Laboratory work involved the use of map-making facilities, binocular and polarizing microscopes, and perhaps a powder X-ray camera. Anything beyond these basic tools was regarded as a luxury. Research took the form largely of field investigations, the attempt being to understand earth processes by observing the imprint they left in rock exposures and on the landscape. Students who became adept at the art were in demand by industrial organizations and government agencies engaged in a search for fossil fuels and mineral resources.

By virtue of its natural environment, the Department was well situated to compete with less favorably located, though more affluent, departments between the Appalachians and the Rockies. Close at hand are rock exposures ranging in age through half of geologic time and presenting a variety of problems for investigation. Although mostly lacking in alpino-type structures, except for the roots of ancient ones in the basement complex, the Colorado Rockies probably constitute the ultimate in germano-type deformation. These attributes, combined with a delightful summer climate and opportunities for winter sports, made it possible to attract capable students and faculty to an extent that might not have been possible otherwise The Department was able to capitalize on these advantages during the twenties and thirties and in the decade following the war. Acquisition of an enlarged and, for the time, well-equipped physical plant in 1951 placed it on a par with more prestigious competitors.

The decade of the fifties was a period of transition for the University from an institution known mainly for undergraduate teaching to one that sought to become a center for graduate research as well. The war had forced government agencies and industrial organizations to engage in research activities on an unprecedented scale. The dearth of basic information that was vital to the success of military and para-military operations pointed to the need to stockpile such information in peace time. The nation's universities loomed as a major resource to be mobilized in this direction. Soon after the war, federal funds for university research, virtually nonexistent in prewar years, became available in modest amounts, mainly from ONR, AEC, and the Air Force Creation of NSF by Congress in 1950 provided an additional source. Launching of the first artificial satellite, Sputnik I, by the USSR on October 4, 1957, followed by a disastrous failure of the first U.S. attempt on December 6, destroyed public complacency resulting from achievements of American science and engineering during the war. Beginning in the late fifties, the trickle of federal research funds became a flood.

Even in the late forties, federal research grants were paying parts of faculty salaries in the College of Engineering and in the Departments of Physics and Chemistry at the University. A research corporation was formed in 1945 involving the University of Colorado and Harvard in joint operation of the High Altitude Observatory at Climax under the guidance of Walter Orr Roberts. This led subsequently to establishing the Department of Astrogeophysics at the University and, in 1960, to organizing the National Center for Atmospheric Research in Boulder with Roberts as Director. In 1954, the National Bureau of Standards established its Radio Propagation Laboratory in Boulder and later expanded the facility to include the National Oceanic and Atmospheric Administration (NOAA), which became affiliated with the University through the formation of the Joint Institute for Laboratory Astrophysics (JILA) in 1962. Other institutes established on the University campus during this period include the Institute for Behavior Sciences (1957) and the Institute for Computing Science (1961). The Nuclear Physics Laboratory, housing the only cyclotron between St. Louis and the west coast, was constructed on the east campus and became operational in 1962. Growth of research facilities at the University were in large part responsible for attracting Ball Brothers Corporation, Beach Aircraft, and later IBM, to the Boulder area.

Meanwhile, the Department profited little from these developments. Inundated with students in the postwar era, it was obliged to continue in the prewar pattern of heavy teaching loads, despite increases in faculty. Research was a luxury few could afford. Federal research funds were not readily available to geoscience departments with limited research programs, the few funds available going to prestigious institutions. Following the Sputnik episode, this trend continued, support funds going mainly to projects in physics, chemistry, and engineering that were more closely related to the space program.

Despite the handicaps, significant research was carried out in the Department during the postwar era, much of it field oriented, funded in part by government agencies and energy companies. The latter contributed graduate scholarships and fellowships, several of which were available annually to promising students. Faculty members used their prior connections with oil or mining companies and agencies such as the U.S. Geological Survey to obtain research support.

The efforts of two individuals, E. E. Wahlstrom and T. R. Walker, were particularly significant in shaping a foundation for departmental policy regarding research. Both achieved recognition during this period and enhanced the Department's image as having a potential for quality research. Wahlstrom was among the first of its faculty to emphasize laboratory investigations as an important adjunct to field work. He developed sophisticated optical techniques for studying rocks and minerals and outfitted a wet laboratory in which he and his students made quantitative chemical analyses of their field samples. He also acquired basic X-ray equipment and initiated studies in crystal chemistry. It was during this era that Walker became interested in diagenetic studies of red beds. He was a pioneer in obtaining grant money to support graduate student research in the Department and a strong advocate for reduced teaching loads to give the faculty more time to work with graduate students. He proposed to accomplish this not by neglecting the undergraduates but by obtaining greater University support for additional faculty and funding for graduate assistants. The substantial gains that were made in this direction were in no small way due to his efforts.

A program sponsored by NSF in the mid-sixties proposed to develop Centers of Excellence at selected universities by providing initial funds for faculty positions and equipment. The University joined a large number of institutions that submitted proposals, and the Department was represented on the committee appointed to draft the proposal, along with Chemistry, Physics, Engineering, Anthropology, and Behavioral Science. The Department's major argument for being included in the program was that, because of the advantage afforded by its natural endowment, the cost of elevating it to a level of excellence was relatively small as compared to that required in other fields. However, in the final draft of the proposal, the committee voted to eliminate Geology and concentrate its efforts in a few areas that already showed promise of excellence. The decision was a bitter disappointment to those who had worked hard to promote the Department's inclusion. Later reflection supported the committee's judgment. At that time, the Department had not yet developed a comprehensive program for achieving excellence. The proposal was funded; it might not have been had weaker departments been included.

A marked change in the Department's research image came about through its affiliation with CIRES and INSTAAR in the late sixties. Decisions that were to result in these affiliations were in the making a decade earlier. The process began with the appointment of Honea and spawning of a geochemistry program in 1958, followed by a beginning in geophysics with the appointment of Strangway in 1963. These steps toward an experimental approach to research were breaks with a past that had been rooted mainly in field observations. Had they not been taken, it is unlikely that CIRES would have been born, since it grew out of the infant geophysics program, largely through the efforts of Chris Harrison, who succeeded Strangway in 1965. Although INSTAAR had been around as a limited operation since 1951, it was reorganized in 1967 to include Quaternary geology. The reorganization was influenced by Bradley's work and by the Department's decision to strengthen its Quaternary program through the appointment of Peter Birkeland. Through the new INSTAAR, the Department added to its faculty John Andrews, whose work in Quaternary research was well known.

Affiliation with CIRES resulted in additions to the faculty and support for research. In addition to the CIRES Fellows who hold tenured appointments (Kisslinger, Spetzler, and Wyss), others have served as adjunct professors. Among them is Charles Archambeau, formerly of the California Institute of Technology; Robert Engdahl who became Director of the U.S. Geological Survey Seismological Laboratory in Golden, and James Whitcomb, who remains on the campus. A major research program of CIRES during the mid-seventies, supported by the Earthquake Hazards Reduction Program of the USGS, involved establishing a telemetered seismic array on Adak Island, Alaska to relate seismic activity in the Aleutian arc to plate structure in a way that might provide information on earthquake precursors. Spetzler's experimental work on evaluating rock and mineral properties at high temperature and pressure has been an important aspect of the seismic program. Recent appointees to CIRES and the Department (Farmer and Goetz) have extended the scope of research activities to isotope geology and remote sensing.

The Department has profited from research opportunities provided by INSTAAR, largely through the work of John Andrews in the Canadian Arctic. The amino acid laboratory, established on the campus by Giff Miller in 1977, among the few of its kind in the United States, provides students and faculty with a valuable tool for dating Quaternary events. The work of Bradley on fluvial and marine geomorphic processes and that of Birkeland on soils and Pleistocene stratigraphy have supplemented the research activities of INSTAAR. The combined efforts have established the University of Colorado as a leading center for Quaternary studies. The recent appointment of Mark Meier as Professor of Geology and Director of INSTAAR adds new luster to the program.

Research activities within the Department have grown apace with those carried on through CIRES and INSTAAR. They include studies in high and low temperature-pressure geochemical reactions, hydrothermal processes and ore deposition, experimental rock deformation, magmatic and tectonic processes related to the formation of arcuate mountain systems; evolution and ecology of micro- and macrofossil organisms; petrologic and geochemical studies of sediments; sedimentary tectonics and basin analysis; polymorphic transitions in the lower lithosphere; and applications of paleomagnetic studies to geologic problems.

Reorganization of the Colorado Geological Survey in 1969 provided an additional avenue of support for graduate student research. The Survey, which in its earlier phase had concentrated on mineral resources, has been concerned mainly with natural hazard studies, including floods, landslides, and the potential for seismic activity. Research funds supplied directly through the Survey have been limited, but cooperative projects through INSTAAR and the USGS have involved Department personnel.

Similar research support has come through the University Museum. The two most recent Museum directors, Peter Robinson (1971-1982) and William Hay (1982-present), are geologists, strengthening ties that have long existed between the Museum and the Department.

Growth of the University's participation in sponsored research over the past two decades in an effort to remain competitive with other institutions, involving most of the science and engineering departments on the campus, has been viewed by some faculty members and alumni as a mixed blessing. Opponents of the system claim that pressures from the University administration to generate grant money, the overhead from which has become a significant part of the University budget, encourages faculty to prostitute themselves in order to obtain grants. Some faculty are equipped by training, experience, and inclination to engage in research activities that qualify for funds; others are not. Those in the latter group are said to feel like second-class citizens, unless they are willing to change direction. Included in this group are those in the arts and humanities, for which grant funds are virtually nonexistent. They suggest that the University should find ways to support fundamental research by qualified persons in any field, recognizing that a major objective of a university is the search for truth. Opponents further suggest that students, particularly undergraduates, become victims of grantsmanship in that the teaching function tends to be subordinated to writing proposals and publishing reports in an effort to generate more funds.

Proponents of sponsored research readily admit that the system is far from ideal. However, they point to the significant accomplishments, including construction of laboratories and procurement of expensive equipment, that could not have been realized without grant support. The University has never been sufficiently affluent to sponsor more than a token research effort on its own. Either the faculty makes use of opportunities that are available through government agencies and private industry or they retreat to the pre-World-War II position of abandoning a research objective. Competent faculty are not attracted to an institution where such a policy exists. During the postwar era, particularly in the past two decades, the University has become recognized as a center for graduate study;

much of the support for graduate work has come from grant funds. Proponents argue that the excitement of discovery in a research-oriented department leavens the entire lump. The enthusiasm filters down to all levels of instruction. The teaching function is enhanced where students and faculty are engaged as partners in the discovery of truth.

The Department has striven to achieve a middle ground in its teaching and research programs. By carefully choosing additions to its faculty with respect to both functions, it has acquired a balance that it hopes to maintain.

The Denver Connection

For many years, earth science instruction was carried out at a center in Denver through the University Extension Division. The program was initiated in the twenties by P. G. Worcester and W. O. Thompson and was carried on in the postwar era by W. W. Longley and H. E. Koerner. The intent was two-fold: 1) to provide young people in the Denver area an opportunity to begin work on a degree program in geology while partly or fully employed, and 2) to furnish a limited number of advanced courses for professionals in the area who wished to augment their earlier training. Classes and laboratory work were scheduled for evening hours, and field trips were arranged on weekends when weather was favorable. Over the years, many students who began work in Denver later transferred to the Boulder campus.

There were times during this period when the University was under pressure to increase its offerings through the Extension Division in advanced courses that could be applied toward degree programs in Boulder. The Denver Extension Center was bombarded with course proposals by persons who were anxious to enlighten students on subjects in which they purported to have expertise. In some instances the proposals were accepted without the blessing of the appropriate Boulder department. Such actions evoked sharp outcries from Boulder faculty groups who suspected that courses in Denver were not comparable to those given on the Boulder campus. The Department settled the issue by insisting that detailed outlines of proposed geology courses be submitted to the faculty for approval together with the credentials of the would-be instructors. Courses beyond the elementary level proposed by persons other than the regular faculty were rarely approved for inclusion in the extension program.

In an effort to resolve the apparent conflict between preservation of University standards and service to the public, the Legislature authorized funds in 1965 to establish a Metropolitan State College in Denver. In the following year, the Colorado Commission on Higher Education recommended support for two-year community and technical colleges throughout the state, including one for Denver in addition to the state college, and a Colorado University Center. The University had meanwhile proceeded with plans to convert its extension center to a university center with admission and teaching standards equivalent to those in Boulder, although there was some doubt concerning the constitutionality of such expansion. The legal impediments were removed in part by legislative action in 1967 and in total by a constitutional amendment in 1972, leading to development of University branches in Denver and Colorado Springs. Actions taken by citizens and the Legislature between the mid-sixties and the mid-seventies resulted in increasing the number of public institutions of higher learning in Colorado to a total of 19.

Following the University's decision in the late sixties to establish a branch campus in Denver, the Department began to look for a person to develop a degree program there and to phase out its extension offerings as the new program gained momentum. A nationwide search established that the right person for the job was a former student, Wesley LeMasurier (M.S., 1962), who had taken a Ph.D. at Stanford in 1965 and was on the faculty at Cornell. Wes arrived in 1968 and, during a formative period for the new department, was rostered with the faculty in Boulder. A specialist in volcanic petrology and Antarctic geology, his initial course offerings were in physical geology and mineralogy.

The College of Arts and Sciences at the University of Colorado, Denver became an autonomous unit in 1971, an achievement that spurred the development of its departments. Since then the Geology Department has expanded to include a faculty of four professors and two instructors.

From the time it began, the Denver department has been in close contact with its parent in Boulder. Representatives of the Boulder department have served on selection committees to choose competent faculty for its Denver counterpart. An attempt has been made to develop the two faculties in ways that enable them to complement each other in teaching and research while maintaining their different roles in serving the needs of students. The Department in Denver has achieved excellence in providing undergraduate training and has arrived at a position where it can offer training at the graduate level, although it has not yet received the blessing of the Regents in this regard. When fully developed, it will provide a service for employed professionals in the Denver area who wish to complete or upgrade their training through evening courses, a goal that has been dreamed about for half a century.

Growth of Support Facilities

The Physical Plant

The core of the building that serves as a home for the Department was constructed in 1910-1911 when there was a full-time faculty of two and fewer than 100 students in the total program. The building was renovated extensively in 1951-52, approximately doubling the original space, to accommodate postwar expansion of the student body. Separation of the geographers in 1957 to form their own department with quarters in the Guggenheim Building provided room for modest expansion and led to minor renovation in 1960. Except for occasional cosmetic improvements to make more effective use of space, there have been no changes in the physical plant during the past quarter century.

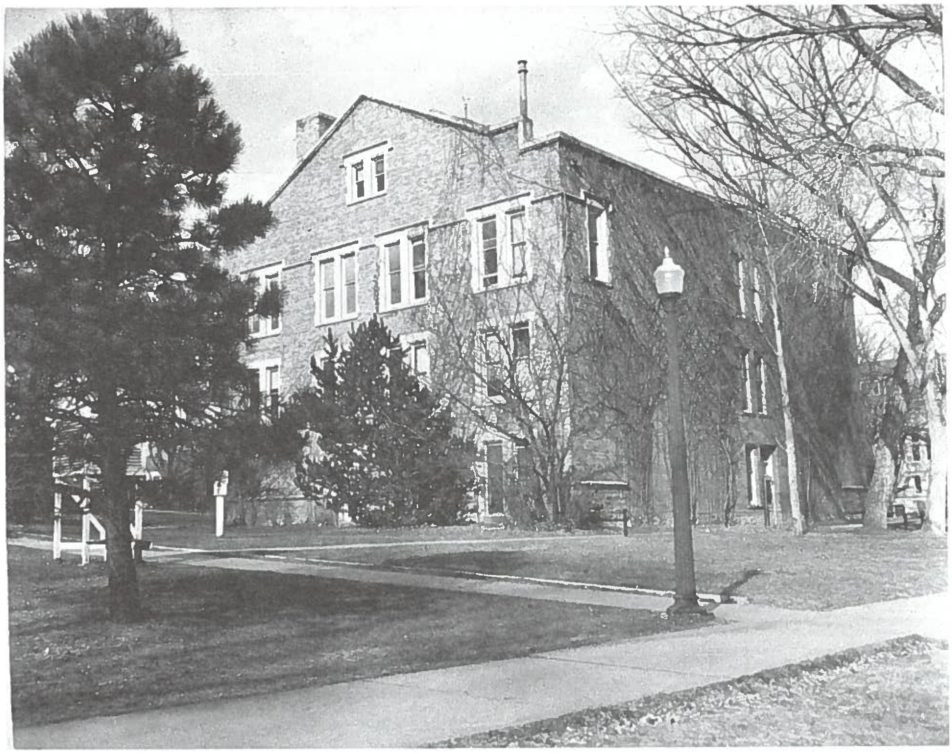
Prior to 1945, the building completed in 1911 served adequately to accommodate the Department's needs, a fact that testifies to the clairvoyance of Professors George and Crawford who planned it. They were able to sell their plans to the University administration on the grounds that the building would initially house the museum collections as well as provide a home for the Department. Even so, their space request was reduced substantially because plans were being formulated to construct a separate museum building. As the space needs of the Department grew, museum collections were displaced to other sites on the campus and ultimately were assembled in the present museum building, completed in the late thirties.

The rapid increase in student enrollment during the late forties crowded the old building to more than its capacity. As undergraduate classes expanded, they were moved to space available elsewhere on the campus, in competition with the requirements of other departments. Even though classes and laboratory sections were scheduled at night and on Saturday, space demands culminated in a choice between denying students access to courses or creating new space through capital construction. The Department chose the latter route, beginning in 1946.

The campaign for new quarters was sparked by R.G. Worcester, then Head of the Department and Dean of the Graduate School. Conversations with University officials convinced him to opt for an addition to the original structure rather than a new building. He also sensed that approval for construction would be enhanced if a substantial part of the funds could be obtained from private sources. Preliminary plans were sketched, including rough cost estimates, and influential alumni were contacted to initiate a drive for funds. Meanwhile, the University Alumni Association proposed that an "all alumni giving campaign" be adopted to exclude campaigns for special purposes. This proposal, which obtained the blessing of the Executive Council of the University, appeared to block the Department's approach.

In April 1948, Worcester appeared before the University Building Program Committee to vent his frustration. He explained that as Graduate Dean he had been obliged heretofore to remain neutral with regard to the Department's space requests. However, since relief had been authorized for Physics, Chemistry, Biology, and Engineering, he felt impelled to make a case for Geology. He requested that architects sketches and cost estimates for additions to the Geology Building be prepared and that means be found to proceed with an alumni campaign for funds. The Committee agreed to make such recommendations to President Stearns, who subsequently approved, and by fall the building campaign was underway.

Phil Worcester stepped down as Department Head in 1949, and his successor, Warren Thompson, took over the task of supervising, with Phil's help, the preconstruction chores of the campaign. In May of that year, the Regents agreed that if the Department would raise a minimum of $100,000 from outside sources, the University would match the amount for capital construction. They indicated that additional funds would be needed for fixtures and equipment, with the implication that matching funds might be provided for whatever the Department could raise for these purposes. Thompson decided to shoot for a subscription total of $150,000 from alumni



The Geology Building, completed in 1911, as it appeared in 1946.

and friends. Early in the campaign, one alumnus, Ellis A. Hall (B.A., 1921, M.A., 1922), an independent oil producer pledged $75,000. Additional pledges received during 1950 were sufficient to guarantee construction, which began in March 1951 and was completed a year later. As in all such endeavors, the original cost estimates of $250,000 fell short of the ultimate figure, which amounted to about $319,000, due largely to a marked increase in construction costs. About $102,000 was subscribed from private sources, the balance being provided by the state.

For a brief period the Department was among the better housed of its kind in the nation, but the apparent affluence was short lived. Following the Korean conflict, enrollments again increased, and by the late fifties all available space was in use. Departure of the geographers in 1957 and collapse of the employment market for young geoscientists in 1958, which resulted in depressed enrollment, provided a few years of respite from acute space concerns. By the late sixties, enrollment projections at the national level suggested that another bulge could be expected. What occurred during the following decade was to surpass even the most generous estimates.

Planning for a space crisis of unknown dimensions began within the Department in 1967. In 1968, the University Planning Office included in its proposed capital budget plans for a new Geology Building. Program planning was scheduled for 1969-1970 and construction was projected to begin in 1971. The building was to be located between the Physics and Engineering complexes on the east part of the main campus. In 1969, the Colorado Commission on Higher Education examined the existing Geology Building and declared it functionally obsolete. In that year, the School of Business, housed for nearly two decades in the erstwhile Student Union, adjacent to Geology, was able to move to its new quarters south of Engineering. An alternative to a new structure for Geology was suggested, involving alteration of the building vacated by Business and remodeling the Geology Building.

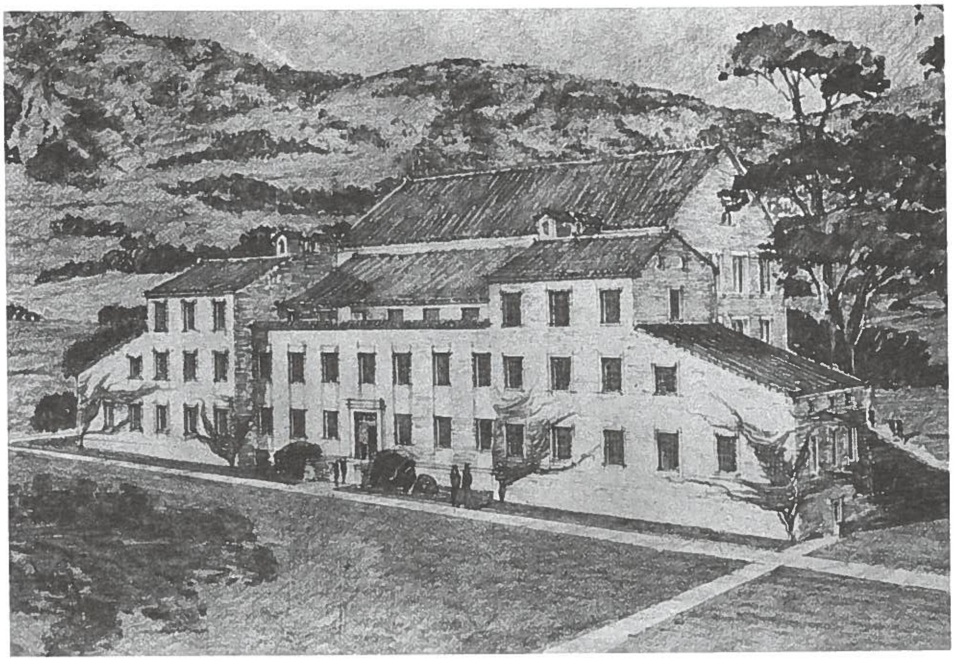
Overcrowding in the late forties forced freshman laboratory sessions into the hallways.

Preliminary plans were drawn for both alternatives. The Department favored a new building with a view to including INSTAAR and CIRES in a structure designed to accommodate the entire earth science family. The new building appeared to be certain of success, but to play safe the Department decided to prepare a proposal to the National Science Foundation for matching funds to use as leverage. Contacts were established with about two dozen major geoscience departments across the country that had acquired new quarters, in part through support from NSF. The departments were generous with suggestions regarding approaches and pit-falls and provided copies of building plans they had adopted. Tentative arrangements were made to send Bill Bradley, then Department Chair, to Washington for a conference with NSF regarding details of the proposal.

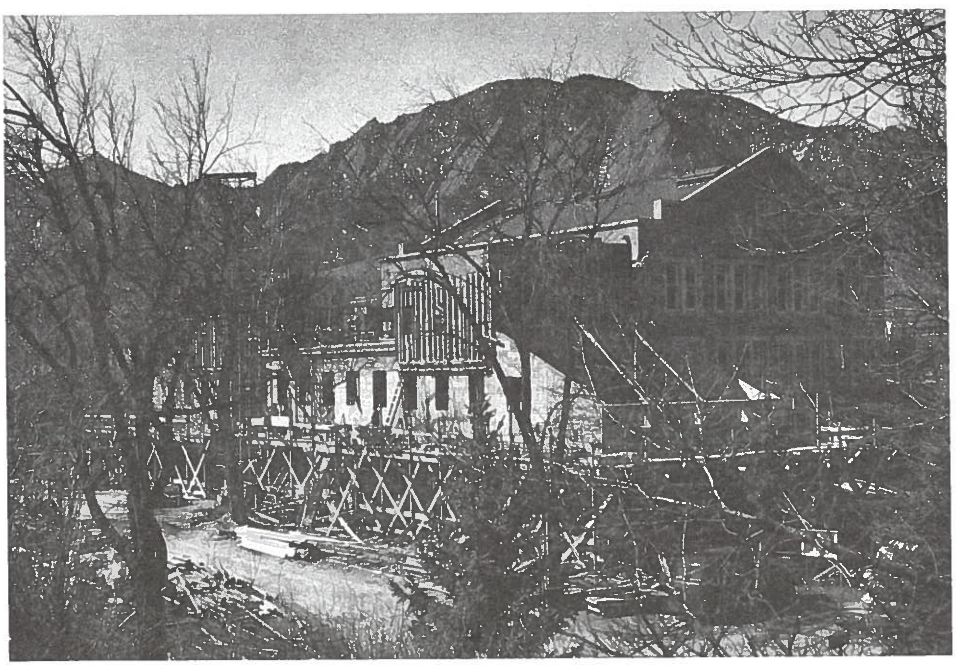
Quite suddenly, these well-laid plans were swept away. Early in 1971, the Colorado Legislature placed an enrollment ceiling on the University and froze all funds for new construction, including funds for planning. Without detailed plans for the proposed building, a cardinal requirement for NSF funding, the Department was forced to abandon preparation of a proposal. Meanwhile, the Economics Department had moved into the former Business Building, effectively removing that option as an alternative. In the ensuing scramble for position on a priority roster to receive state funds for new construction, if and when they were restored, the Department slipped, for reasons that are not at all clear, from first to tenth place.

In 1973, the University conceived the notion of a Centennial Building to commemorate its 100th anniversary in 1976 and to furnish space, at least temporarily, for departments that were overcrowded. Filled with new hope, the Department submitted a request for inclusion in the centennial structure, providing a detailed outline of its space requirements. However, funds for the building could not be found, and the project was abandoned.

Gradually, the Department managed to reestablish its position on the priority list



Architect's sketch for the east wing, 1950. Old building in background.



The east wing under construction, 1951.

The completed structure, ready for occupancy, spring of 1952.

for new space, largely by dint of great effort on the part of Don Eicher, Department Chair, 1976-1980 and by Erle Kauffman who succeeded him. An all-campus review of space requests by the administration in 1977 noted that the Geology facility is totally obsolete and recommended new construction. A departmental planning committee agreed to push for an Earth and Environmental Sciences Center to house Geology, CIRES, and INSTAAR at an estimated cost of $27 million. In May of 1981, the Boulder Campus Planning Commission approved the concept and established the project as one of highest priority. However, the Board of Regents reacted with skepticism to the cost figure and proposed that ways be found to reduce it. An alternative under consideration is to approach the project in three separate stages–stage one to include the needs of the Department, stage two those of CIRES, and stage three those of INSTAAR. An effort is under way to solicit funds from private sources in order to reduce the cost to the University. Recently, a program plan for a $10 million facility was approved by the Boulder Campus Planning Commission with a proposed completion date of 1990. Although the project remains a top priority, it remains to be funded.

Meanwhile, Geological Sciences continues to be the only pre-World-War-II department on the campus to occupy its original quarters. The remodeling completed in 1952 was designed to accommodate a student body of 750 (150 degree candidates and 600 nonmajors per semester) and a faculty and staff of 15. In the more than three decades that have elapsed, the faculty and staff have increased to 27 and the student body to more than 1,500 in an average semester, about one-third of which are enrolled in degree programs. Little can be done to increase usable floor space in the present structure, which remains essentially at the 1952 level. The situation is effectively summarized in a memorandum by Kauffman in 1982 in which he stated that the Geology Building has fallen into a state of disrepair. This situation, coupled with overcrowding and lack of facilities for effective teaching and research, has had a demoralizing effect on students and faculty. A positive element resulting from the long delay is that the Department is now in a much better position to define its needs and to design for the future than it was when its plans were scrapped in 1971.

The Library

The Department has had its own branch library, housed in the Geology Building, for more than 60 years. By the mid-twenties, the collection had become large enough and sufficiently used to warrant a branch librarian. Ms. Virginia Holbert was appointed to the position in 1925 and served until her retirement in 1960. During this time the collection grew to include most of the major domestic journals and many of the federal and-state publications, as well as the more important books to appear in the subdisciplines. Alumni and friends have contributed for many years to a fund that provides for special purchases for the library. Of major assistance were funds from the estate of the late John G. Bartram to establish a memorial library collection in his name.

The second Earth Science Librarian was Dederick C. Ward, a graduate of William and Mary College Virginia, who completed an M.S. in Geology at the University of Colorado in 1958 and an M.A. in Library Science at the University of Denver in 1961. Ward was hired to replace Holbert in 1961 and succeeded in obtaining a full-time assistant, Mrs. Sylvia McCracken, in 1962. For nearly two decades, Dedy Ward, assisted by Sylvia, shepherded the development of the Earth Science Library from what has been a useful but restricted instrument, tailored mainly to teaching requirements, into a cosmopolitan collection geared to the research needs of graduate students and faculty. Ward's background in geology enabled him to exercise wise choices in procuring library materials on a limited budget. He added important foreign journals and documents, mostly lacking in earlier times. He also acquired and installed a microfilm reader to make use of a growing volume of microfilm literature.

Dedy Ward was decidedly more than a mere keeper of books. He developed ways to facilitate student use of the library and encouraged the faculty to make greater use of library materials in their courses. He was instrumental in organizing the Geoscience Information Society in 1965 and in sponsoring its acceptance as a member society by the American Geological Institute in 1967. Subsequently, he served as a member of the AGI GEO-REF Advisory Committee associated with the National Data Bank in Falls Church, Virginia. On a sabbatical leave in 1975, Ward toured many of the classical regions of western Europe that are enshrined in geological literature and visited several of the major European university libraries. He assisted in organizing an International Conference on Geologic Information and co-chaired its first meeting at Imperial College, London in April, 1978, a session attended by 200 representatives from 27 countries.

Early on, it became clear that Dedy Ward was destined for a larger role than that provided by the departmental library. In order to encourage him to remain, he was regularly promoted within the staff of the University Library and ultimately became Science Librarian. The austerity program adopted by the Colorado General Assembly in the late seventies resulted in a substantial reduction in library funds. Plans for a new science library that had been under discussion for a decade appeared to be stalled indefinitely. These turns in events were discouraging to Ward, who had dreamed of building a first-class earth science collection at Colorado as well as strengthening the collections in other fields of science. He resigned in 1980 to accept a position as Earth Science Librarian at the University of Illinois.

Since Ward's departure, the affairs of the Earth Science Library have been directed by capable persons provided from the University Library staff. Some of the damage inflicted by the austerity program of the late seventies has been repaired, and progress has been made in enlarging the library holdings. Recently, an electronic security system was installed to stem the disappearance of volumes from the library, a problem that has increased markedly in recent years because of pressures imposed by large enrollments and a limited staff. There are no immediate plans to seek a professional Earth Science Librarian, although the task of securing adequate holdings to support teaching and research programs of the Department has become increasingly complex. The problem is mitigated in part by proximity to other good technical libraries, including those at NOAA and NCAR in Boulder and the USGS in Denver.

The Museum

The Department and the University Museum have common roots that extend to the foundation of the campus community. The exhibit of ores and metallurgical products donated to the University in 1880 by the State Geologist became a nucleus for a future museum collection and provided teaching material for pre-department courses in earth science. In the same year (1902) that the Department was officially organized by N. M. Fenneman, Junius Henderson was appointed as interim curator of what was to become seven years later the University Museum. Henderson later involved faculty personnel in geology, biology, and anthropology as curators of museum collections in their separate fields, while himself offering course work in areas for which he had expertise. The tradition established by Henderson has been continued by his successors, and the Department and the Museum have enjoyed a cooperative relationship.

Ties between the Department and the Museum were strengthened in 1961 by the appointment of Peter Robinson (Ph.D., Yale 1960) as Curator of Geology on the Museum staff. He became a Professor of Natural History and Museum Director in 1971, a post he maintained until he relinquished the directorship in 1982. Peter's field of interest is vertebrate paleontology. His research, in which he has managed to involve his students, has taken him to the Antilles, western Europe the Egyptian Sudan, Morocco, Tunisia, and Spain, as well as to many areas in western North America.

In 1972, Robinson recruited as curator of fossil vertebrates for the Museum a second vertebrate paleontologist, Judith A. Harris (then Van Couvering), who had just completed a doctorate at Cambridge University, England. She has conducted studies on fossil vertebrates in Greece, Israel, and east Africa. Following Koerner's retirement in 1971, Robinson and Harris enlarged the course offerings in vertebrate paleontology and organized an interdisciplinary program, involving Geology, Biology, and the Museum, leading to a doctorate in the subject.

When Robinson stepped down from the Museum directorship in 1982, a search for a new director ensued. The person chosen was William W. Hay (B.S. Southern Methodist, 1955; M.S. University of Illinois 1958; Ph.D. Stanford, 1960) whose interests cover a broad range in the field of marine geology and biostratigraphy. Prior to coming to Colorado, Bill had served as Chairman of the Division of Marine Geology and Geophysics at the Rosenstiel School of Marine and Atmospheric Science, University of Miami (1974-1976) and Dean of the Rosenstiel School (1977-1980). Since 1979, he has been President of Joint Oceanographic Institution, Inc. of Washington, D.C.

Hay's research activities have led to an impressive list of publications covering a variety of subjects, including the taxonomy of coccoliths, scanning electron microscopy techniques, probability in ecology, tectonism in relation to erosion and sedimentation, and mass balance for the ocean sedimentary system. His professional appointments include membership in the International Stratigraphic Commission on Zonation of Cretaceous Tertiary Deep Sea Sediments (1975-present); Code Committee of the North American Commission on Stratigraphic Nomenclature (1978-present); Scientific Committee on Oceanographic Research (1977-1983); Executive Committee, Gulf Universities Research Consortium (1976-1980); and JOIDES Executive Committee (1976-1980).

Bill has lectured and conducted courses in the Department intermittently since his arrival. He furnishes a contact with topics in marine geology to which students have had little access in the past.

Office and Laboratory Staff

The point at which the Department first acquired a full-time secretary is difficult to establish. Among the first on record was Geraldine Wilson, wife of faculty member R. W. Wilson, who served during the late thirties and early forties. She resigned in 1943 and was replaced by Frances Demuth, who retired in 1950. For nearly two decades following Fran's departure, the post was occupied successively by 10 or more persons, mainly wives of graduate students or young faculty in other departments, who needed employment to bolster the family exchequer. When their spouses departed, or the need was no longer pressing, they left. Continuity in office procedures during this period was maintained largely through the efforts of the departmental executive officer.

The present secretarial staff began to take shape in 1968. By that time, the University administration had been persuaded to approve a half-time appointment to assist the secretary, then Lois Bergren. The position was filled by Edith Ellis, and when Lois resigned in 1969, Paulina Franz (then Thure) was appointed to replace her. Paulina and Edith formed an effective team that managed the Department's office affairs for almost two decades. Edith had meanwhile consented to a full-time appointment to assist in handling the ever increasing load of paperwork, and from time to time student help was employed. In 1981, Kay Fox was added to the staff on a half-time basis as a third member of the team. Sarah Hatch was added to the group in 1986 as a Word Processor Operator. After 18 years with the Department, Paulina retired on March 1,1987, leaving a large void in the ranks. Hopefully, she and husband Art will now find time to do some of the things they have long postponed. The faculty, staff, and students have joined in wishing her Godspeed in her new life.

Aside from the mountains of paperwork that these ladies manage to cope with, their roles in keeping the faculty out of trouble with deans and vice chancellors, reminding students of rules and deadlines, listening to complaints or furnishing shoulders to cry on, dealing with daily inquiries from citizens and itinerants, all of which they accomplish with the patience of Job and the wisdom of Solomon, have contributed effectively to the Department's image in the University community. The University's selection of Edith as its staff employee of the month for October 1986 is a testimony to the role she has played in that regard. Both Edith and Paulina were recently honored at a reception for employees with 20 years contribution to the University of Colorado.

A fitting tribute to the position of a department's secretarial staff in the academic hierarchy is given by the following bit of anonymous free verse, which was circulated on the campus a few years ago:

The Dean:

Leaps tall buildings in a single bound, is more powerful than a locomotive, is faster than a speeding bullet, walks on water, gives policy to God.

The Department Chair:

Leaps short buildings in a single bound, is more powerful than a switch engine, is just as fast as a speeding bullet, walks on water if sea is calm, talks with God.

The Professor:

Leaps short buildings with a running start and favorable winds, is almost as powerful as a switch engine, is nearly as fast as a speeding bullet, walks on water in an indoor swimming pool, talks with God if special request is approved.

The Associate Professor:

Barely clears a Quonset hut, loses tug of war with a locomotive, can fire a speeding bullet, swims well without benefit of accessories, is occasionally addressed by God.

The Assistant Professor:

Makes high marks on the walls when trying to leap buildings, is run over by locomotives, can sometimes handle a gun without inflicting self-injury, dog paddles effectively, talks to animals.

A Graduate Student:

Runs into buildings, recognizes locomotives two out of three times, is not issued ammunition, can stay afloat with a life jacket, talks to walls.

An Undergraduate:

Trips on door step when trying to enter buildings, says "look at the choo-choo," wets himself with a water pistol, plays in the bath tub, is learning to talk.

The Department Secretary:

Lifts tall buildings and walks under them, kicks locomotives off the tracks, catches speeding bullets in her teeth, freezes water with a single glance, **SHE IS GOD!**

In the Department of Geological Sciences at the University of Colorado, God is represented by a committee of four.

The need for a technician to supervise the photo lab, repair laboratory and field equipment, prepare thin and polished sections of rock and ores, do occasional drafting, and make minor alterations or improvements to classroom and laboratory facilities had been discussed with University officials for many years before such a person first appeared on the scene in 1968. Since then, there has been a total of four, the first three of whom stayed less than five years each. The present technician, Paul Boni, has been on the job since 1979. The demands that are made on a general technician by faculty and students are such that no one person can hope to become expert in all phases of the work. Most science departments have three or more, each performing a restricted function. Boni comes close to being a jack of all trades, as well as a master of some and appears to have been challenged by requests that led to frustration on the part of his predecessors.

Acquisition of a microprobe analyzer from NCAR in 1980 necessitated finding a person trained in geology and electronics to update the instrument for use in analyzing earth materials, to keep it in a state of calibration and repair, to train faculty and students in its use, and to attract grant funds for sponsored research. An extensive search for the right person led to the selection of John W. Drexler (Ph.D. Michigan Technological University, 1982), who joined the Department as Director of Analytical Facilities following completion of his doctorate. He was subsequently appointed an Assistant Professor, Attendant. John's training in the use of electronic equipment includes not only the electron microprobe but also the atomic absorption spectrometer, X-ray fluorescence equipment, the scanning electron microscope, and neutron activation and gamma ray spectrometers. The Department now possesses parts of this equipment and hopes to soon add the remainder to its laboratories. John's prior employment includes summer work in minerals exploration in the Ambler district, Alaska (1978), and the Lima area, Peru (1979), and work with Rockwell International on design of a nuclear waste repository in basalt (1980).

Drexler has contributed effectively to a team effort of teaching and research in mineralogy, geochemistry, petrology, and economic geology that had been visualized for some years prior to his arrival. He has collaborated with other faculty in writing proposals to acquire additional equipment and research support; several of the proposals have been funded. He regularly offers courses to train students in the uses of electronic equipment and interpretation of resulting data.

Through a joint program between IBM and the University, the Department has obtained the services of Howard McDonough, a senior engineer with IBM. Beginning with the fall semester, 1986, he will be in residence for at least two years, during which time he will supervise computerization of the Department's records. He is offering a basic course in FORTRAN programming and consults with advanced students regarding computer problems related to their studies and research.

Support from Government, Industry, and the Profession

Government agencies, including federal, state, and municipal, have been major sources of support for departmental programs for many years. Before the early thirties, support came mainly from the Colorado Geological Survey, which was headquartered in the Department. Many of the graduate theses completed during this early period were supported in part by state funds. Following the demise of the Colorado Survey in 1932, the support vacuum was filled partially by the U.S. Geological Survey, which agreed to take over some of the functions performed by the state organization. Resurrection of the Colorado Survey in 1969 revived a relationship that had been dormant for more than 35 years. A major concern of the new Survey is land use planning. In the early seventies, the Windsor Project, an environmental study of the Fort Collins-Loveland-Greeley area, was funded by state and federal agencies and directed by the Colorado Survey. The investigations were conducted mainly by graduate students from the University of Colorado, Colorado State University, and Colorado School of Mines.

The federal government's decision in the late forties to establish in Denver a major center for several of its agencies, including the Geological Survey, was a decided plus for the Department. Survey personnel constitute a large reservoir of specialized talent for lectures and seminars. The USGS has been generous in permitting the use of its library and laboratory facilities and in its support for graduate research. Noteworthy in this regard is the Survey's support of work by Braddock and his students in unraveling the Precambrian geology of the northern Front Range, an effort that began more than two decades ago and still continues. In many instances the investment in student training has produced dividends, in that the recipients elected to pursue careers with the USGS. A substantial number of well-known Survey geologists are alumni of the Department.

In 1969, the city of Boulder became interested in providing support for a graduate student in exchange for work on problems stemming from conflicts between natural processes and Boulder's rapid growth. The city Engineering Department was persuaded that a geologist with engineering background could help in relation to foundation problems, waste disposal, slope stability, and flood control. The timing was ripe for such a relationship because of growing awareness on a national scale of urban environmental problems and the role of engineering geology in furnishing solutions. Two doctoral students served the city in this capacity, Victor R. Baker (1969-1971) and James A. Pendleton (1972-1980).

Support from industry has been an important factor in the life of the Department. For many years, major oil and mining companies have included the Department on their lists for annual visits by recruiters in search of new personnel. The companies have also contributed funds for student scholarships, fellowships, and research grants. Upon occasion, they have provided funds for teaching and research equipment. One of the largest grants was received in 1980 from Atlantic Richfield. A sum of $150,000 to be used over a period of three years was designated for support of junior faculty and graduate student research as part of the company's program to aid science and engineering education. Part of the grant was used to purchase an X-ray fluorescence analyzer, an instrument that is essential for modern chemical analysis of geologic materials. Resulting from such investments, many of the Department's alumni are employed by major industrial companies in positions ranging from field exploration to the top levels of management.

Relocation of the headquarters of the Geological Society of America from New York City to Boulder in 1967 provided the Department with access to a large professional society, a contact that has proven to be a valuable asset. Other than providing a more central location for the Society's operation, the choice of Boulder was influenced in part by proximity to a major university with a well established geology department. From the outset, the informal arrangement between the Department and the Society has been one of reciprocity. Several of the Department's faculty have served in important offices and committees of the Society, and a Department alumnus, Dwight Roberts, is now President of the GSA Foundation. Society personnel have conducted departmental seminars and have served as speakers to student groups. Visiting professionals from many parts of the nation, as well as from foreign societies, have provided resource personnel that have enriched the Department's activities. Location of the Society in Boulder has undoubtedly been a factor in attracting competent students and faculty to the Department and has thus contributed to its growth.

Support from Alumni

An important index of a department's success in training students can be measured in the support provided by its alumni. The Department of Geological Sciences can take pride in the close relationship it has maintained with its alumni for more than three-quarters of a century. The feeling of kinship stems in large part from the esprit de corps that has characterized student-faculty relationships throughout this period.

The Department has endeavored to maintain its contacts with alumni in a variety of ways. One of the more effective has been through the annual newsletter, which is mailed to all alumni and friends with known addresses. Many alumni recall with mixed emotions when as students, they were drafted to help prepare and assemble the newsletter for distribution. From time to time, the newsletter has been supplemented by notes and memoranda mailed to inform alumni of important developments.

For many years, the Department has sponsored an alumni gathering in connection with the annual homecoming celebration. Prior to the mid-sixties, the occasion was in the nature of a tea, held in the Geology Building following the football game. The tea was gradually replaced with more potent beverages as the University's social policies became liberalized. For the past decade, the gathering has taken the form of a cocktail party held at the University Club. The occasion has always been supported with enthusiasm regardless of the refreshments.

A large number of the Department's alumni are stationed in the Denver area, and many others occasionally visit the city in connection with professional assignments. Beginning in the early fifties, luncheon or dinner gatherings were arranged at regular intervals to bring together local or visiting alumni and Department faculty for food and conversation. The gatherings provided a means for communication and exchange of ideas. The Department reported on its activities, problems, and accomplishments, and alumni engaged in the "real world" told the Department what students should have by way of preparation to survive. Although the interest has waxed and waned, the affairs have been well attended and have accomplished a useful purpose.

National and regional conventions of the major professional societies have furnished occasions for social gatherings for alumni and attending faculty. Dates, times, and meeting rooms for the gatherings are scheduled well in advance and announced in the convention programs.

Recently, the Department sponsored an Alumni Weekend to coincide with Homecoming events, including the football game, a pregame lunch, and a post-game party followed by dinner and a time to reminisce. The intent is to make the affair an annual one, perhaps to include a field trip for interested persons.

These efforts by the Department to cultivate relationships with alumni have paid dividends in maintaining alumni interest in its affairs. The contributions, monetary and otherwise, that alumni have made to the welfare of the Department, if recounted in detail, would fill a large volume. They include what in aggregate are large sums of money for the building fund (both that of 1951 and the present effort), for purchase of equipment, for student scholarships, and for enrichment of other departmental programs. In addition, numerous individuals have given generously of their time and energy to projects sponsored by the Department or by alumni groups. Many have contributed books and maps for the library, specimens for laboratory study, slides and films for classroom use, and through lectures to student groups, the results of their personal endeavors.

The Geology Foundation, organized by alumni in 1956, was established to promote, the welfare of the Department. The organization was approved by the Board of Regents and the University of Colorado Development Foundation, thus creating the only body on the Boulder campus authorized to promote development at the departmental level. The founders promptly drew up a constitution providing for a Board of Directors comprised of 16 members, an Executive Committee of five, and procedures for interaction with the Department. A major provision was to establish a Geology Fund, to be expended by the executive officer of the Department, with approval of the President of the University, for student loans, educational grants and scholarships, and research projects related to the educational programs of the Department. The initial Board of Directors included, in addition to well-known local alumni, representatives from Casper, Houston, New York City, New Orleans, Tulsa, Cleveland, Salt Lake City, and Abilene.

For more than a decade a quorum of the Foundation directors met periodically with one or more representatives of the Department and the Director of University Development. Their accomplishments were numerous, but enthusiasm lagged with the passing of time as the original group became dispersed and other commitments sapped their energies There has been no activity on the part of the Foundation in the recent past.

The level of the Department's interaction with alumni has subsided in recent years for a variety of reasons. Part of the problem lies in the fact that alumni of the Department fall mainly into two groups in terms of age and interests. The older group received their degrees during the postwar period between 1946 and 1960. The younger group is comprised mainly of alums who graduated since 1975. Low enrollments during the intervening period resulted in few graduates. A large percentage of the older group settled in the Denver area. They were mainly petroleum oriented and achieved success at the management levels in regional offices of energy companies and related industries. Their common interests provided a cohesiveness that made them highly effective in an alumni organization. The nucleus of this group has been decimated by retirement, reassignment, and mortality, and they have not been replaced. Departmental rapport with the group was fostered over the years by Phil Worcester, Warren Thompson, Warren Longley, John Chronic, and Bruce Curtis, none of whom remain on the scene. The younger group of alums are much more diverse in training and interests than their predecessors, and they are widely dispersed, a smaller percentage having remained in the local region. The newer faculty, in terms of age or date of appointment, who now constitute a majority in the Department, do not feel a strong kinship with the older alums and have not yet established a viable relationship with the more recent graduates.

A renewal of alumni interest in Department affairs is indicated by recent developments. An Alumni Advisory Board, consisting of representatives of both the older and younger alumni groups from industry, government, and academia, was organized in the fall of 1985, largely through the effort of the Department Chair, Hartmut Spetzler. Three meetings of the group have been held with members of the faculty to sketch plans for future activity. The intent is to broaden the base of alumni participation and to promote an interchange of ideas regarding the needs and aspirations of the Department. The following are alumni members of the Advisory Board:

Gerald G. Loucks, Chair: B.A. 1950; Petroleum Geologist, Cedaredge, CO.

Omer B. Raup, Vice-Chair: Ph.D. 1962; U.S. Geological Survey, Denver.

Thomas L. Thompson: B.A. 1950, Ph.D. Stanford, 1962; Petroleum Geologist, Boulder.

Victor R. Baker: Ph.D. 1971; Dept. of Geosciences, University of Arizona.

David Eggler: Ph.D. 1967; Dept. of Geosciences, Penn. State University.

Timothy L. Grove: B.A. 1971, Ph.D. Harvard, 1976; Dept. of Earth, Atmospheric, and Planetary Sciences, Mass. Institute of Technology.

John Harms: Ph.D. 1959; Harms and Brady Inc., Littleton, CO.

Howard Lester: B.A. 1936; Petroleum Geologist, Boerne, TX.

John Rold: M.A. 1950; State Geologist, Colorado Geological Survey, Denver.

Frederick Tietz: M.S. 1956; President, BHP Petroleum Inc., Houston, TX.

The Department and the University

Service to the Campus and Local Community

The faculties of all departments are expected to participate in functions other than teaching and research that serve the best interests of the academic community. The record indicates that the Department has more than pulled its weight in this regard. Four of its faculty (Worcester, Toepelman, Thompson, and Wahlstrom) have held positions in the upper echelon of University administration. P. G. Worcester was Dean of Men (1920-1930) and Dean of the Graduate School (1943-1952). W. C. Toepelman counseled student draftees during World War II. After the war, he was named Director of Veterans Affairs to assist returning veteran students to adjust to campus life and to secure their benefits under the GI Bill. He served on several commissions at the local, state, and national levels regarding legislation that affected veterans. W. O. Thompson, a University athlete during his student days, served as Faculty Athletic Representative to the Big Eight Conference from 1948 to 1966, during which time he held important offices in the National Collegiate Athletic Association. E. E. Wahlstrom was named Acting Dean of the Faculties in 1964 and served as Dean of the Faculties and Vice Provost from 1968 to 1970.

Two of the Department's alumni have also been involved in administration as directors of the University of Colorado Foundation. William A. Fowler (M.S. 1952) served in this position from 1960 to 1966. He was succeeded by Dwight Roberts (B.A.1957), who served until 1982, when he resigned to become President of the Geological Society of America Foundation.

Faculty of the Department have served on countless boards, committees, and special assignments involved in conducting the business of the University. Some random examples illustrate the diversity of these activities. Larry Warner served for a decade (1952-1962) as Secretary to the Graduate Faculty and the Executive Committee of the Graduate School. He was a member of the Center of Excellence Committee (1963-1964) that drafted a University proposal for an NSF Science Development Grant. T. R. Walker was Chair of the University Council on Research and Creative Work (1965-1967) and a member of the Chancellor's Advisory Committee on Reappointment and Tenure (1977-1978). He also served as Secretary to the Faculty of the College of Arts and Sciences during the administrations of three deans. Bruce Curtis worked for many years on the University Artist Series Committee. Don Runnells has served two terms (1976-1979; 1983-1986) with the University Appeals Committee on Academic Rules and Procedures. Chuck Stern has been a member of the Committee on Courses of the College of Arts and Sciences since 1984. Erle Kauffman has served on the Arts and Sciences Dean's Committee on Science Policy (1982-1984), the Boulder Campus Planning Commission (1984), and the College of Arts and Sciences Space Committee (1984). Virtually all of the faculty have been, and continue to be from time to time, involved in similar assignments.

At various times, the Department has established ties with other science departments to promote programs for teaching and research in areas where interests overlap. Geomorphologists, paleontologists, geochemists, and geophysicists have been involved in cooperative efforts with faculty and students in anthropology, geography, biology, chemistry, physics, and engineering. The Department cooperated for several decades with the Department of Civil Engineering in reciprocal course offerings for undergraduates, and faculty members of the two departments have shared research projects and supervision of graduate theses. A similar arrangement has existed with biology, mainly through Museum personnel rostered with the Department.

During the mid-fifties, the College of Arts and Sciences established an Interdisciplinary Studies Program in order to give students background information in areas outside their major subject fields without involvement in the minutia that characterizes introductory courses in the various disciplines.

The program developed in response to a national movement in higher education as a means to cope with the postwar information explosion. Because of their interdisciplinary training and interests, faculty of the Department were sought by the College to assist in teaching a general course in physical science. The Department assumed a major role in teaching this course for more than a decade. Gradually, the College acquired persons with backgrounds in interdisciplinary studies to manage the program. The science courses became oriented more toward biology and the history of science.

A further innovation, involving the concept of a college within a college, was introduced by Arts and Sciences in the mid-sixties as the Sewall Hall Program. A small number of qualified freshman applicants was selected each year to reside in Sewall Hall and to participate in limited enrollment seminars covering a range of topics but related to traditional disciplines. The objective was to give qualified students some of the advantages of a small liberal arts college while attending a large university. As with the Interdisciplinary Studies Program, funds were not available initially to hire a separate faculty, and existing faculty in various departments were called upon for support. The Department participated in the program, intermittently as needed, for two decades. With time, the College has been able to acquire a limited faculty assigned to Sewall Hall duty, and participation of other faculty has diminished.

Relationships between the Department and the city of Boulder have been mutually advantageous. Largely through the efforts of Bill Bradley and friends in the U.S. Geological Survey, the city was persuaded in the late sixties to provide limited support for a doctoral student who would act as a part-time urban geologist. The first student to serve in this capacity was Victor R. Baker (B.S. Rensselaer Polytechnic Institute, 1967; Ph.D. University of Colorado, 1971). After completing his doctorate, Vic joined the faculty of the University of Texas, Austin. While there, he published an account of this work for the city of Boulder in an article entitled "Urban Geology of Boulder, Colorado, a Progress Report" (*Environmental Geology* 1975). It has been recognized as an important contribution to the literature on urban geology. Vic is presently on the faculty of the University of Arizona, Tucson.

Following Baker's departure from Boulder, the city position was taken over by James A. Pendleton (B.A. Princeton, 1969; M.A. 1971, Ph.D. 1978, University of Colorado). Building on Baker's work, Jim undertook a detailed study of the geology of the Boulder area in relation to urban development. Early results were so impressive that he was called upon to assist in a variety of problems. His duties soon expanded to embrace a full-time position as City Geologist. His doctoral thesis, "Geology and the Conduct of Local Government; an Urban Geologist's Viewpoint," serves as a model for the profession. However, the position did not offer sufficient challenge to hold him. Soon after completing his studies, he accepted an assignment as Chief Engineering Geologist for the Mine Land Reclamation Division of the Colorado Department of Natural Resources.

Faculty of the Department have been called upon intermittently by the city for assistance and advice. A case in point was Bradley's work with an advisory committee in 1978-79 to recommend flood control measures on Boulder Creek.

Service to the State and Nation

As a state institution, the University, from its inception, has been involved in service to the state government and the citizens of Colorado. The role of the Department in this connection has been partly through its relationship to the Colorado Geological Survey. The two directors of the Survey to date have been related to the Department, the first as a faculty member and the second as an alumnus. R. D. George became State Geologist soon after the Survey was organized circa 1905 and remained until it was disbanded in 1932. It was reorganized in 1969 with John W. Rold (M.A. 1950) as its director, a position he has retained to the present. During the early period, the Colorado Survey was concerned mainly with development of the state's natural resources. Since its reorganization, the state Survey has devoted major attention to environmental problems. Several faculty and large numbers of students have been involved in the Survey's activities throughout its history. Another alumnus who presently serves the state in an important capacity is Bruce Benson (B.A. 1964), Chair of the Colorado Commission on Higher Education. The Commission acts to coordinate and improve the programs of state-supported colleges and universities in Colorado and makes recommendations to the Legislature concerning matters of policy and funding. Faculty of the Department have also served on several occasions in an advisory capacity to the state government. For example, Carl Kisslinger and Don Runnells were, on separate occasions, members of the Governor's Council on Science and Technology.

On the national level, the Department's faculty and alumni have made significant contributions to the public welfare. Among the more important contributions was involvement in a science teacher training program, sponsored by the University and funded by the National Science Foundation, during the early sixties. The program was part of a nationwide effort, organized in response to concerns that emerged from the Sputnik incident, regarding science education in secondary schools. Emphasis was on retreading secondary school teachers of science and mathematics who were deficient in subject matter preparation. Both summer and academic year institutes were included, and courses were conducted in mathematics, physics, chemistry, biology, and geology. Additional lectures on special topics were provided by resident faculty and invited guests. Applicants from all parts of the nation were screened carefully to determine deficiencies that the institutes were designed to correct. The Department's contribution was in furnishing faculty for courses and lectures in the earth sciences. Among the participants were Bradley, Chronic, Eicher, Honea, Thompson, Wahlstrom, and Warner. Unsolicited letters from teachers who participated in the program, expressing gratitude for what they had received, were very rewarding.

Early in the same period, a different approach to science education was conceived by the American Geological Institute. The proposal was to organize, with NSF support, an Earth Science Curriculum Project, the purpose of which was to develop a general course in earth science and related aspects of chemistry, physics, and biology that would substitute for a traditional course in general science at the junior high school level. A similar project in biology, with headquarters at the University, had been organized in the late fifties.

The Department's involvement in what came to be known as ESCP began in November 1960 at the national meeting of GSA in Cincinnati. At one of the sessions, Larry Warner encountered his erstwhile Johns Hopkins roommate, R. C. Stephenson, then Executive Director of AGI. Over a late afternoon scotch and soda, Steve outlined a plan to establish ESCP on the campus in Boulder and asked Larry to test the climate for University cooperation. Subsequently, a meeting of Stephenson with President Newton and other officials was arranged and an agreement was worked out. Writing of a text and laboratory manual was carried out by a team of earth scientists assembled from campuses across the nation. Most of the work was done in space provided by the Department during the summers of 1962-1963. During the summer of 1964, faculty of the Department participated in a program to train teachers assembled from Utah, Idaho, Nevada, Arizona, New Mexico, and Colorado in the use of ESCP materials and to obtain teacher reaction. The materials were tested during the following academic year in the Jefferson County schools with Warner acting as a consultant to the project on behalf of the Department. For several years after the materials were published for use in schools throughout the country, ESCP maintained its headquarters in Boulder and made use of the Department's facilities.

Individual members of the Department have provided service to the nation on many occasions. Notable examples are: W. C. Toepelman, consultation in the late fifties with the American Council on Education regarding legislation that affected veterans; Don Eicher, member, NSF Review Panel for Deep Sea Drilling (1982); John Andrews, member, Committee of the National Research Council to evaluate the Arctic program of the Department of Energy; Don Runnells, member, Review Board, Argonne National Laboratory (1980-1984); Carl Kisslinger, member, NSF Advisory Group on Earthquake Prediction and Hazard Mitigation (1976); Peter Birkeland, member, NAS-NRC Committee on Space Program for Earth Observations (1969-1971); Joe Smyth, staff member, Los Alamos National Laboratory, (1976-present).

The Department's alumni also have contributed to the nation's welfare as members of government bureaus, industrial groups, and national committees. Notable among them is Benjamin F. Bailar (B.A. 1955) who was appointed U.S. Postmaster General in 1975. However, the Department cannot take full credit for Ben's success, since he acquired an M.B.A. degree from Harvard in 1959, worked briefly for Continental Oil, and later became Corporate Vice President of Continental Can before joining the Postal Service in 1972. It is hoped that the perspective he gained from his training in geology helped him to attain his career objectives.

The most spectacular project in which the Department became involved through its alumni and faculty was the lunar program of the National Aeronautics and Space Administration, leading to the Apollo 11 and 12 moon landings in 1969. Much of the preliminary analysis of simulated lunar terrain was carried out by the Branch of Surface Planetary Exploration of the USGS with headquarters at Flagstaff, Arizona. Four of the Department's alumni (Gordon A. Swann, Ph.D. 1962; Raymond M. Batson, B.A. 1962; Henry E. Holt, Ph.D. 1962; the late Robert L. Sutton, B.A. 1951) worked for several years at the Flagstaff Center and the Houston Manned Spacecraft Center on problems related to the geology of the lunar surface and provided geological training for the astronauts. Three other alumni (Maurice A. Brock, B.A. 1950; Newall J. Trask, M.A. 1956; George E. Ulrich, Ph.D. 1963), employed by the USGS Branch of Astrogeologic Studies at Menlo Park, California, were engaged in mapping potential Apollo landing sites, evolving plans for geologic investigations by the lunar roving vehicle, and potential applications of lunar research to studies of the earth. An eighth alumnus, Paul D. Lohman, Jr. (Ph.D. 1963), joined the NASA Goddard Space Flight Center soon after graduation and developed techniques for geologic interpretation of spacecraft photos of earth and lunar terrains. His interpretations, in which he was associated in part by a ninth alumnus, Stephen J. Gawarecki (Ph.D. 1963) of the USGS, were of particular interest to the Apollo program. Three of the Department's faculty have been involved in lunar projects. Hartmut Spetzler served on the Lunar Science Review Panel (1974-1977) and on the Lunar Sample Allocation Planning Team (1977-1979). Before joining the faculty, Joe Smyth served as a staff scientist at the Lunar Science Institute in Houston (1972-1976). During the seventies, Ed Larson conducted paleomagnetic studies on lunar samples and compared the results with those obtained from meteorites.

The International Dimension

Because the distribution of energy and mineral resources and natural phenomena that are subjects for geologic research are not limited by national or geographic boundaries, earth scientists are required to have a global perspective. Travel to remote places, as well as to foreign centers of human activity, has been an important element in their training and experience. Emphasis on this element has increased as natural resources become harder to find and problems related to the composition, structure, and history of the earth become more complex.

Virtually all of the faculty who joined the Department since World War II have spent time in foreign lands. The trend may have started with Zena Hunter Andrews' appointment as a Fulbright Scholar in 1955 to lecture at Mandalay University, Burma. During the three decades that followed, many of the faculty were involved in foreign activities. Examples include: John Chronic's assignments in Scotland, Ethiopia, Australia, and Puerto Rico; Ted Walker's research and teaching in various parts of western Europe, the Middle East, north Africa, and Latin America; Bill Bradley's work in Australia and Wales; Don Eicher's stint as a lecturer at the University of Edinburgh; and Ed Larson's research in the Mariana Islands in collaboration with Japanese colleagues.

The scope of faculty activities in foreign areas has increased markedly since 1970. Included are John Andrew's studies in the Canadian Arctic; Peter Birkeland's studies in New Zealand, Tasmania, Israel, and various parts of Europe; collaboration by Kisslinger, Wyss, and Spetzler with foreign scientists on earthquake studies in Japan, China, Europe, India, and the USSR; Quaternary research by Miller in Baffin Island, Spitzbergen, Norway, and Tunisia; Atkinson's studies of ore deposits in Mexico and Chile; Stern's research on subduction processes in the southern Andes, Himalayas, and South Africa; lectures by Kauffman at colleges and universities in many countries; structural studies by Kligfield in the Alps, Scottish Highlands, Appenines, Antarctic Peninsula, Andes, and Himalayas; Smyth's lectures and field work in western Europe, South Africa, Australia, and Japan; and work by Kraus in the western desert of Egypt. In addition, these and other faculty members have represented the University as delegates at scores of international meetings and colloquia and have served on dozens of international committees and panels related to their specialties.

Not only has its faculty represented it throughout the world, the Department also has attracted many renowned foreign scientists to Boulder. Two of them were visiting lecturers in the Department, each for an academic year under exchange arrangements with local faculty. In 1958-1959, John Chronic exchanged places with Gordon Y. Craig, a noted Scottish paleontologist at the University of Edinburgh. Gordon has since returned to Boulder for brief visits while on lecture tours in the United States and has hosted faculty members from Boulder on their visits to Scotland. A decade later, Ted Walker negotiated a similar arrangement with Rene Hantke of the Swiss Federal Institute. In their teaching, both Craig and Hantke introduced European points of view that are not familiar to most American students.

During the sixties, the American Geological Institute sponsored a program through NSF to bring distinguished foreign earth scientists to American universities for brief periods to lecture on their specialties and to mingle with students and faculty. The Department was able to obtain several of these persons for visits of up to a week. The list includes Professor Rudolph Trumpy, Swiss Federal Institute, Zurich; Professor Yakov Bentor, Hebrew University, Jerusalem; Professor Lester King, University of Natal, South Africa; the late Professor Hishashi Kuno, Tokyo University; and Professor L. U. de Sitter, University of Utrecht, The Netherlands.

In 1965, the Department hosted the Seventh Congress of the International Association for Quaternary Research (INQUA), with Bill Bradley serving as chairman of the local committee More than 800 Quaternary scientists from 40 nations assembled in Boulder for a week in early September to discuss problems related to the most recent period of earth history. Topics covering the glacial stages, the development of man, and extinction of many species of large terrestrial animals were included in the program. One of the principal speakers was Dr. W. W. Bishop of the Uganda Museum, who lectured on the Quaternary history of the East African Rift System.

The number of foreign visitors to the Department has increased markedly in recent years. They come mainly from western Europe, Australia, New Zealand, and South Africa but in part from Japan, China, eastern Europe, and the Soviet Union. Many are friends of, or coworkers with, members of the Department, who prevail upon them to visit Boulder while on missions in the United States. Some are visiting fellows of CIRES and INSTAAR for periods of as much as a year. Others are brought to the area by the Geological Society in Boulder, or by the USGS and other federal agencies in Denver. During the time required to complete a degree program, students are exposed to great minds of the profession from many lands. Since 1978, Hartmut Spetzler has been a coordinator of the USA–USSR Cooperative Earthquake Prediction Program. He has commonly entertained visiting Russian scientists in his home and has been heard to say, "This may be one small thing I can do to improve international relations."

Beginning early in the century, alumni of the Department have represented it in many foreign countries. Among the early graduates, J. Terry Duce (B.A. 1915) worked for many years in the Middle East and became a Vice President of the Arabian American Oil Company. Philip Andrews (B.A. 1921) spent 23 years as a geologist for Standard of California in Trinidad, Venezuela, Ecuador, and Columbia. The list of more recent graduates that have taken foreign assignments with industries and government agencies is much too long to enumerate. Many have embarked on foreign careers similar to those of Duce and Andrews.

Since World War II, many foreign students have come to the Department for advanced degrees. Most of them have returned for employment in their native countries. A partial list includes Robertus Regout, The Netherlands (M.S. 1951); Ok June Kim, South Korea (Ph.D. 1955); Swai Sundharovat, Thailand (M.S. 1956); Nyan Thin, Burma (M.S. 1961); Saleh Billo, Saudi Arabia (M.S. 1966); Georgio Panella, Italy (Ph.D. 1966); Prinya Nutalaya, Thailand (Ph.D. 1966); Peter Cook, Australia (Ph.D. 1969); Raymundo Punongbayan, Philippines (Ph.D. 1972); Enrique Torres, Mexico (M.S. 1977); Nikos Solounias, Greece (Ph.D. 1979); Ola Saether, Norway (Ph.D. 1980); Alaittin Sayili, Turkey (M.S. 1983); Gonzalo Cruz, Mexico (Ph.D. 1983).

A recent chapter in the Department's foreign dimension involves students from Iran. For several years prior to the fall of the monarchy, the Shah's government sponsored training for several thousand Iranian students at American universities. Four of them (Mohammed Karimpour, Esmail Esmaili, Hassan Amini, and Hojat Krosrovi) enrolled for advanced degree programs in the Department. Following the revolution, they became, in effect, displaced persons. The new government did not honor monetary commitments made by the Shah, leaving Iranian students in America largely without support to continue their studies. Moreover, as proteges of the Shah, they risked an uncertain reception in choosing to return to Iran. The Department did its best to find part-time employment and other sources of support for its four Iranians. By dint of great effort and considerable sacrifice on their part, they have come through the crisis intact. Three have completed Ph.D. degrees. Two (Amini and Esmaili) have found employment in the United States; the third (Karimpour) returned to Iran to accept a teaching assignment.

A View to the Future: Some Problems and Prospects

Having achieved a position of some distinction in the realm of geoscience education, the Department is concerned with maintaining its status and improving its programs for training future geoscientists. The task is a formidable one, considering uncertainties in professional trends and the promise of stiff competition from departments at other first-rate universities, many of whom are more affluent than the University of Colorado. A half century ago, the design for a good training program was relatively simple, and one could hope that the training provided would sustain the recipient for most of a professional lifetime. This can no longer be assumed. Haunted by the specter of future shock and inundated by a tidal wave of information, the modern student feels the need for guidance to an extent not required by earlier generations. Success in today's market demands a degree of clairvoyance on the part of the student and an even larger measure of it on the part of the faculty. A department that can provide a clean window to the future has a decided advantage.

In viewing the future, a consideration of what society is likely to expect of the next generation of geoscientists furnishes a point of departure. A list of such expectations can be compiled with reasonable certainty and must include the following:

1) Providing minerals, energy, and water, all of which are in limited supply and are becoming harder to locate, for an expanding world population, three fourths of which lives in underdeveloped countries that aspire to a better way of life

2) Devising ways for disposal of urban-industrial wastes, including toxic and radioactive materials, a major problem for developed nations (three billion tons annually in the United States alone)

3) Mitigation of natural hazards, including earthquakes, volcanic eruptions, floods, and landslides

4) Provisions for intelligent land use to allow more effective development of resources and to increase urban safety while reducing human impact on a sensitive environment

5) Diagnosis of long-term effects, such as climatic change that may result from combustion of fossil fuels, causing shifts in sea level that could jeopardize coastal cities

6) Continuing a search for new knowledge that may provide answers to present and future problems

The list of items included under each of these headings is long and in aggregate reaches into virtually all aspects of human activity. Spirited debates have ensued regarding details for each of the topics mentioned. However, there is general agreement that real problems exist, and that they arise in large part from a widespread ignorance of natural processes that relate to a dynamic earth. It behooves geoscientists not only to identify the problems but to prescribe solutions based on an understanding of how the earth works. Outlining what is needed to provide such an understanding constitutes the next step.

Early in the present decade, at the request of the National Science Foundation, a committee was organized under the aegis of the National Research Council to prepare a report on the state of the geosciences and to recommend a research funding policy for the eighties. The report, entitled "Opportunities for Research in the Geological Sciences" was issued by the National Academy Press in 1983. It is of interest to note that of the committee's eleven members, six have had some connection with the Department, and five reside in the Boulder/Denver area. Included are Carl Kisslinger, CIRES; William W. Hay, University Museum; Allison R. Palmer, Centennial Science Program Coordinator, Geological Society of America; John C. Harms, Harms and Brady, Littleton; Samuel S. Adams, Adams and Associates, Boulder (recently chosen to head the Geology Department at the Colorado School of Mines, Golden); and Clarence R. Allen, California

Institute of Technology. Kisslinger is a Professor in the Department; Hay teaches a course in oceanography; Palmer commonly conducts student seminars; Harms is an alumnus (Ph.D. 1959); Allen is a former summer student (1948); and Adams is a good friend.

The committee recommended eight areas in which intensive studies are most likely to provide a better understanding of planet Earth:

1) Structure and composition of the continental lithosphere, including continental margins; use of deep drilling to provide details

2) Quantitative models for sedimentary basin evolution

3) Improved understanding of magma generation and emplacement

4) Improved knowledge of physical and chemical properties of rocks

5) A better understanding of tectonic processes, the physical and chemical states that produce them, and the structures that result

6) A model for convection in the earth's interior as a mechanism for plate motion, or development of an alternative, a subject that involves the rheology and thermodynamics of the earth's mantle

7) Origin and evolution of life as revealed in the fossil record; applications to interpretation of paleoclimates, mass extinctions, and continental rearrangements

8) Dynamic processes that shape the landscape at the earth's surface and their relation to natural hazards and environmental stresses

The committee report also emphasized the need for theoretical studies to furnish a basis for interpretation of data. Conclusions drawn from observations commonly are based on inferences regarding conditions and processes deep within the earth or remote in time. Theories applied to explain data about the earth largely have been borrowed from other sciences. Modification of these, and development of new ones, for application to the geosciences is essential.

It is heartening to note that the Department already is engaged to some degree on research in all of the areas mentioned, and plans to expand and improve the studies are outlined in the 1982 self-analysis. Involvement of students in these research activities becomes an important part of their training.

In 1983, the National Aeronautics and Space Administration established an Earth System Sciences Committee to review the science of the earth as an integrated system of interacting components (solid earth, hydrosphere, biosphere, atmosphere, and near space) and to recommend an implementation strategy for global earth studies. The committee issued a preliminary report early in 1986 entitled "A Program for Global Change." Close cooperation of NASA, NOAA, NSF, and other agencies with their counterparts in other developed nations is regarded as essential for a worldwide study of the earth. The goal is to develop capability to predict changes in the system that may be expected within the next century, both from natural causes and in response to human activity. Geoscientists will necessarily play a major part in this effort. Academic institutions, including the University of Colorado, are expected to become involved, and the Department must be prepared to assume a leadership role.

The formula for geoscience education at the university level promises to become increasingly complex. Geologists always have depended to some extent upon background information furnished by the other natural sciences, and in the modern arena the dependence is emphasized. However, geoscientists have made discoveries that have modified concepts in the other sciences, and a sense of mutual interdependence is developing. In order to share in this interchange it is more important now than ever before that earth science students become literate in the other sciences as well as in modern advances in their own. The transition from a qualitative, empirical approach to earth problems to a more quantitative basis for deduction has placed greater emphasis on mathematics. Whereas a few decades ago the average geologist could get by with no more than a semester each of algebra and trigonometry, the minimum requirement is now two or more semesters of calculus. The explosive increase in science information, which promises to become even more intense, mandates that students be trained in the use of computers for data processing and retrieval and be able to modify or develop software that pertains to their studies and research. In addition, the modern student is obliged to become knowledgeable about an ever increasing array of sophisticated electronic equipment needed for laboratory studies of earth materials in all branches of the discipline. As noted in a recent article in *Geotimes* (Oct. 1985), Alvin Tofler's *Third Wave* has arrived in geology.

In connection with the new instrumentation, a word of warning comes from Francis Pettijohn, a giant in his field and now an elder statesman in the profession. In his recent book, *Memoirs of an Unrepentant Field Geologist*, Pettijohn laments that many modern geologists appear to have become so preoccupied with their electronic gadgets and the comforts of an air-conditioned laboratory that they forget where the rocks they are studying came from. He regards the new instruments as supplements to, not replacements for, the Brunton compass, aneroid altimeter, plane table, and binocular or petrographic microscope that were the mainstays of the traditional field geologist. "A mass spectrometer," he notes, "is just a very expensive hand lens. It doesn't of itself solve any geological problems. It is an analytical tool." In short, for a full understanding of how the earth works, Pettijohn feels that there is no substitute for shoe leather. His book is a potent argument for continuing to train students in the art of field observations and mapping techniques, lest they, in his words "lose touch with the earth." The Department is fortunate to be located in an area where Nature's laboratory is well stocked with experiments on just about everything, the results of which are recorded in the rocks. The exposures provide access to the dimension of geologic time, which cannot be duplicated in a man-made laboratory.

For future generations of geoscientists the term "field," which traditionally has referred to continental terrains, must be expanded to include the oceans and space. The deep ocean basins contain potential sources of useful minerals in the form of manganese nodules on the ocean floor and sulfide deposits associated with rift zones. Desalination of sea water may ultimately provide a source of water for coastal cities as well as magnesium metal and halogen salts for industry. The oceans also have been looked upon as potential sinks for domestic and industrial wastes. Experience with the shelf and estuarine zones in this connection have thus far proven disastrous. Active subduction zones associated with deep trenches have been proposed as an ultimate answer. However much research remains to be done before they can be certified for such use. Extensive use of the deep oceans for any purpose must await agreement on adequate laws of the sea to avoid international conflicts. Geoscientists must be prepared to play an advisory role in developing such laws.

The usefulness of geoscientists in space programs has been amply demonstrated through their contributions to lunar science and interpretation of hyperaltitude photography. As remote sensing techniques become more sophisticated, their use can be expected to increase in land classification, locating mineral deposits and energy sources, mitigation of natural hazards, and as a research tool in the study of planetary processes. The University's bid for eminence in space science presents a challenge to the Department to expand the role it has played, through its alumni and faculty, in lunar exploration.

To advocate that earth science education should include more than technical training is axiomatic. The fact that the earth sciences have reached a point of interaction with the economic, political, and social affairs of the human race asserts that the successful geoscientist cannot remain isolated from human activities. At the very least, one must learn to read, write, and think and must arrive at a basis for value judgments. A trained technician who cannot think creatively or communicate with colleagues and the public or win their confidence is likely to remain on the sidelines.

An element that should be emphasized in student training concerns what Lewis Branscomb, a former Boulderite, now Vice President and Chief Scientist of IBM, refers to as "Integrity in Science" (*American Scientist*, Sept.-Oct. 1985). He calls for a commitment to quality in scientific research. Germane to this is T. C. Chamberlin's article on "The Method of Multiple Working

Hypotheses," first published in 1897 and reprinted in 1931 (*Journal of Geology*, vol. 39) that should be required reading for all students of the geosciences. Earth scientists, perhaps more so than their colleagues in physics, chemistry, and biology, are prone to reach conclusions based on partial, and sometimes flimsy, evidence. The literature of geology is strewn with the wrecks of ideas arrived at too hastily, often to the embarrassment of the authors. Perhaps the phenomenon stems from the fact that, on a human scale, the earth is very large, very complex, and very old, making verification of hypotheses by experimentation generally difficult and often impossible. Students who form the habit of shooting from the hip while in school may be haunted by the practice in later life. Calling them to account at an early stage may prove to be a kindness.

A perennial problem among geoscience departments is in regard to the number of students they should train for professional work and in what areas. The problem is complicated by sudden changes in student enrollment resulting from economic and political factors that affect employment opportunities. At the time of this writing, the glut of fossil fuels and certain metals on the world market has resulted in widespread unemployment among geoscientists involved in exploration for these commodities.

Some guidelines are set forth in a recent article by Paul Bailey (*GSA Bulletin*, 1984). He notes that there are presently some half-million practicing geoscientists in the world, more than 10 percent of whom are in the United States. The number increases by about 12,000 annually and is expected to reach 750,000 by the end of the century. His major conclusion, substantiated by a detailed investigation, is that in all medium to large nations, regardless of size or population, the ratio of the number of geoscientists to gross national product (GNP) is roughly constant, the average being one geologist for each $50 million GNP Major elements in the GNP are agriculture, mining (including extraction of fossil fuels), industry, and services.

Traditionally, geologists have been linked primarily to the mining sector. In the developed countries (United States, Europe, Japan), services account for about 60 percent of the GNP, industry for about 30 percent, and agriculture and mining for the remaining 10 percent. In developing countries (Asia, Africa, Latin America), agriculture and mining account for more than a third of the GNP, and industry and services are about evenly divided.

Three conclusions of some importance to geoscience training programs in the United States emerge from Bailey's discussion. First, the long-term number of employment opportunities cannot be expected to increase unless there is an increase in GNP. Second, new positions will appear mainly in the service sector in connection with government agencies, consulting firms, research laboratories, and teaching. Third, traditional employment in exploration for minerals and fossil fuels is not likely to increase except in third world nations. The recent loss of freeboard by the metals and petroleum industries in the U.S. is a case in point. Students who aspire to such employment must look forward to the possibility of foreign assignments.

The responsibilities of geoscience departments do not end with the training of professionals. The matter of informing the laity and promoting public relations is an important aspect of earth science education. In a recent article (*Geotimes*, June 1985), Marvin Kaufman, Executive Director of the American Geological Institute, laments the low public image of geology in comparison to physics, chemistry, biology, and engineering sciences. *Science Digest* (December 1984) published a list of selections for America's top 100 young scientists; not a single geoscientist is among them. In its 1984 annual report on science education in America, the National Science Foundation does not even mention geology.

The image problem is succinctly implied in a report allegedly written by a Canadian elementary student in response to a science assignment:

"Geology is the thing that tells you all about stones and rocks before they are dug out of their native haunts. It also tells us about fossils which are supposed to be the remains of big fierce animals that were turned into stone in the Stone age. The biggest of these animals is called Dinnasour, and there is one in the park in Calgary that was turned into concrete and remains there to this day along with other fearsome beasts of the time There was no people in those distant times except a few Bible characters. One of them was called Mrs. Lot, and she was turned into salt.

"People who study geology are called geologists. Much of their time is spent searching for samples to put in museums for to encourage others to study geology and keep the business going. A lot of their time is also spent in looking for better jobs, and for oil, and going to conventions, and things like that. My pop says they're just like doctors. They put a lot of letters after their name and look wise and tell you nuthin and charge you plenty for it. All the mines are found by a kind of geology laborer called prospectors. These poor prospectors have no book learning, but they make use of their thumb in a secret way called the rule of thumb. When they discover a good thing, the geologists and their pals called promoters swindle them out it. This kind of swindling is supposed to be fair game and is called litigation, or something like that. My pop wasn't sure."

Several years ago, Peter Flawn, a noted environmental geologist who became President of the University of Texas, Austin, pointed up the need for a professional commitment to inform the public (*GSA Bulletin*, 1979). The core of Flawn's message is that geoscientists have the responsibility of building an information base for formulating public policy and for translating and communicating that information to all segments of society. Earth science professors, through their classes and professional societies, have an opportunity to translate and communicate Today's students become tomorrow's citizens, many of whom will achieve positions of leadership in government, industry, and academia. Regardless of their roles in society, they will be called upon to vote and to express opinions on a array of issues that presume some knowledge of earth science, such as water supply; flood control, land use foundation code restrictions, use and conservation of minerals and energy, and disposal of wastes. If they are to make wise choices, it is important that they know the facts.

For more than three quarters of a century, the Department has assumed the dual role of training professionals and informing the public. It has attempted to revise its curriculum as the science evolved in order to provide its graduates with firm backgrounds for professional careers. In addition, there have always been courses, seminars, and lectures designed to spread the gospel to the general public. A third element in the program, the quest for new truth through research, present in latent form from the beginning, has become increasingly important during the past two decades. Achieving an appropriate balance among the three components–training professionals, informing the public, and finding new truth–seems likely to remain the Department's goal for the foreseeable future.

The First Dozen Years of the Future: An Introduction to the 1997 Edition

Gifford H. Miller,
Department Chair

As Larry Warner was completing the first addition of this book in 1986, he included a thought-provoking chapter on what the future might hold for a geoscience department. While the actual course of world events could not have been envisioned at that time, Larry was remarkably on target in identifying some of the emerging themes that would impact the Earth Sciences, and higher education in general. The dramatic increase in the acquisition and dissemination of facts and knowledge and the expanding boundary of the discipline was already apparent. Larry began by outlining societal expectations of the geoscience community to address issues relating to natural resources, natural hazards, waste disposal, and climate change. He noted the match between the Department's developments and a recent NRC report on the future of our discipline, and he challenged the Department to assume a leadership role in what was then the infancy of the Global Change initiative. But while encouraging the Department to look forward, Larry also reminded us to not forget the source of our discipline, the field setting, enjoining us not to lose touch with the Earth. Just three years ago, as we redefined our field program, Larry's words served well. The field experience, as a problem solving exercise, remains the capstone of our curriculum. But reflecting the breadth of our program, we now offer a diverse series of field modules that allows students to gain first-hand field experience in two or three tightly focused courses that are most appropriate for the students' career objectives. We think Larry would approve.

The study of the physical properties of the Earth has evolved from simple observations by the earliest humans, through formalization of the scientific discipline of Geology in the 1700s and the general recog-

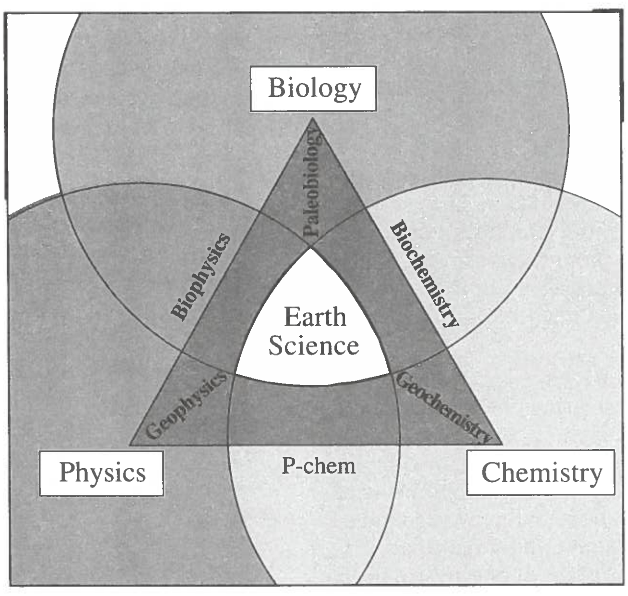


Figure 1: The Earth Sciences are inherently interdisciplinary, lying at the intersection of the traditional disciplines of Biology, Physics, and Chemistry.

nition of the great antiquity of our planet and the universe in the late 1800s. By the time the Department was established in 1902, many of the basic properties of the Earth had been outlined, but theoretical explanations for the primary processes responsible for the origin and distribution of continents, oceans, and mountain ranges remained obscure. Most research in the geosciences during the early years was descriptive and qualitative. The great Earth Science revolution of the early 1960s, culminating in the theory of plate tectonics, altered the foundation of our discipline, providing a unifying theoretical basis for a broad range of previously disparate observations. It was an example of how interactions with fields peripheral to a traditional Geology Department, coupled with our established skills as observers of natural phenomena, could lead to unforeseen advances in the fundamental principles of Earth Science.

Lying at the intersection of Physics, Chemistry and Biology, Earth Science is fundamentally interdisciplinary. Quantitative methods are applied in an expanding effort to study the Earth as a dynamic, interconnected system, composed of numerous subsystems each interacting in complex, nonlinear ways. And the interactions of physical and biological processes that created and maintain an environment that supports life has created a whole new discipline in biogeochemistry.

These approaches have resulted in the emphasis in research and teaching shifting from description and cataloging of events through time, to more focused inquiry into the fundamental processes involved in the operation and maintenance of Earth's environment.

As geologists, we have special responsibilities to use these principles to understand our planet. This includes evaluating natural resources essential for economic development, and understanding the impacts of a growing population, so that we can maintain an environment conducive to all life. Broad recognition of the importance of these endeavors has rekindled student interest in the Earth Sciences; over the last five years, the number of students enrolled in Geology courses at CU-Boulder has more than doubled and the number of majors has more than tripled.

The Department of Geological Sciences currently has 24 tenured and tenure-track faculty and 5 Special Faculty; reflecting the interdisciplinary nature of our science, sixteen of our faculty hold joint appointments in another campus unit. Our faculty study dynamic processes deep within the Earth and complex interactions between the solid earth, the oceans, the atmosphere, and life. Within this range of topics we address the formation and preservation of fossil fuels and minerals, the processes that result in large-scale movement of the Earth's crust and the resultant earthquake hazards, how the Earth's climate system operates today and in the past, the physical and chemical processes that move water and wastes on and near the earth's surface, and the interaction between physical, chemical, and biological processes that maintain an environment conducive to life on this planet. And our tentacles are branching out to the surfaces of other planets in our solar system. We share the excitement of geological discovery with graduate students and undergraduate science majors, and we teach an appreciation for the history of the Earth, and the relevant processes that impact our lives to interested liberal arts students.

What we are, and where we expect our discipline to move over the coming years, is reflected in our **Mission Statement**:

The Department of Geological Sciences, through excellence in teaching and research, advances understanding and appreciation of the Earth: its resources, structure, processes, and history. We work to create an informed and scientifically literate public, capable of making the choices required for a sustainable future, and we are dedicated to educating the next generation of leading Earth and planetary scientists. Through basic research, our faculty and students further understanding of the past, present, and future whole Earth system, including linkages between the solid Earth, and its enveloping hydrosphere, atmosphere, and biosphere.

Recent Trends

In the twelve years since Larry Warner completed the first addition of this book, the Department has undergone substantial evolution. These changes are driven in part by the natural turn-over of faculty and the ever-changing interests of the students, but they have also been influenced by larger issues related to national and international events. In the rapidly changing post-Cold War era, the role of higher education is being re-evaluated nationally and locally. Although the urgency for continued investment in basic research is being questioned in some quarters, it is also recognized that societal need for Earth resources remains high and will continue to increase, while the continued growth in human population increases the importance of natural hazard evaluations. And by virtue of our sheer numbers, human activities are now beginning to impact global-scale processes. In this milieu, the relevance of the Earth Sciences takes on a renewed importance.

As part of our recent Self Study, we have tracked the changing demands for Geology courses over the past decade, and majors for the past half century. The numbers of students enrolled in our courses has been cyclical, following national trends. But in response to a renewed focus on our undergraduate course offerings in the late 1980s, enrollment has increased steadily, and is now more than double the 1987 figure and still rising. Although the number of Geology majors is not as high as in some of the other natural sciences, the trends in student interest, measured as the percentage increase in majors, places Geology as one of the fastest growing of the natural science disciplines. The relevance of the Earth Sciences, whether tied to the continuing need for additional natural resources, the hazards associated with plate boundaries, or the movement of groundwater, has gained increasing recognition and national attention. We welcome the challenge of articulating the central role that the Earth Sciences will play as we ease into the third millennium.

New Faces in the Faculty

The rapid expansion of university faculties to meet the surge in student demand following World War II meant that there was likely to be a substantial number of faculty approaching retirement age 30 years later. Over the past twelve years, the Department has indeed witnessed a large turn-over in the faculty. Thirteen faculty have either retired or left the University since Larry completed his account, and nine new tenure-track faculty have joined our ranks. Recent departures include Bill Bradley (retired, 1989), Ted Walker (retired, 1991), Max Wyss (to the University of Alaska, 1990), Roy Kligfield (to the private sector, 1992), Don Runnells (to the private sector, 1992), Don Eicher (retired, 1993), Karl Kisslinger (retired, 1994), Jim Munoz (retired, 1995), Bill Braddock (retired, 1995), Ed Larson (retired, 1996), Erle Kauffman (to Indiana University, 1996), Mark Meier (retired, 1997), Peter Birkeland (retired, 1997). These faculty were influential in determining the course of the Department through much of the 1960s through the 1980s, and we will miss their many contributions to our program. But of course with the departure of our colleagues and valued members of the faculty, comes the opportunity to hire exciting young faculty members whom we expect to emerge as the new leaders in the profession. New tenure-track faculty who have joined the program since 1986 include Bruce Jakosky (planetary geology, 1988), Jim White (isotope geochemistry, 1988), Paul Weimer (petroleum geology, 1990), Anne Sheehan (seismology, 1993), Shemin Ge (hydrogeology, 1993), Karl Mueller (structural geology, 1994), James Syvitski (marine sedimentology, 1995), Julia Cole (paleoclimatology, 1995), Kathryn Nagy (aqueous geochemistry, 1997). Details on these new faculty appear elsewhere in the book.

And the Heart of the Department, the Front Office

While the core of any program is its faculty, they would not be able to function without the heart of the program, a competent and accommodating Front Office Staff. The Front Office is the one place where nearly all of the faculty, as well as many of the graduate students and undergraduate majors, pass through on a daily basis. When the Front Office runs well, so does the Department. But no office is static, and just as the faculty have turned over, so has the office staff. Edith Ellis and Paulina Franz headed up the Front Office for two decades from the late 1960s to the late 1980s. From 1981, they were assisted by Kay Fox. Paulina stepped down in 1987, Kay retired shortly thereafter, and after more than twenty-five years at the helm, Edith Ellis retired in 1994. Paulina was replaced by Kris White in 1989, who served as Graduate Secretary until she was swept off her feet by one of our new young faculty, Jim White. Gloria Figueroa-Timmons replaced Kris, but was recruited away by an offer of an even more responsible position (could this be possible?) in 1993. Lynn Jackson filled in for a year and a bit, and beginning in 1996 Kathy Freeman was recruited from APAS to cover the Graduate Secretary duties. As the volume of external grant funds began to increase in the 1980s, we hired Mark Bishop as a full-time accountant. When Don Runnells left for the private sector, he took Mark with him, to our dismay. We went through a series of short-term appointments (Mary Wikoff, Rebekah Tan, Margaret Ahlbrandt), and have finally arrived at stability with Jane Sims, who is keeping our ever growing research accounts (but discouragingly stagnant General Fund allocations) in order. From the Chair's perspective, the Administrative Assistant is the key person in the Front Office. When Edith announced her intention to retire only a few months into my term as Chair, near panic ensued. Edith was replaced temporarily by Anne Carrington, who left after a few months for Engineering. We redefined the position to give us greater flexibility in recruiting, and after an awkward few months with the position vacant, we enticed Beth Hanson into the position in early summer 1995. Since arriving at the Department, Beth has served on the Chancellor's Fellows Program, and helped network the Department with other programs on campus. We are pleased to have her on board. Completing the transition, Sue Long joined the Front Office recently, to replace Kathe Kelley who was with us from 1994-1996. Kathy Freeman and Sue together oversee most of the class scheduling and graduate student paperwork, and handle the daily barrage of questions from faculty, students, and the general public. The Front Office is running well again, to the pleasure of all.

On the laboratory side, John Drexler was hired in 1982 to oversee the operation of the Electron Microprobe. John has developed a secure financial base to operate and maintain the Probe, as well as to greatly expand the analytical offerings in the Central Analytical Laboratory. John also developed a computer resource center widely used by graduate students and faculty that has been a great service for the Department. As we move into the Benson Building, John will be relieved to have that responsibility devolved to our new 24-platform Instructional Computing Laboratory in a 1220 sq. ft. room on the third floor. And in the Rock Shop, Paul Boni continues to oversee rock crushing and thin-section operations, as well as looking after our old building and the teaching collections, jobs he has been doing since joining the staff in 1979. We hope that the building maintenance activities in the new building will be essentially non-existent.

Awards and Recognitions

Over the years our faculty have received numerous awards, honors, prizes and honorary degrees. Rather than tabulate them all here, I simply relate the most recent of these recognitions. John Andrews, Professor of Geological Sciences at CU-Boulder since 1967, was the awarded the University of Colorado Medal by the Board of Regents at the Summer, 1997 Commencement. This honor is the highest recognition the University can bestow on its faculty, and John is the first to be so recognized from Geological Sciences. Below is an abbreviated version of the citation that was included in the commencement program and read at Commencement in recognition of John's many accomplishments:

John T. Andrews, a world-class researcher and devoted teacher-mentor, has brought distinction to the University of Colorado at Boulder through his long-time, active presence on campus. A member of the faculty for nearly 30 years, he is a fellow in the Institute of Arctic and Alpine Research, and was promoted to full professor in the

Department of Geological Sciences at the age of 35.

Dr. Andrews' standing among peers places him in the highest rank nationally and internationally in the field of glacial and Quaternary geology and geomorphology. His studies on the effects of ice sheets and glaciers have led to the exploration of new methods of dating and to the importance of ice sheet/ocean interactions on the global climate system. His work provides the critical data against which models predictive of climate change are measured.

Among his many honors is the Doctor of Science presented in 1978 by his alma mater, the University of Nottingham in his native England. In 1995, John Andrews was recognized by his election as foreign member of the Norwegian Academy of Science.

In addition to his professional contributions, Dr. Andrews has been a dynamic campus leader, serving as chairman of his department, providing leadership at INSTAAR, and he was instrumental in the Boulder Faculty Assembly effort to establish better relationships for the University with Boulder civic and business leaders. He established and coordinated the Honors Program and the undergraduate internship program in Geological Sciences, developed and taught a popular course on global change, and co-developed an undergraduate course in statistics for geologists and geographers. His teaching has been consistently rated highly by students. Dr. Andrews' teaching excellence has attracted high-quality graduate students to the University. Many have earned doctorates and master's degrees under his guidance and are teaching at universities and colleges in the United States, Canada, the United Kingdom, and Iceland.

The Board of Regents is honored to award the University of Colorado Medal to John T. Andrews for his outstanding accomplishments in scientific research, dedication to teaching excellence, and distinguished service to the University.

And the Next Dozen Years?

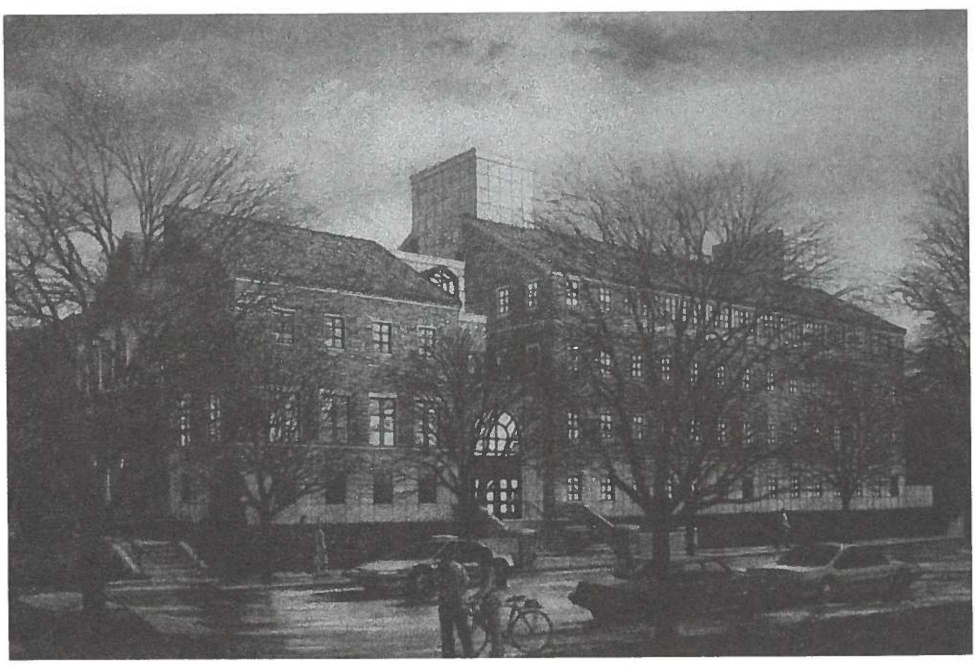
Moving in to a state-of-the-art new building at a time when student interest in the Earth Sciences is strong and still growing, and employment opportunities in the private sector expanding, leads indeed to optimism. Tempering that optimism, of course, is the history of our discipline that has exhibited greater national cyclicity than any other natural science. The lesson from the past is that our focus should be on first principles, training students who understand the basis of our discipline, and who will be able to adapt to the inevitable unexpected developments that will occur. These students should be well trained in the field setting, but also capable of utilizing the dramatic advances of technology to evaluate and resolve specific problems. More than ever, communication and teamwork are essential in modern scientific inquiry, and the same holds for practical applications in the private sector. Processes acting at or near the Earth's surface and on human timescales are the currency of the coming decade. Research that crosses, rather than follows, standard disciplinary boundaries has the greatest probability of providing new insights. It is an exciting time for the Earth Sciences, but also a challenge to us all as we continue to refine our curriculum to provide the best training for students to prepare them for the next century. As a faculty, we welcome that challenge.

The Benson Earth Sciences Building

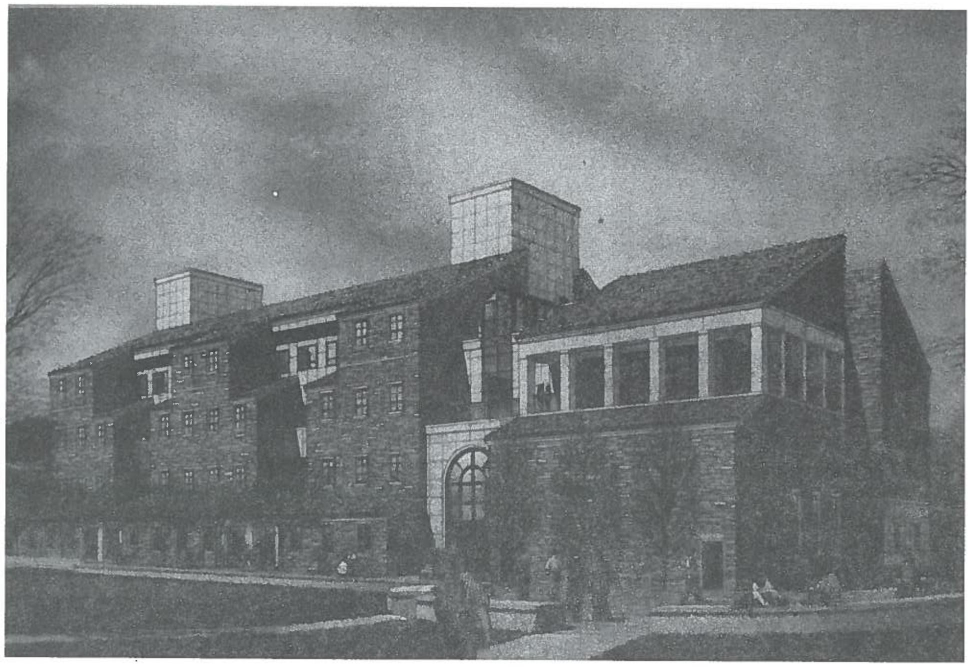
The original Department of Geology at CU-Boulder was created at the turn of the century. In 1911, when the Department moved into the building that would house our program for the next 86 years, we totaled two faculty members. Geology was in its infancy then. Barely a decade had passed since the great antiquity of the earth had been finally resolved. X-rays had only recently been discovered and their utility in studying minerals had not yet been realized. Mass spectrometers, scanning electron microscopes, microprobes, and most of the other fundamental analytical tools that we use today were still to be invented. So it is not surprising that the original building was not designed to accommodate the tools that form the basis of modern scientific inquiry. In recent years many faculty with strong analytical programs have had to occupy laboratory space in other buildings, simply because our building could not provide the required infrastructure. Fragmentation of our program, particularly for the graduate students, was a consequence. Recognizing the need for improved teaching and research space, the Department began a major push for a new building in the late 1960s. In 1969 the Geology Building was declared "functionally obsolete" by the Colorado Commission on Higher Education (CCHE). Construction of a new building for the Department, located east of Physics, was scheduled to begin in 1971. Problems with State funding for higher education subsequently eliminated that option. A joint Geological Sciences / INSTAAR / CIRES Building proposed in the 1970s came to a similar fate. Disappointed but undaunted, we joined with the CU Foundation in the 1980s to raise funds from the private sector to help "seed" a building fund for our own building. Contributions, principally from alumni, began to generate interest in the project. A major contribution by alumnus Bruce Benson, made the project suddenly appear viable. A subsequent substantial gift from the Crail-Johnson Foundation for the Earth Science Library through CU alumnus Eric Johnson, and inclusion of the building as a goal of the University's first Capital Campaign in the late 1980s, insured that the building would be an eventuality. Following a successful Capital Campaign by the University, Chancellor Jim Corbridge committed a substantial sum toward the project, and in late 1993 the State of Colorado made their commitment to fund the final portion of the project. By early 1994 we were well and truly underway with the design phase for the new building, to be built, ironically, on the exact site proposed thirty years previously. As this second edition goes to press, the building is nearing completion. In recognition of the essential role of the gift by the Benson family, the building bears their name: the Benson Earth Sciences Building.

Working with our architectural firm in Denver, we sought to design a new home for the Department that would meet the needs and aspirations not only of the current faculty and students, but of those well beyond the turn of the century. In the long process from vision to construction, we learned more about floor plans, conduit, modular components, value engineering and the myriad of technicalities that are part of any modern building than any of us care to remember. But through this process we have forged a structure that will serve our program and reflect the discipline. The building blends with the rural Italian look that characterizes campus architecture, while maintaining a distinctive presence. Inside, there is no question that this is a geology building. The heart of the building is a central four-story glass-roofed atrium that defines the building; the floor and walls are adorned with a special stone treatment. The library and auditorium open directly off the atrium, whereas administration is accessed via a grand staircase. Most of the activities will be located on the four main floors, with a large portion of the basement unfinished for future expansion, and a fifth floor houses mechanical support. Oriented along a north-south axis facing Colorado Avenue directly across from the Stadium, the building will take advantage of its southern exposure. Faculty/student offices face the new quadrangle, backed by common dry lab space, while the north side houses the laboratory block and most of the classrooms. All of the introductory classrooms are located on the first two floors, and we have purposefully designed visual "treats" in these areas to capture the imagination of students and visitors to the Department. No more central pillars to distract students in the classrooms; our large classrooms lack those cumbersome support posts that plagued generations of students. Several of these new classrooms are also "smart," capable of projecting images directly off computers that can be plugged easily into the campus ethernet backbone. And a 1200 sq. ft. instructional computer classroom on the third floor with 25 to 30 platforms allows an increasing number of courses to utilize computers as part of the instructional process. Built-in lockers and an undergraduate study room for majors were carved out of storage space in response to student input, and we captured a lovely patio space along the south side of the building for students and faculty to share a coffee or lunch.

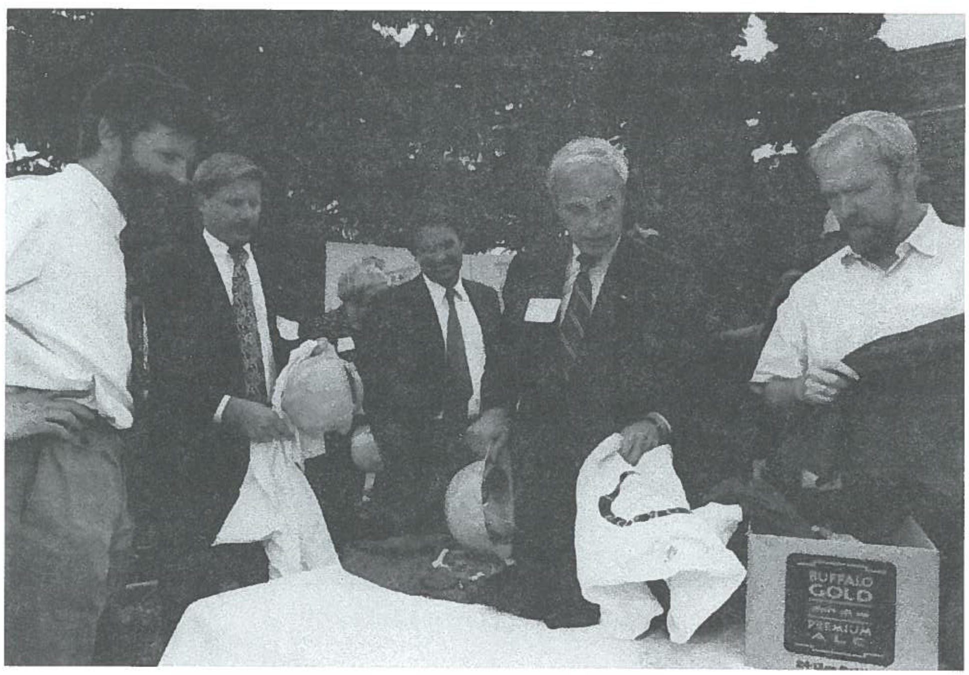
The Department will be different in the new building. In addition to the quality of our new facility, we will be bringing into our primary building many faculty who have been housed elsewhere on campus for many years. Most of the solid-earth geophysics group (Anne Sheehan, Roger Bilham, Craig Jones) will move across with us, as will Lang Farmer and Bill Hay. And with several vacant faculty lines to be filled, the building will quickly reach the limits of its capacity. Fortunately, unfinished basement space will allow modest expansion of our program.



Artist's rendition of the north side (front entrance), 1996.



Artist's rendition of the south side, 1996.



Department T-shirts and hard hats for everyone! From left to right: Gifford Miller, Eric Johnson, David Watkins, Bruce Benson, and Chuck Patterson

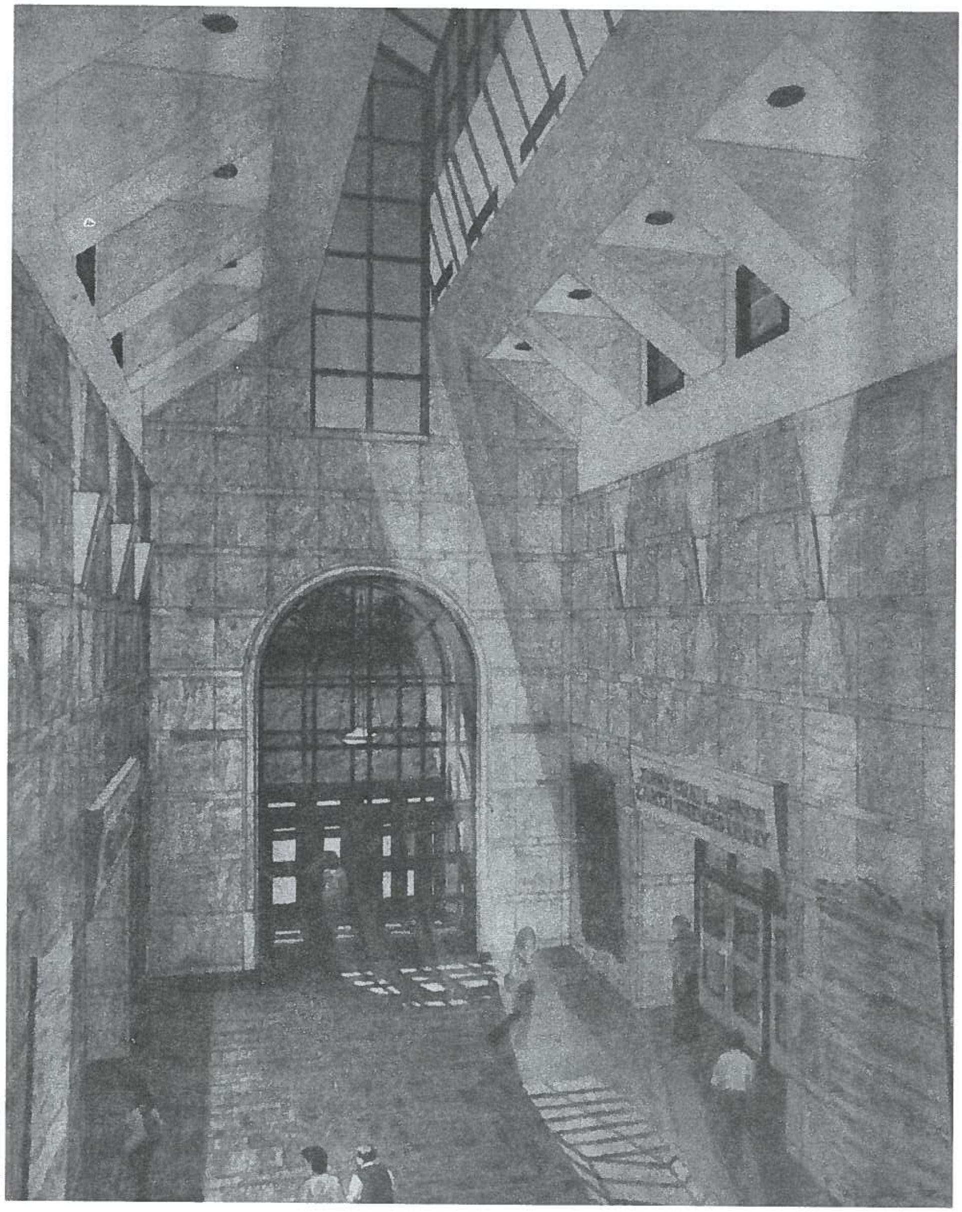
The Jerry Crail Johnson Earth Sciences Library

More changes have taken place in the Earth Sciences Library in the last ten years, since the original history of the Department of Geological Sciences was written, than in all of the previous sixty years of its existence. Following the departure of Dederick Ward in 1980, the Earth Sciences Library fell under the direction of the Science Library in Norlin, with no librarian on site in the Geology Building. Several dedicated staff members, chiefly Anita Cochran and Terrie O'Neal, maintained the library during those years. In 1988, Suzanne T. Larsen became the third Earth Sciences Librarian. Larsen had held previous faculty positions at Adams State College in Alamosa, Colorado, and at the Colorado School of Mines. She had also been a reference librarian with the Department of Energy's National Uranium Resource Evaluation project in Grand Junction, Colorado. Her appointment was primarily driven by the fact that an alumnus of the Department of Geological Sciences, Eric C. Johnson (B.A., 1982), had proposed a substantial gift to the Earth Sciences Library, through the Crail-Johnson Foundation. Several Johnson siblings had attended the University of Colorado, Boulder. The gift was primarily to fund the library portion of a long-dreamed-of new geology building. John Andrews, then department chair, recognized the need to again have an experienced librarian in the Earth Sciences Library to direct the use of the gift funds and to plan the new library. He successfully petitioned the University and the University Libraries to once more support the position of an Earth Sciences Librarian. The appointment began as only half-time, but within six months was increased to full-time.

As plans for the construction of a new building were pursued, a portion of the original gift was made available to the Earth Sciences Library on an annual basis to strengthen the collection, purchase network computers, and provide funding for on-line searching. Since the new building was at best several years in the future, some of the funding was also used to remodel the Earth Sciences Library in 1988 to better reflect the new focus on electronic reference and research. On-line and CD-ROM databases were replacing the traditional paper indexes, and the University Libraries' catalog converted to an on-line catalog. GeoRef, the electronic version of the American Geological Institute's venerable Bibliography and Index of Geology, which has citations dating from as early as 1785, soon became an irreplaceable tool for research.

Construction began on the long-awaited new geology building, officially named the Benson Earth Sciences Building, in the spring of 1996. The Earth Sciences Library, to be known as the Jerry Crail Johnson Earth Sciences Library, featured as a primary component of the building. The Library is named in memory of the mother of the Johnson family, one of the first women to graduate from Northwestern University with a degree in geology. She had a life long love of books. The Library expands from 2,400 sq. ft. in the old location to 11,000 sq. ft. and includes the Map Library, which occupied about 2,000 sq. ft. in Norlin Library. One staff member from the Map Library moves with the collection to the Jerry Crail Johnson Earth Sciences Library. As the new building approached completion, approval was obtained to recruit a librarian to oversee the map collection, which has had little professional attention for many years. With a staff of two faculty-rank Librarians, two Library Technician III's, a half-time Library Technician II, and student assistants, the Earth Sciences Library looks forward to better staffing than at any time in its history. However, with more than four times the previous square footage on two separate floors and a second collection to support, this still represents a very sparse staffing level.

The Jerry Crail Johnson Earth Sciences Library is designed to support future directions libraries are taking. The focus on electronic access to information will continue to increase, with a growing capacity to bring full-text, including high-end graphics, to the desktop. The increasing focus on digital spatial data will see the use of maps progress from table top to computer screen, using geographical information systems software to manipulate data and create unique maps. The increasingly interdisciplinary nature of geological sciences, reflected in the expanding focus of the library collection, will necessitate access to a myriad of subject-oriented citation databases. We cannot rely only on GeoRef any more. The future looks busy, bright and very interesting for the new Earth Sciences Library.



Artist's rendition of the atrium, showing the entrance to the new Jerry Crail Johnson Earth Sciences Library, 1996.

Engaging Undergraduates in Research

Many undergraduates remain uncertain about the possibilities available to them as Geology majors, and lack access to professional information. Their experience with our profession is too often limited to the classroom; rarely have they been engaged in the excitement of geological discovery. To alleviate this situation, the Department sponsors an Undergraduate Mentoring Program. The goal of the program is to simultaneously enhance the educational environment for undergraduate majors and to facilitate research in the Department. Funds are available to allow graduate students and faculty to incorporate undergraduates in their research, either in the field or in the laboratory. In exchange for this research assistance, each sponsor assumes a one-on-one mentoring responsibility for an undergraduate major, providing advice on professional development, graduate school, and employment opportunities. The Department holds informal social gatherings for mentors and mentorees during the academic year, usually centered around a specific topic, such as career options, choosing a graduate school, etc.

The Department is only able to offer the mentoring program through the generous gifts of our friends and alumni and contributions from the private sector. The program was initiated in 1995-1996, with funding from gifts provided by alumnus Bruce Benson and the Shell Foundation. For each of the first three years, the Department awarded close to 30 Mentoring awards, averaging $1000 each. Response from the students and their mentors has been uniformly favorable, and we are currently attempting to permanently endow the program through the Bruce Curtis Fund; this will be one of our priority targets in the University's upcoming Capital Campaign.

Proposals are invited from faculty, post-docs, Departmental research scientists and graduate students who are interested in serving as mentors to undergraduate majors. We encourage proposals that identify sub-projects for which the undergraduate can take a lead role. Grants are for one year; Graduate Students are particularly encouraged to participate in this program.

We feel that the Undergraduate Mentoring Program is one of the most effective investments we can make in our program. The University recently recognized our Mentoring Program as one of the best examples on the Boulder Campus of personalizing the educational experience for undergraduates. The undergraduate majors benefit by exposure at an early point in their career to the research environment, and by developing personal ties to graduate students and faculty. Faculty and students have access to motivated assistants as they pursue their research objectives. And our ability to recruit outstanding new majors from the general student body is enhanced as word of the program grows.

Department of Geological Sciences Advisory Board

The current Advisory Board was organized in the latter part of 1985 and had its first official meeting on January 25, 1986. Hartmut Spetzler, Department Chair, Victor Baker, Tim Grove, Gerry Loucks, Board Chair, Omer Raup, Fred Tietz and Tommy Thompson acted as pioneers towards this effort.

The Statement of Purpose for the advisory Board indicates:

"The Advisory Board of the Department of Geological Sciences was formed to foster closer ties between the Department, alumni, friends, and private industry. The primary purpose of the Board is to guide and assist the Department in improving the quality of education for undergraduates and graduate students in the geological sciences. Other important functions include the acquisition of private financial support for the Department and advocacy with the University administration on behalf of the Department."

By 1988 the Board had expanded to include Dave Eggler, Bob Graebner, John Harms, Eric Johnson, Howard Lester, John Rold, Elwin Peacock, Jon Connor, Stan Dempsey, John Masters, Jane Selverstone, and Gary Grauberger, with Omer Raup serving as chair. Items of Board concern included: how do we organize efforts towards obtaining a new building for the Department; can we focus more attention on education and research in the areas of energy and minerals occurrence; and how can the Board become better aware of student problems within the Department. At the request of the Board, the faculty, after due consideration, proposed that the Administration establish a Center for the Study of Energy and Mineral Resources. Following Administration approval, the Minerals and Energy Resource Center (MERC) was created in 1989. The Board continued participation in the organization of MERC as they spearheaded the search for a permanent director. The Center's name was changed to Energy and Minerals Applied Research Center (EMARC) in the fall of 1989.

Board membership is for three years, unless extended. Consequently, by 1992 rotation of Board members brought new participants: Jeff Abbott, Tom Berg, Wolf Berger, Fred Baker, Bill Downs, Don Gustafson, Charles Ross, Gene Shearer, Chair, Christine Turner, Jack Threet, Barbara Tewksbury, and Tom Vinckier to the semi-annual meetings. After several anxious years of decreasing numbers of undergraduate geology majors, the Board and faculty were able to breathe a sigh of relief as the undergraduate student body showed an increasing enrollment interest in the geological sciences. The Energy and Minerals Applied Research Center was a well functioning entity by this time, much to the satisfaction of the Board. And Board efforts began concentrating on increasing emphasis on the teaching of field geology, both at the undergraduate and graduate levels. After all, the UCB has one of the best "backyards" in the nation for the study of sedimentary and igneous rocks. Discussions continued regarding the new geology building. In the fall of 1992, Steve Colman, Tom Fouch, Bob Giegengack, Jim Hastings, Sid Moran, and Bill Meyers joined the Board and became involved as the Board made the decision to accept the fiscal responsibility of securing donations for the Bruce F. Curtis Endowment Fund.

Essi Esmaili and Wayne Ziemianski joined the Board in 1993, and Scott Laurent, Dick Koepnick, Dave Muller, and Rich Reynolds became Board members in 1994. From these years to the present (1997), the Board has had the opportunity to observe positive results from the time and efforts put forth by the membership during the past eleven years. Members should have a sense of satisfaction and pride as they observe the new Benson Earth Sciences Building; the more than tenfold expansion of the Bruce F. Curtis Endowment Fund to include the mentorship program; the successful expansion of field geology instruction at UCB; and educational expertise associated with the internationally recognized subsea exploration program developed as a part of the Energy and Minerals Applied Research Center agenda.

Much appreciation is extended to the department for this opportunity to include information on the Advisory Board in the update of Larry Warner's publication on the Department of Geological Sciences at UCB. Coincidentally, the publication presents the opportunity for chairs Loucks, Raup and Shearer to offer their sincerest thanks to the many Board members who have donated time, dollars, expertise, and data to the Advisory Board efforts.

Eugene M. Shearer
Chair, Advisory Board 1990-1998
Department of Geological Sciences
University of Colorado at Boulder

Energy and Minerals Applied Research Center

The Energy and Minerals Applied Research Center (EMARC) was established in 1988 to develop a major teaching and research program in the applied fields of geology. In nine years, EMARC has established itself as one of the leading research programs in petroleum geology in the United States and the world. William Atkinson directs a large research program in mineral deposits. Phil Oxley (1989-1990), Jack Edwards (1992-1994), and Paul Weimer (1995-present) have served as the directors of the center. Erle Kauffman served twice as interim director (1988-1989, 1990-1991).

The principal goals of EMARC are to: (1) attract good quality students, (2) form strategic alliances and contractual relationships with industry, government agencies, and other research funding organizations, (3) fund student education and research, (4) conduct high-quality, leading-edge geologic research applicable to the present and future needs of the petroleum and mining industries, and (5) obtain employment for graduates.

Research staff who have formed the backbone of the center with their contributions include Bruce Trudgill, Andy Pulham, Carl Fiduk, Tomas Villamil, and Claudia Arango. Faculty have included William Atkinson, Roger Bilham, David Budd, Phil Choquette, Jack Edwards, Don Eicher, William Hay, Erle Kauffman, Roy Kligfield, Mary Kraus, Karl Mueller, Phil Oxley, Mark Rowan, and Paul Weimer. Colleen Velie has worked as an administrative assistant since 1990 supporting all aspects of the center.

An advisory board was established during 1995 to develop some long-term working relationships with eleven key companies who have a vested interest in seeing the EMARC research program succeed. In addition to sponsoring numerous research projects, this advisory board has contributed $30 million in geophysical seismic data, $2.5 million in seismic interpretation software, and $0.3 million in biostratigraphic data. After the significant downturn in the middle to late 1980s in the petroleum industry, recruiters have flocked back to campus during 1996 and 1997.

Current research projects are focusing on petroleum industry trends for the 21st century: deep water exploration and development, and better reservoir development for increasing reserves. To date, thirty companies have supported EMARC's research. This has had many beneficial aspects for the sponsors. For example, sponsors can hire EMARC students as interns and preview them as employees, and companies get quick access to the results of cutting-edge research. Furthermore, companies have the opportunity to give immediate feedback on research projects, thus improving the overall quality of the EMARC program.

Studies have included sequence stratigraphy, structural geology, and reservoir geology. EMARC has conducted six major research projects whose results have had immediate application to the sponsoring companies. The projects include integrated studies of the northern Gulf of Mexico, including the stratigraphic evolution of the area, structural evolution (salt, faults, folds), and the petroleum systems. An unprecedented consortium with four companies resulted in the drilling of the BAHA well in Alaminos Canyon in the northwestern deep Gulf of Mexico, in the deepest water (7612 feet) to date (Figure 1). Reservoir studies have focused on the architecture of marginal marine reservoirs, and how they are compartmentalized by key stratigraphic surfaces. Reservoirs that have been studied include fields from U.S. and Canadian western Interior, Great Plains, North Sea, northern South America, and Papua New Guinea.

Notes on Minerals Programs Carried out under EMARC

A donation from alumnus Gary Grauberger to the Department provided an initial impetus for the founding of EMARC. Gary had profited from the sale of gold properties he had personally discovered, and wanted to share his success with us. Some of the funds were used to provide fellowships to needy students in mineral deposits, and to help them carry out field work for master's theses. Two students who benefited particularly were Michele Murray and Scott Bennett, who worked at the Santa Gertrudis mine in Sonora, Mexico. The deposits there showed characteristics of both the Carlin-type gold deposits and shear-zone hosted, syn-kinematic gold-bearing quartz-carbonate veins. In 1991, Tenneco Minerals company provided a substantial award to fund theses on their properties. Dave Greenan carried out a thesis on the Goldstrike gold mine in southwestern Utah, and Paul Boni began a thesis on Tenneco's trona mine near Green River, Wyoming. Before the money was used up, Tenneco sold their gold business to USMX, and the trona mine to Solvay. Paul Boni continued with the trona study, and we offered our services in the form of a thesis to USMX. The latter company asked for a study of a red-bed copper deposit in the Sierra de Samalayuca, Chihuahua, Mexico. This was carried out by Craig Bruno. Other minerals theses carried out with EMARC support of students include a study of gold and silver tellurides at Gold Hill, Colorado, by Bruce Geller, and a study of tectonics and gold deposits in northwestern Sonora, Mexico, by Alexander Iriondo, as well as a study of ammonium in hydrothermal alteration zones in Nevada by William Baugh. In summary, the EMARC program helped raise money and provide small grants to students that greatly helped our program of graduate theses in economic geology.

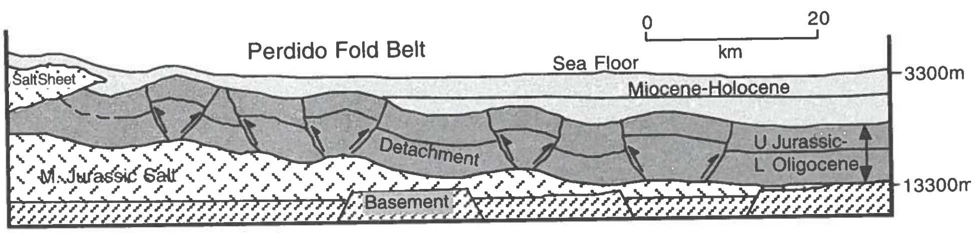


Figure 1. Schematic cross section across the Perdido Foldbelt, northwestern deep Gulf of Mexico. The BAHA well was drilled in the structurally highest fold in 7612 feet of water from April to June 1996. The well encountered drilling problems and was abandoned at 3594 subsea drilling depth. Results remain confidential. A second exploration well is expected to be drilled during 1999. The results of EMARC's research were used to pick the location of the drilling site.

Contributions from Faculty

John T. Andrews

When I first arrived at Boulder I did not anticipate that I would still be here 30 years later. But the department, INSTAAR, and the University have all been good to me and I am glad I stayed around. During my tenure here I have supervised around 60 graduate students (about one-half PhD students and the other Masters students). In the early years most students worked in the Canadian arctic but with some notable exceptions who undertook research in Alaska or Colorado. In the late 1970s I moved toward a major change in my research focus. Prior to that period virtually all my research had been in the fields of glacial geology, Quaternary chronology and climate change, or glacial isostatic recovery. The change involved becoming deeply involved in Quaternary marine geology and specifically ice sheet/ocean interactions. Whereas prior to this time all my research was focused on Baffin Island or adjacent areas this move resulted in involvement with marine research cruises to places such as Iceland, East Greenland, Antarctica, and the fiords and areas of Baffin Island and the Labrador Sea. Since ca. 1987 virtually all my graduate students have been working on marine data of various kinds, and on problems associated with abrupt changes in ocean environments, including Heinrich events (massive iceberg discharge events).

My teaching has always been an important element of my career and I have usually taught 3-4 courses per academic year. The major courses I have taught over the years includes Glacial Geology (4356/5356), Introduction to Statistics for the Earth Sciences (GEOL/GEOG 3023), and The Geological Record of Global Change (GEOL 3040).

Possibly my major service was to be Chair of the department, 1987-1990, and again for the spring semester 1993.

In terms of honors and awards, I have been president of the American Quaternary Association and the Quaternary and Geomorphology Division of the Geological Society of America. In 1978 I was awarded the D.Sc. from the University of Nottingham, England. The Norwegian Academy of Science and Letters honored me by electing me a foreign fellow of their academy in 1995, and in 1997 the Regents of the University of Colorado awarded me the University Medal.

The University of Colorado, Boulder, has been a great place to do research and teach. Over the years the reputation of the department in the fields of Quaternary geology and climate change has steadily increased so that now our program is known internationally and nationally. The strength was initially built on the quality of faculty such as Bill Bradley, Peter Birkeland, and with due modesty, myself. Over the last decade or more the faculty in this field has grown and diversified so that it is now one of the major strengths of the department.

Bill Atkinson

Since he was hired, Bill Atkinson's primary mission has been to educate students about the scientific and economic aspects of mineral deposits, and to carry out research on the processes of ore deposition. His program includes courses in ore deposits, the geochemistry of hydrothermal deposits, a field course, and a lab course in the study of ores. Special advanced seminars have been held from time to time, and there have been many field trips. His regular research meetings for his advisees have been augmented by pot-luck suppers for students and alumni alike. To date, Bill has been the principal advisor for 28 M.S.s and 10 Ph.D.s. Thesis projects have been quite varied, with topics such as porphyry copper deposits in Alaska, Montana, Colorado and Chile; skarn (metamorphosed limestone) in New Mexico, Utah and Nevada: metamorphic gold veins in Alaska, Mexico and Bolivia; epithermal gold, silver and tungsten vein deposits in Colorado, Nevada, and Chihuahua, Mexico. Other theses included titanium deposits in Wyoming, tin in rhyolite in New Mexico, Carlin-type gold deposits of Nevada, and theories of mineral deposition in the Mississippi Valley type lead-zinc ores. Another explored the impact of environmental laws on the Florida phosphate mining industry. Students even studied the tectonics of NE Nevada and of NW Sonora, Mexico.

Many trips to thesis project areas were memorable. On one, we were crossing the Sonoran desert in Mexico on one of those tiny roads, when a rattlesnake crossed in front of us. Someone hollered "rattlesnake!", and a European student in the group immediately rolled up his car window! One of Bill's scariest moments came when he and two students slipped across the border carrying a load of old cow skulls the students had collected to sell in the U.S. If the border guards had seen them, they might still be there. On a trip to Nome, Alaska, they were invited to visit a private placer gold operation, where they watched a sluicing operation recover a pile of 15 pounds of pure gold! Another trip took Bill to Spain, to see the world's largest mercury deposits at Almadén, mined since the days before the Romans. Some students have described his "death marches" in the desert of Sonora and Nevada, but those are other stories.

Class field trips were a lot of fun, too. Bill took several groups to the Stillwater Complex in Montana, a rather long day's drive from Boulder. On one infamous trip, Bill told the group that the water was safe to drink, since he had worked there the previous summer, and had had no problem. Unfortunately, the summer had been dry, and the water was low. Two students had brought their own water, and they were the only ones who didn't get giardia! On another trip to Stillwater, they had a flat, and a tire dealer failed to put the wheel with a new tire on correctly. As a result, the lug bolts began to snap off, one by one! When we reached Jackson Hole, there were only two left. Another trip to Stillwater featured a spaghetti dinner by Professor Chuck Stern, who managed to cram 10 pounds of spaghetti into a small pot, and cooked it into a solid mass. On a trip to Baja California, they stopped to pick up a student in the CU band at a bowl game in Tempe, then went to San Diego, where twenty of them stayed with another student's sister. Far down the highway into Baja California, they had a flat tire, and found the end of a snapped-off axle from another poor motorist at the same spot! They hired a fisherman with a small boat to visit a gypsum mine a few miles off Santa Rosalía, and were overwhelmed with the hospitality of the manager, who said he never gets visitors. He fed us a nice lunch in their dining hall, and gave us a tour of their installation. We enjoyed walking among the cirio trees, which look like inverted green carrots twenty feet tall, and marveling at mountains of peridotite from the mantle, scraped off onto the continent.

So many funny things happened on those trips, that it would take a whole book to tell them all! Like the student who switched cars during a trip to Nevada to talk with a van load of guests from the University of Sonora. The caravan got separated at night, and the student had to sit up and shiver all night without his sleeping bag! Flat tires, broken windows, sliding on snow and mud, snad in the food! But they remember all the fun we had.

Funding for students has been hard to come by, since the national funding agencies prefer that the mining companies support research in this field, but the mining companies don't have much money to spare for this. NASA funded a Ph.D. thesis, but only after the topic of investigation was changed to regional tectonics. Alumnus Gary Grauberger, who did well in the gold business, helped us substantially. His donation provided support for research assistantships for several students, as well as supporting field trips and thesis expenses. Anaconda and Tenneco Minerals supported other theses, and donations from many other companies provided logistical support. The USGS was an important resource for a number of students, especially those who were employees of the Survey before earning their degrees. One student, Avrom Howard, started his own company to fund his graduate work.

Bill's research in recent years was inspired by an article by Mark Reed, of the University of Oregon, who pointed out that the transport of gold in hydrothermal, or hot spring, systems, depends on the concentrations of H_2S available. If there is a lot, it can wind up in the hot spring, but if only a little, it may wind up being deposited with lead and zinc, as at Central City, Colorado. So this is why "gold is where you find it," and Bill has been studying the geological indicators that tell you where to look. This led him to study a district in Mexico, Moctezuma, Sonora, where there is still a variety of deposit types worth investigating.

In 1986, a visiting Chilean professor asked Bill to put together a week-long seminar on the geochemistry of gold, at the University of Chile in Santiago. After he did this, he received other invitations to put on the seminar, in Spanish, for mining companies in Chile, Mexico and Spain, twice for the University of Sonora, for the Mexican National University in Mexico City, for the Consejo de Recursos Minerales (Council of Mineral Resources) in Mexico, and for the Technical University in Oruro, Bolivia. In order to improve his Spanish after the first seminar in Chile, Bill found a novel way to work on the language. He put on English classes for recent Mexican immigrants, once a week, for five years. As a result, both he and the immigrants reached fluency in the other's language.

Bill has just a few years left till he's 65. At that point, he may continue to teach part time, and do consulting in far-away places, in strange languages. If space were available, he would like to mention each of his students, and how much he has enjoyed knowing them.

Roger Bilham

At the University of Wales in Cardiff I completed degrees in Physics, and then in Geology, and was fortunate to be accepted in Cambridge for a Ph.D. in Geophysics. The transition was accompanied by field work interspersed with latent violence: to Arctic Norway (mapping Pre-Cambrian units covered in unexploded shells), to Scotland (where I destroyed a government Landrover and its delicately suspended gravimeter by driving them over a cliff), and overland journeys to Prague (the day before the Soviet invasion), to Turkey, Iran (stoned-by rocks), Afghanistan (lost on the Khyber Pass), Pakistan (Floods) and India (disease) and to Paris (basalt cobbles and tear gas - La Lut continuee).

Cambridge in 1967 was a hot bed of plate tectonics and the Dept. of Geodesy and Geophysics hosted a remarkable assortment of links that had led to its formulation. I was faced by three people during my interview there: the amiable and engaging Sir Edward Bullard, a brilliant David Davies, organist and seismologist, who was to be my supervisor until he left to become the editor of Nature, and an electronic engineer, Tim Owens, who was there as a kind of reality check. One of the interview questions was how might you measure the rate of opening of the Red Sea. My answer was a shot in the dark - a completely absurd underwater pipe containing a vacuum that we would shoot a laser beam down. I learned later that this was almost fatal, but Teddy Bullard, who was a master of fatal ideas as long as you were prepared to argue them through to burial, thought that this was the kind of nonsense he needed to keep people on their toes in the lab. His anecdotes about everything from first hand accounts of Rutherford in action, to the number of dolphins in the South Pacific were global in breadth and myopic in detail, and were always delivered with enormous humor.

Teddy Bullard's early geophysical career, as opposed to his interesting activities preventing magnetic mines blowing up ships in the war, involved East Africa, and it was his gravity work there (he boasted a knowledge of the local vernacular "clom roop di beasti," meaning "please mount your horse") that was to reveal him as a true friend. One day soon after I had started a post-doc position in Cambridge in 1971, he received a phone call from a general in the War Department. "We have a man in Khartoum who says he is one of your people, do you want him back?" I had been stranded in the Sudan after running out of funds in an interesting tour through insurgent Turkey, Syria (jailed for photographing a military installation), Lebanon (the Palestinian freedom fighters) and Ethiopia (as a guest of the Eritrean Liberation Front - napalm and kalashnicoffs). Teddy introduced the question during elevenses as a vote (coffee and biscuits always happened exactly at 11 every morning and everyone had to attend). The assembled geophysicists of England voted to send me the airfare. A boyish twinkle pervaded Teddy's eyes as he debriefed my three month adventure. It was why in subsequent years his letters of reference for me always started "In his youth he was a bit wild but..."

My dissertation was on strain in the Earth: designing, building and installing strainmeters to measure atomic-sized deformation beneath the fields and towns of England, Germany, Luxembourg, Canada, Mexico and Iran. It seemed then, and does so still, astonishing to be able to measure such small quantities accurately. The research was mostly joining different colored wires to each other, transistors, and the earth. I was fortunate to work very closely with Geof King, a rebel in society and science whose relations to scientific order can be best described as the grit in the oyster whose presence is vital for the production of pearls. We were somewhat naughty as students, and I would be appalled to contemplate a pair of similar students in my current classes. But for all the pranks (painting the inside of the railway tunnels by dynamiting pots of paint, eels in the wave tank at the physics exhibition) we seemed to have spent a lot of time debunking scientific myths in pubs, and on long journeys to remote parts of the world (Turkey, Iran). It was during the second pint in a Yorkshire pub that Geof outlined why all the measurements of tidal tilt in Europe were actually measurements of tidal strain, because the underground tunnels changed shape more than they rotated as the moon passed over them. It was the end of an era of confusion for many European laboratories, and was, coincidentally taken up and meticulously quantified by my predecessor in Colorado, Chris Harrison.

After 8 years in Cambridge I found myself being invited to Lamont Doherty Earth Observatory in Columbia University to work on the physics of earthquake prediction. Strain was central to this problem and Lamont had a strong tradition in strainmeter development. I was able to broaden the scope of strain measurement to include tilt, tide gauges, hydrostatic leveling and subsurface radar, which we applied in Alaska, California, the Caribbean, China and Iceland. We set up the first satellite telemetered tide gauge array in the world monitoring the passage of 0.1 mm amplitude trapped waves along the coast of Alaska, superimposed on a 2 m tide and storms and things. But it was the introduction of GPS satellite geodesy that was to truly open the possibilities of strain measurement on a global scale.

In 1985 I was invited to visit Boulder as a JILA Visiting Fellow to strengthen the possible development of GPS and water vapor radiometry into a geodetic tool. This was to lead to a 5 member consortium of Universities (now 27) that became known as the University Navstar Consortium (UNAVCO). For several years this grew within CIRES until its size required a change in location. UCAR became its host institution and it has continued to grow with a 1996 budget of $1.5M. In 1986 I joined the Department of Geological Sciences and was appointed a Fellow of CIRES. In the next few years, stimulated by a bunch of wonderful students, we started measurement projects throughout the world. Anything that moved was fair game. My students and I have since measured in Iceland (Christine Hackman and Freysteinn Sigmundsson), and California (Roland Burgmann, Paul Bodin, Jeff Behr and Scott Whitehead), the Himalayas (Ken Hurst, Mike Jackson, Freddy Blume, Paul Vincent and Becky Bendick), Africa (Mike Jackson, Samson Tesfaye, Becky Bendick), India (Becky Bendick, Roland Burgmann, and Freddy Blume), Tibet (Paul Bodin, Freysteinn Sigmundsson) and Venezuela (Mike Kozuch, Freddy Blume) and most recently in Mexico and other parts of the Caribbean in collaborative projects with Professor Kristine Larson. Interestingly, only in Iceland were we able to undertake measurements away from land mines, flying bullets or other forms of peril or implied violence. As recently as last month Becky Bendick was jailed (in Ethiopia) for setting up a GPS receiver in what was designated an inappropriate location without proper paperwork. We have been held-up at gunpoint in India, in Afar, and in California.

What did we find out in this last decade? Things are certainly moving. We have an uplift rate for the Himalayas and the Altyn Tagh mountains (5-8 mm/year), and a convergence rate (215 mm/year) for India colliding with Tibet. We have processed data from the summit of Everest and from the equator. We have also published rates of shear and widening for Iceland, for the rates of creep on the San Andreas fault system between Mexico and San Francisco Bay. We are close to understanding the widening rate of the Ethiopian rift, a number whose eventual measurement using radio waves would not have surprised Teddy Bullard.

We have come to understand the morphology of strike-slip faults, and mountain ranges, and something of the connectivity of slipping segments within a fault system. We have rummaged through colonial history to shed light on mystery earthquakes in India, in order to understand a yet more mysterious future. In short we have significantly improved our understanding of Earth's dynamic processes and their relevance to seismic hazards at plate boundaries. I am pleased to realize that as a result of my contribution to geodynamics in CU Boulder, Geological Sciences is now armed with 19 geodetic quality GPS receivers and an FG5 absolute gravimeter, all potentially accurate to 3 mm in terms of displacement over any distance, and 15 creepmeters and a laser tiltmeter. Ten GPS signals, 6 creep and 2 tilt channels provide continuous data streams from California, the Himalayas, Mexico and Ethiopia some of which deluge us with daily data via satellites parked over the equator.

But perhaps the most interesting research results have followed from teaching classes of undergraduates the elements of the exciting world of geology. The why and wherefore of geology requires explanations and justifications to the sleepy hoards at 8 am and 11 am (students seem to be awake most between 9 and 10 when I don't teach). Why are earthquakes important? Because they knock down buildings on top of people. Such a simple notion, but the consequences are globally violent, and getting worse. Volcanoes and floods all obey general scaling laws that tell us rather clearly that these fixed-hazard phenomena are not fixed-risk problems to a society that is apparently continuing to double in population, and build unwisely. We appear to be on a world heading for superlatives in terms of natural disasters, and our students will watch them increase in destructiveness thinking this is inevitable. Rising global sea level, increased risk from natural processes, reduced availability of inexpensive energy, reduced access to water, sediment filled reservoirs, and dwindling minerals resources and waste disposal options. All these things happening in a society in which the credibility of science and engineering, and even education, is at an all time low in terms of student desires.

Scientists have a terrible responsibility to inform the world of what is possible, and what may happen if wisdom is not applied to the labyrinth of possible futures that confront us. Not to do so is to be irresponsible. The press has the power to deliver our message but they may also find it difficult to qualify with accuracy. That it is possible is demonstrated by the nightly weather show, a showy blend of probabilistic forecast and technology to a level where most viewers can assess its credibility. It is up to us to face the challenge of responsible outreach on more complex issues. Geology provides a unique opportunity to present the issues to young minds so that they can make important decisions by themselves in future years. For some of them Geology is the only science they will encounter in their path through life, and for many Geology is taken since it surely contains no arithmetic. It has been a great source of inspiration to me to work with my colleagues in Geological Sciences, each experts in their chosen fields, and from each of whom I have learned so much in my decade in Boulder.

What's the best bit in all this? It's eating out in Boulder, and sometimes in more remote places, or sometimes as email after a movie of our work is aired on the TV. A young face will walk up to me and say - "I was in your class - it was terrific," unlike just after the exams when sad-looking characters have somewhat different phrases to ventilate. In real life I seem to only get nice things coming my way. But why is it that so many geology students use their geology skills as waiters?

Pete Birkeland

After 30 years, Sue and I have decided we need more flexi-time, so are retiring (she from teaching the city exercise classes). We have many fine memories of the years.

When I arrived here, I started out with 2 courses/semester, and did I scramble. I had taught the Quaternary course at Berkeley, but all the others were new to me. I left Berkeley to get into more teaching and geology, so the load was fine. The salary was the same as at Berkeley (about $10K, and included about $800 startup to fund my field research program—I strung it out to last at least 2 summers).

Field trips with faculty and students were a great part of the job. Early on Braddock, Bradley, and Larson took a bunch of us out to see central Colorado geology, and the good food of Minturn. From this, and talking with Gerry Richmond (USGS), I decided to take on the rock glaciers of Mt. Sopris. Other trips included several to view Rio Grande geology, followed by skiing R and R at Taos, where our family was joined by the Bradley family and Ed Larson. One memorable trip was to the glacial landscape of the midcontinent, where we about ate them out of business at Ike's Chicken Shack in northern Minnesota, and the infamous Soil Circle was probably invented. Later we went out to California on the desert trip where we mixed cold weather with John Andrew's hot curry. I always took a bunch of students to the Friends of the Pleistocene meetings (FOP), including trips to the deserts of California, Arizona, and New Mexico. In the following years many of my students helped lead them, and on one we backed the van into the only tree in Texas. The students were so eager for field trips that they would talk me into taking the Quaternary class into new areas so they could tag along—so we went to the La Sal Mountains and the Wind River Mountains. When Ted Walker offered a trip to Baja to see the redbeds, he got students from all geology disciplines, and even a geographer! The mega-trips stopped about when Bradley and Walker retired, and the field-crazy students got their degrees. Whenever that era of faculty and students gets together, the talk quickly digresses to the numerous funny incidences that took place on those field trips. Nel Caine, John Pitlick and myself in the last few years resurrected the field trips as a geomorphology course, so off we would go to New Mexico and Utah.

Trips to see students in the field were always a big part of our summer, and Sue, Karl and Robin (in their younger years) would usually come along. We travelled to all parts of the western USA, and I got as far east as the Missouri tills and dirt. Lucky for us that three students worked in Peru, for we got to spend parts of two summers there. Only after we left did the Sendero Luminuso come out of hiding!

As time went on we focussed on sabbaticals, and a lot of my research came from these trips. In the late 70's we spent a year in New Zealand working in the mountains, with Karl as a digger and Robin a note taker. In the mid-80s we decided to get more environmental so Sue, Robin and I took our bikes around the world to work on soils and slopes in New Zealand, Tasmania, Israel and Corsica—otherwise known as the 14-month summer! By the early 80's mountain bikes had been invented so Sue and I used them to study soils on odd western Pacific carbonate islands.

For us, this was the heyday of geology. The faculty were supportive, as were the staff (I forget the number of times Edith and Paulina patched me up from bike accidents). Ed and I slaved away at several editions of Putnam's Geology, trading authorship with each edition, and trying to increase our cut of the royalties. Ed did not think much of the deal I originally struck—1/6 for each of us, and 2/3 for Mrs. Putnam. The students, especially the thesis ones, made it all worthwhile as they have been a hard-working, fun-loving bunch, all of whom have done well and made their mark. When I wrote the two editions of my soils book (now finishing the 3rd) all I had to do is plagiarize their work. Unfortunately for them, I was able to get only a few grants, so they had to make due on the cheap. My motto had been to do the work anyway, even if not funded, rather than switch gears to more popular topics. Some of the students even out-did me when it came to being cheap! In the end we all benefited as we had to be highly motivated and resourceful.

The publication rate of the professors was dictated by the professors. We did the work we enjoyed doing, and published it (usually only once) when we were done. This resulted in about 1 paper/year, much of it single authored, and we seldom co-authored student's theses.

One legacy I leave is the cluttered office. Once my office would fill up, a larger one would become vacant and I would take it over. I write this from Bill Bradley's former (large) office where I have to high step over piles of stuff. My former (small) office is occupied by Paul Weimer, and his stuff is piled high and at the angle of repose. Time to move on to a new building!

Bill Bradley

When Larry Warner completed his book in 1986, I was already in a countdown to retirement. Going half-time in 1985 had been the first step; retiring fully in 1989 concluded the process. At that time I had taught at CU for 34 years, more than half my life. Despite such a major change, the phased transition helped make the adjustment easy. One of the benefits of retirement is being able to do things at a more leisurely pace than was formerly possible.

My most rewarding retirement activity has been working with Cloud Ridge Naturalists, a local organization that provides natural history education in the field. Founder and director of Cloud Ridge is Audrey Benedict, a CU graduate in geology and biology, whose husband Jim is also a CU graduate in geology. Among the seminars are raft trips on western rivers, on which I work with biologists and others to help participants understand what they are seeing. It's adult education in beautiful and interesting country, and it's so much fun that Louise and I take other Cloud Ridge seminars.

1994 brought a heart-warming event in the form of the Distinguished Career Award from the Quaternary Geology and Geomorphology Division of the Geological Society of America. Responsibility lay with a Gang of Four: Pete Birkeland, John Andrews, Nel Caine, and John Pitlick. They worked tirelessly behind the scenes, twisting arms, stretching truth, arranging documentation. Pete gave the citation in a performance that deserved the Academy Award for that year, and which totally changed the character of the usually staid GSA award ceremonies.

Boulder and CU have changed a lot since my arrival in 1955. Growth is one big change. Boulder had 30,000 residents at that time (all of them thirsty because Boulder had not yet voted itself "wet"); its population has now more than tripled. CU had 9,000 students then; those numbers would also have more than tripled, had it not been for an enrollment cap. As both communities have grown, life has changed: it is more varied, complex, frenetic, and contentious (some of these may be in the aging eyes of the beholder).

CU, like many schools, has also had a dramatic change in mission. In 1955 CU was primarily a teaching institution, with most effort directed toward the undergraduates. Contract research was a minor activity. Research now is a large and integral part of CU's operation. And teaching graduate students has become as important as teaching undergraduates.

I joined a department already known for its congenial, family-like atmosphere, a reflection of the personality of Warren Thompson, then head of department. He believed people could do their jobs and at the same time enjoy one anothers company. He had a long-lasting effect on the character of the department.

1955 was a lucky year for me in many ways—lucky that CU was hiring someone in my field; lucky that my interest in teaching fit the CU mission; lucky that Ted Walker, my good friend and first geology instructor at Wisconsin, was already here; and lucky that head of department was Warren Thompson.

David A. Budd

David Budd joined the CU faculty in January 1987, as a replacement for Ted Walker. Like Ted, David's expertise is in sedimentary petrology, but his specialty is carbonates rather than siliciclastics. David received his B.A., M.S., and Ph.D. degrees from The College of Wooster (1976), Duke University (1978), and the University of Texas at Austin (1984), respectively. Before joining CU, David worked in reservoir geology for 3.5 years at ARCO's exploration and production research facility in Plano, Texas. This experience, plus earlier work at the Texas Bureau of Economic Geology, gave David a strong subsurface orientation to his research and teaching.

In his first few years at CU, David taught undergraduate courses in sedimentology and historical geology, graduate courses in carbonate petrology and carbonate depositional systems (with a very popular week-long field trip to the Guadalupe Mountains of New Mexico), and co-taught seminars in sedimentary geochemistry and sedimentary records of sea-level changes. Until Paul Weimer's arrival, David's graduate courses were the only place that CU students were exposed to sequence stratigraphy and subsurface core analysis. David's graduate-level courses were well enrolled and quite popular at first, but by the early 1990s, the down sizing in the petroleum industry resulted in a lack of graduate students with interests in David's courses. As a result, David now teaches almost exclusively at the undergraduate level. He reinstituted a summer field geology course and his standard repertoire in the academic year now includes Introduction to Field Geology, Writing in the Geosciences, and historical geology. Beginning in 1998, David will be adding a non-major Environmental Geology course to his inventory.

David's first graduate student completed his degree in 1990, and by December 1997, David will have seen eight M.S. and four Ph.D. students finish under his supervision. Those students have worked on projects that ranged from carbonate facies and stratigraphic analysis of oil reservoirs or aquifers, to strictly carbonate diagenesis, to the hydrochemistry of groundwater systems, to paleoceanography. The corresponding rocks have ranged in age from Holocene sediments to Mississippian dolomites. About 1/3 have done field-oriented projects while the others did subsurface studies that utilize core material. The first five all had interest in petroleum careers and remain employed in some aspect of that industry. However, five of the last 7 had interests in the environmental field and are now working in that industry.

Some of David's most important contributions have been in service to the Department. He has served on six faculty search committees, the Department's governing committee for four years, chaired curriculum committees that revamped undergraduate degree requirements and the field geology program, was associate chair for three years, and the undergraduate advisor from November 1993 through Spring 1998. David has also served as a Councilor for the Society of Sedimentary Geologists, an associate editor of the Journal of Sedimentary Petrology, a co-convener of a 1993 AAPG Hedberg Research Conference, and as a member of the technical program committee for the 1994 AAPG/SEPM National Meeting held in Denver.

David's research interests continue to be in the origin and alteration of carbonate sediments and rocks, in particular, their geochemistry and relationship to pore fluids. A strong component of his work is geared to documenting the relationships between diagenesis, porosity, and permeability heterogeneity in carbonate reservoirs and aquifers. Small grants from petroleum companies during David's first few years at CU helped him start his program, and the Petroleum Research Fund of the American Chemical Society has been a continual source of funding. David and students have evaluated groundwater chemistry as a record of diagenetic systems, explored the use of image analysis in reconstructing pore networks over time, used synchrotron light sources to understand aspects of carbonate cathodoluminescene petrology, developed techniques for quantifying exposure surfaces in carbonate rocks, described examples of reservoir and aquifer heterogeneity, investigated the recrystallization of skeletal fragments, and explored calcite cementation in modern aquifers and the deep sea. An NSF grant in 1990 got David started in the study of Cenozoic carbonates of Florida, and he has found those rocks to be fertile ground for many research problems and graduate theses. His research continues to focus around these carbonates with complimentary studies of permeability evolution with burial and facies control on permeability and hydrogeologic units.

John Drexler

During the tenure of Drexler the department has continued to expand its analytical facilities. In 1987, an NSF grant provided the department with a state-of-the-art electron microprobe, an instrument that was unmatched in its sophistication and capabilities in the Rocky Mountain Region. The electron microprobe would serve as the cornerstone to the newly remodeled central analytical facilities. Remodeling of the 2,000 sq. ft. facility was funded by one of our most generous alumni, Mr. Bruce Benson. The facility now contains a scanning electron microscope (SEM), three x-ray fluorescence units (EDSXRF's and WDSXRF), an ion chromatography (IC), fluid inclusion, cathodoluminescence, gas chromatography (GC) and GC/MS, inductive-coupled plasma atomic emission (ICPAES), image analysis system, and a GIS system. In addition to these laboratory-housed instruments, the facility maintains multiple field units for measuring water quality parameters that graduate students and faculty can carry to their research and thesis areas. These units are also used for teaching the undergraduate course in Environmental Field Methods.

The central analytical facility has developed into a focal point for materials characterization on the CU Boulder campus. The laboratory provides researchers from the university, government, and private industries tools to characterize all types of materials (minerals, rocks, thin-films, superconductors, bio-films, alloys, composites, hazardous wastes, waters, and others), providing answers to research and real-world problems.

The future? The University is seeking to make the analytical facility play an even larger role in the materials and environmental community, on campus and off. Backed by the administration, a multi-million dollar funding attempt is currently underway to form the Environmental and Materials Science Laboratory (EMSL) in the new Benson Earth Science Building. The Laboratory, with its additional staff and equipment, will lead the campus into multidisciplinary interactions.

John D. Edwards

Jack received a B.S. in Mechanical Engineering from Cornell University in 1946, attended Colorado School of Mines in 1948-49, and in 1952 obtained a Ph.D. in Geology from Columbia University.

He began his geological career as a field geologist with the United States Geological Survey in Mexico. Stratigraphic studies of Tertiary Red Conglomerates in Central Mexico was the subject of his dissertation, published as USGS Professional Paper 264-H. In 1950, he joined Shell Oil Company. From then until 1962, he gained experience in field geology, photogeology, and subsurface interpretation in West Texas, New Mexico, and southern Colorado. From 1962-1966, he worked in Shell's California region, as Division Exploration Manager in Bakersfield and as Area Exploration Manager in Los Angeles in 1966, after a six-month training assignment in The Hague, he was appointed Chief Geologist for Shell Oil in New York City and later Assistant to the Vice President of Exploration. He became Exploration Training Manager in Houston in 1974 and in 1979 joined the Shell Oil subsidiary, Pecten International Company in Houston. His final position at Pecten before his retirement in 1987 was Latin American Exploration Operations Manager. He worked principally in exploration ventures in the Brazilian Amazon and offshore. He shared in the discovery of JM gas field in west Texas, Altimont oil field in Utah, Merlusa gas field in Santos Basin, Brazil and several small fields in Texas, California and Alaska.

During his retirement, Jack was an AAPG Distinguished Lecturer on the subject of Divergent Passive Margin Basins and edited AAPG Memoir 48 (1990) on the same topic. Jack came out of retirement in 1992 from Durango to take on the directorship of EMARC. He has presented one-week structural geology training courses for International Human Resource Development Corp. in Jakarta, Brisbane, Melbourne, Rabat, Damascus and Mexico City. In the Department he has taught Fold Belts and External Basins, Senior Paper, and Mineral Resources, World Affairs, and the Environment. In the latter course he brought in many local experts as guest lecturers.

Jack has served in several professional organizations. These included Associate Editor of the Geological Society of America Bulletin and AAPG program chairman then board member for five Offshore Technology Conferences in Houston. During 1995-96 he was a counselor on the executive board of the Rocky Mountain Association of Geologists. His recent publication "Crude Oil and Alternate Energy Production Forecasts for the Twenty-First Century: The End of the Hydrocarbon Era" appeared in the August 1997 Bulletin of the American Association of Petroleum Geologists.

During the summers of 1993, 1995 and 1997 he took his five sons and daughters and fourteen grandchildren on geological rafting trips down the Grand Canyon. In 1997 he lectured at Beijing University and toured the Three Gorges of the Yangtze River. He plans to continue teaching as an Adjunct Geology Professor at CU, teach structural geology courses overseas, lecture on Twenty-First Century Energy and serve on Masters and Ph.D. committees. He will continue to ski, snowshoe, hike, bike, swim and play tennis.

Don Eicher

(please see "A Recollection" on page 118)

Lang Farmer

G. Lang Farmer (B.A. University of California, San Diego, 1977; Ph.D., University of California, Los Angeles) has been a faculty member in the Department since completing a postdoctoral appointment at the Los Alamos National Laboratory in 1985. Lang's research interests are in radiogenic isotope geology, and over the past ten years he has operated a complete clean chemistry and solid source mass spectrometry facility. This facility was located at CIRES prior to 1997 (where Lang has been a Fellow since his arrival at CU), but with the opening of the Benson Earth Sciences Building, the entire operation moved into the building and into a new 1400 sq. ft., Class 20-10,000 clean room facility. This facility, as one of the few clean chemistry laboratories on campus, represents a unique feature of the new building. Lang, coincidentally, was also the chair of the Departmental committee involved in the design and construction of the Benson Earth Sciences Building, but assures us that this had nothing to do with the high quality or cost of his new laboratory. Over the next few years, Lang plans to continue applying isotopic and trace element data to problems in igneous petrology, tectonics, and hydrology, and to continue teaching his courses in physical geology, geochemistry , and isotope geology.

Shemin Ge

Shemin Ge is a hydrogeologist who joined the department in the fall of 1993. Shemin earned a B.S. degree in geotechnical engineering from Wuhan University of Technology in China. She then went to Vancouver, Canada for graduate work and received a M.S. in geotechnical engineering from the University of British Columbia. Following that, she switched over to hydrogeologic studies at the Johns Hopkins University and earned two degrees, a M.A. and a Ph.D. Following graduation, she worked for an environmental and water-resource company as a hydrogeologist for three years.

Since arriving at CU, Shemin has developed an externally supported research program. Her research group includes a number of highly motivated graduate students and postdocs. Their research activities are along two fronts balanced between the fundamental understanding of some of the critical hydrogeologic issues in geologic processes, and the emerging environmental related hydrogeologic issues impacting modern society. Shemin is continuing her study of the coupling mechanisms among fluid flow, rock deformation, solute transport, and heat transfer in geologic basins. New collaborative efforts on flow in small scale fractures has been initiated. She is also exploring research in groundwater contamination and water resource management. Teaching-wise, Shemin is filling the void left by Bruce Curtis, and has developed a major class in hydrogeology for juniors and seniors. At the graduate level, she teaches advanced hydrogeology and groundwater modeling. Her combined academic and industrial background has given many students a productive learning experience. In addition, she also contributes to the 1000-level physical geology and field hydrology courses.

Alexander Goetz

Alexander F.H. Goetz received all his degrees from Caltech (B.S., 1961; M.S. 1962; Ph.D. 1967). Alex came to the Department in 1985 via Bell Telephone Laboratories (Bellcom) and NASA JPL. At Bell Labs he was involved in the Apollo program and had his photographic experiments flown to the moon on Apollo 8 and 12. At JPL, among other things, he started the geologic remote sensing program that he headed for 10 years and developed a series of sensors that were flown on the space shuttle and were slated for NASA's

Earth Observing System. Alex has received numerous awards, among them the NASA Medal for Scientific Achievement and the NASA/Department of Interior William T. Pecora Award. He also has strong connections to industry in developing new sensors for Earth remote sensing.

Upon arrival at CU in 1986, Alex took up the challenge of forming and directing the Center for the Study of Earth from Space (CSES) within CIRES. Although directed by a geophysicist, CSES delves into all aspects of the study of the Earth's surface. CSES faculty, students, and staff specialize in using remote sensing techniques to study the geosphere, biosphere and cyrosphere. Currently, four faculty are rostered in CSES. Besides the Director, assistant professor in EPOB, Carol Wessman, a landscape ecologist, Professor Vijay Gupta, Geological Sciences, a theoretical hydrologist, and Professor Konrad Steffen, an arctic climatologist in Geography, are all housed in CSES. One more faculty position, for a mesoscale climate modeler, is still open. Assistant Research Professor Fred Kruse left CSES in 1995 to pursue consulting interests and is one of the founders of Analytical Imaging Geophysics (AIG). Fred and other students and staff of CSES that joined AIG have developed an image processing software package based on the IDL language called ENVI, now marketed through RSI of Boulder. The origins of the software were in CSES where a package called SIPS was developed to analyze imaging spectrometer or hyperspectral imaging data as it is now named.

CSES research in different disciplines is bound together by the common interest in using remote sensing data of various kinds to study the Earth. A technique for which CSES is world famous is imaging spectrometry, also known as hyperspectral imaging, that makes possible analysis of Earth surface cover from aircraft and space sensors with the same spectroscopic techniques used in the laboratory by chemists. These techniques are sensitive enough, for instance, to determine ion substitution in micas or the swelling potential of clay soils from afar. Carol and Alex are the main users of hyperspectral image data to study vegetation biochemistry in forests and grasslands to gain understanding of carbon balance on land and the role of vegetation in maintaining landscape stability in the High Plains. From 1988 to 1992 Carol and 12 others were on a NASA-selected team led by Alex to develop an imaging spectrometer sensor called HIRIS for the NASA Mission to Planet Earth Observing System (EOS). Drastic budget cutbacks beginning in 1990 led to a much scaled-down EOS mission and HIRIS was dropped. The need for hyperspectral imaging remains and the interest is growing. Alex has been involved in a number of NASA, DOD and industry teams developing instrument and space mission concepts that will come to fruition early in the next millennium. CSES students and those taking remote sensing courses from CSES faculty are finding many opportunities in the current job market.

Bruce Jakosky

Bruce Jakosky became a member of Geological Sciences in 1988, after having been in the Laboratory for Atmospheric and Space Physics at CU since 1982. His research is in the broad area of planetary geology, and includes the nature of planetary surfaces and atmospheres. Much of his interest has been in the area of the Mars surface and climate system. This involves understanding the physical nature of the surface layer, the exchange of gas between the surface and atmosphere, the seasonal cycles of the atmosphere and how they vary on long timescales, and the billion-year evolution of the atmosphere.

Of recent interest is the question of the possible existence of life on Mars. Mars has all of the environmental conditions thought to be necessary for life to both originate and continue to exist. Public attention became focused on this question in 1996 with the discovery of possible evidence for fossil life in one of the meteorites that came from Mars. Jakosky has been using stable isotopic evidence to describe the nature of the processes by which the atmosphere has evolved through time as well as the possible biological implications. He is involved in planning for future missions that will search for life on Mars, and is an investigator on the Mars Global Surveyor spacecraft mission that is currently in orbit around Mars.

Erle G. Kauffman

Erle Kauffman, a research scientist chosen from the ranks of the Smithsonian Institution, was invited to head the Department of Geological Sciences in 1980. The next decade and a half were influenced by Erle's leadership, first as Department Chair (1980-1984), then as faculty member. During the early years, the Department expanded from a faculty of 18 to 28, and departmental teaching efforts, research publications and federal funding increased substantially, and the Department's stature rose. A balanced curriculum had been pursued and achieved across the subdisciplines of geology, and a blend of the old and new resulted in one of the most up-dated curricula in the country. Erle Kauffman and Don Eicher were responsible for improving and modernizing the paleobiology program, and for graduating numerous M.S. and Ph.D. students.

Erle and Don formulated a paleobiology curriculum which focused on the life history of Mesozoic and Cenozoic groups, their evolutionary pathways, and the environments in which they lived. They integrated innovative new classes in paleontology and stratigraphy into the program, yet retained the traditions of teaching theory and systematics during lectures. Erle and Don took their research efforts, and groups of students, into the field for rock-based training, and for testing theories of paleontology and stratigraphy. This blend of classroom and field-oriented studies led to camaraderie among students and professors which was unsurpassed by any other university's research group during these years.

A natural field laboratory lay in Colorado's backyard. Fossiliferous strata and well-exposed outcrops extended across numerous western states and were the result of a great seaway, the Western Interior Seaway, which covered the region during the Cretaceous. This paleoceanographic setting was the backdrop for extensive studies in stratigraphy, biostratigraphy, evolution, and extinction. Emphasis for field training was on techniques for stratigraphic and sedimentologic data collection, at the centimeter scale of resolution, and on the quantitative collection of fossils from each horizon. A well-documented stratigraphic framework was thus established through the Western Interior Seaway, and biostratigraphic and chronostratigraphic markers were easily integrated into this framework. Pueblo, Colorado, became the focal point of these works, and international teams of researchers visited this stratigraphic and fossiliferous mecca. Kauffman and his research teams collected a sample rock "library" across critical study intervals and sent samples to researchers in various parts of the world. Kauffman, Eicher and students from Colorado, and from countries throughout the world, published numerous papers on the paleontology, stratigraphy, sedimentology, geochemistry and tectonics of the Western Interior Seaway.

A second natural laboratory for testing theories on evolution and extinction lay in the Caribbean region, and Kauffman and students visited the islands of this archipelago during the winter months. Rudist bivalves were the focus of these investigations, as was the development of carbonate platforms in a tectonically active regime. A third laboratory was the Cenozoic nonmarine strata of Wyoming; another was the Mesozoic and Cenozoic of the west, and yet another, the Paleozoic strata and fossils of the Great Basin and Germany.

Funding from oil companies and national funding agencies supported these field-based research projects. Western Interior and Caribbean field excursions were set up by oil company personnel, and Kauffman and Eicher participated in and/or led these excursions.

The efforts of the research teams have not gone unnoticed by the geologic community. Erle Kauffman was awarded SEPM's R.C. Moore Medal for excellence in paleontology, and the 1998 Twenhofel Medal for excellence and sustained contributions in sedimentary geology. The students from these research teams moved on to positions in industry and academia; they continue to work on Mesozoic and Cenozoic projects and have branched out into new fields of research. Don Eicher retired from the program and the department in 1993. Erle Kauffman left the Department to accept a position at Indiana University in September, 1996.

Carl Kisslinger

I joined the Department of Geologic Sciences as a Professor in 1972, when I came to the University as the first appointed director of the Cooperative Institute for Research in Environmental Sciences (CIRES). I took over from Chris Harrison, who had served as the creator and acting director of CIRES from its founding in 1968. The department was the obvious academic home for me in the University in view of my teaching and research background and experience, in solid-earth geophysics, with emphasis on seismology, in exploration, nuclear test monitoring, and earthquake studies.

When I arrived, I felt that I had two tasks before me: in cooperation with NOAA, to build CIRES from the small but excellent institute that it was into an internationally recognized center for interdisciplinary earth science, and to work with colleagues in the department to broaden and strengthen the academic geophysics program. Chris Harrison and Ed Larson were the two geophysicists who had carried the load for a number of years.

With the quick additions of Max Wyss and Hartmut Spetzler through CIRES positions we were on our way. As the years passed, the department's offerings in geophysics, in the broad sense of that term, expanded greatly, as we developed strength in rock and mineral physics and chemistry, tectonophysics, hydrology, and remote sensing applied to geological problems. The Geophysics Ph.D. program, an interdepartmental program directly under the Graduate School with eight departments now participating, was conceived by Chris Harrison and approved shortly after the CIRES build-up in the discipline. This program has helped to bring together the capabilities in earth-oriented science that are scattered in two colleges, several departments, and research institutes on the CU-Boulder campus.

After 1985, my undergraduate teaching continued to be in the Dynamic Earth course for non-majors that Spetzler and I created soon after we arrived, and the senior-level Physics of the Solid Earth course that he and I had offered for physics and engineering majors, as well as our own undergraduates in the geophysics option. In addition, I took over half of the Geophysics and Tectonics course, with Ed Larson, when Wyss left the University. I enjoyed greatly this opportunity to teach a good-sized class of general geology majors for the first time. My graduate teaching continued to emphasize seismic wave theory and a range of specialized topics in advanced seismology.

My research during this time shifted strongly into investigations of the temporal and spatial distributions of earthquake aftershocks, with a long-term goal of better understanding of earthquake processes. This work was stimulated and influenced by the occurrence of the great earthquake of May, 1986, within our regional seismographic network in the Aleutian Islands (supported by the USGS). The hundreds of aftershocks we recorded simply had to be analyzed.

From the lessons learned in working with the Andreanof Islands earthquake, I turned to other problems, including the behavior of aftershocks of southern California earthquakes (I gave up my pledge to complete a career in seismology without working on California seismicity). With Lucy Jones of the USGS, I worked out the story for about three dozen sequences and offered the hypothesis that aftershock decay rate is strongly affected by the temperature at the depths of the hypocenters. A follow-up of this idea was carried out by Fred Creamer, who got his Ph.D. with me for completing a study of Japanese sequences. The conclusion of that study was that there seems to be a transition temperature, close to that for the brittle-ductile transition in common rock forming minerals, above which the temperature is the governing parameter for decay rate.

During all of this aftershock work, together with Susanna Gross, I began to explore alternate mathematical forms to model the rate of decay. I have proposed that the stretched exponential function (Williams-Watts relaxation) is a plausible form in place of the long-accepted modified Omori relation. Other groups are now testing this idea. My most recent aftershock study, carried out via email with a collaborator in Japan, looks at the possibility that a strong earthquake can kick off aftershocks in an adjacent tectonic block in which essentially no slip occurs in the main shock. This result casts doubt of the use of the aftershock distribution alone as a measure of the rupture surface of the mainshock.

In 1992, I was asked to be chair of the Panel on Seismic Hazard Evaluation of the Committee on Seismology, National Research Council / National Academy of Sciences. This was to be a one-year job that ended up taking four. The assignment got me deeply into the highly charged area of estimation of earthquake hazards at the sites of critical facilities, especially nuclear power plants. The end product of the panel work was a report, published in early 1997, reviewing in detail a massive report, done for the Nuclear Regulatory Commission, on the methodology for doing probabilistic seismic hazard analysis. During this time, Mike Kozuch completed his Ph.D. thesis on earthquake hazard analysis for Venezuela.

Meanwhile, I took over again as CIRES director on an interim basis from June, 1993, until my retirement on September 1, 1994. This was an unexpected interruption of my intended glide toward a gentle retirement landing, but it all worked out well, mostly due to the excellent condition in which I found CIRES management at the end of Bob Siever's term as director

Since retirement I have stayed active on a number of projects. I have been an associate editor of the Journal of Geophysical Research for a number of years, a great way to stay in touch with some of the good work in my field going on out there. I have also served on some university committees, as a pay-back for the excellent support in CIRES I continue to enjoy. I chaired the re-organized Chancellor's Committee on Conflict of Interest and Commitment (talk about a highly charged area) for one year and continue to be a member. I also represent the Boulder campus on the Executive Committee for the system-wide graduate school. Finally, I try to help out as a member of the advisory committee for the Natural Hazards Research and Information Center. I do all of this stuff before noon, Monday through Friday, and get back to being a retired faculty member at lunch time. As the movie said, it's a wonderful life.

Mark Meier

I joined the University of Colorado, as Professor of Geological Sciences and Director of INSTAAR, at the end of 1985, at about the same time Larry Warner was finishing his book. In 1994 I stepped down as Director of INSTAAR and shortly thereafter reduced my faculty appointment to half time; at the end of the 1996-97 academic year my formal teaching commitments will be over. But am I retired? Grant money through the University of Colorado (which pays part of my salary) is assured for several years, and it will take that long for my current graduate students to finish. So I am not totally gone, yet.

Before coming to CU, I had served on a number of Academy panels, and came to realize that a major sea change in the earth sciences was going to happen. The classical and restricted view of geology subject matter was, and still is, recognized as essential. But new and exciting interdisciplinary opportunities and practical earth-sciences topics broader than the conventional fields were attracting new interest. One of the first initiatives I took at CU was to begin a one year course for non science majors on the interdisciplinary subject of global change. Now this broad area has been enthusiastically embraced by the department, with a significant fraction of student-credit hours and faculty involved. I also worked, but much less successfully, in trying to awaken and unite a university-wide interest in the subject of hydrology. CU has considerable strength in this broad field in several of its departments and institutes, and I am still hoping that this department will take the lead in catalyzing a program of national significance in this very important subject of our times.

In my short years with the department, I have seen considerable growth in its national standing as well as in its breadth of interests. This has been aided by the growth of research grant funding obtained by faculty affiliated with the department and with an institute (INSTAAR, CIRES, LASP). And this rise in research productivity has occurred, in part, because we have been able to attract productive new faculty. This is, of course, a positive feedback process, and I hope that the feedback continues!

From my perspective, we are on the right track.

Gifford H. Miller

Following a dozen years as a full-time research scientist supporting my activities on federal grants through INSTAAR here at CU-Boulder, I joined the faculty in Geological Sciences in 1986. Those early years included a two-year post-doctoral fellowship with Ed Hare at the Geophysical Laboratory, Carnegie Institution of Washington (1974-1976) and a year's visiting professorship with Jan Mangerud at the University of Bergen, Norway (1979-1980). My original research programs focussed on the Quaternary history and glacial geology of the Arctic, originally focussing on the Eastern Canadian Arctic where I continue to work jointly with John Andrews, but subsequently expanding into Svalbard in the Norwegian Arctic, followed by field studies on Franz Josef Land and Novaya Zemlya in the Russian Arctic. As part of this research it became apparent that the science lacked adequate dating methods, and I developed a laboratory to utilize systematic diagenetic chemical alterations of protein amino acids in carbonate fossils as a means of providing additional age control for key sites. And with this tool, came additional field opportunities that took me to NW Europe, the Mediterranean basin, the hyperarid Sahara and eventually to Australia.

As my field program expanded from a narrow focus on the Arctic to more global issues, I became interested in the operation of the Earth's climate system. Toward this end, I am specifically interested in recent Earth history as a tool to reconstruct the coupled ocean/atmosphere/ice climate system. By reconstructing past environmental changes it is possible to get a better understanding of the rates and magnitude of natural climate variability, and the various feedback mechanisms in the climate system. The reconstruction of changes in the recent past is based on materials preserved in the geologic record (ice cores, peat bogs, lake sediments, etc.). To reconstruct the entire climate system, local records must be placed in a global perspective; this requires an independent time frame for each site. The need for improved methods of dating these deposits fueled my interest in geochronology, and led to the creation in 1986 of the Center for Geochronological Research, which I continue to direct. My current research projects include 1) the timing and mechanism of ice-sheet growth and decay in Arctic Canada and the European Arctic, and the interactions between ice sheets, oceans, and the atmosphere during the last deglaciation, 2) developing new or improved applications of protein diagenesis in carbonate fossils to date geological and archaeological events, 3) the climate-forcing of wet/dry cycles in monsoonal Australia, the earliest immigration of humans to the continent, and their impact on climate and megafauna extinction, and 4) providing high-resolution records of Quaternary environmental change for the Arctic, based on proxy evidence preserved in lake sediments.

My teaching activities reflect my scholarly interests. I have been instrumental in developing the Department's undergraduate course in Global Change, and I teach graduate courses in the broad area of Quaternary science. As Chair of Geological Sciences since 1993, I have been emersed in the design and construction of our new building, as well as the usual other administrative obligations. I look forward to a sabbatical next year when I hope to begin a major new field project in NW Australia as well as lake coring field campaigns on Greenland and Baffin Island.

Karl Mueller

Karl Mueller is a structural geologist who joined the department in the fall of 1995. Karl earned B.S (1982) and M.Sc. (1984) degrees from San Diego State University where he worked on the evolution of active fault systems and alluvial sedimentation in northern Baja California. He then went to work for ARCO Exploration Company for three years in Dallas, Texas evaluating Eocene trends in the Gulf Coast. Following that, he completed a Ph.D. (1992) at the University of Wyoming, while mapping highly extended regions of northeast Nevada and age dating Tertiary deposits. Upon completion of his doctorate, Karl taught for a year at the University of Montana, Missoula as a visiting assistant professor. He then moved to Princeton University for two years where he was a postdoctoral research associate with John Suppe's structural geology group.

Since arriving at CU, Karl has developed an externally funded research program and computer laboratory for structural geology and active tectonics research. His research group consists of graduate students interested in combining structural geology, tectonic geomorphology and seismology to better understand growth of active folds in transpressive tectonic environments. His early projects were located in the Los Angeles Basin, southern San Joaquin Valley and in the New Madrid Seismic Zone. This work is aimed at defining slip rates, styles of near surface folding and seismic hazard above active blind thrusts. Funding for the projects includes grants from NSF, NEHRP, NASA and SCEC.

Karl teaches undergraduate classes in structural geology, structural field mapping and historical geology. At the graduate level he teaches a course in neotectonics and earthquake geology. His academic and industry background provides an ideal perspective for training students for both applied and theoretical work in the geotechnical and petroleum industries.

Kathryn L. Nagy

Kathy Nagy is the most recent addition to the faculty. Her appointment as Associate Professor in aqueous geochemistry began in the Fall of 1997. She brings a variety of practical experiences to her new teaching job. Starting with an undergraduate degree at the University of Delaware where she performed a senior thesis investigating trace Pb and hydrocarbons in salt marsh sediment resulting from fossil fuel use, she then traveled to Rhode Island and pursued a masters degree at Brown studying oxygen isotopic exchange in hydrothermal systems. Her Ph.D. was acquired at Texas A&M University in the subject of the thermodynamics of calcite/brine interactions, after which she traveled back to the northeast and held a post-doctoral position at Yale. There she discovered clay minerals and carried out experimental and theoretical studies of their rates of dissolution and growth in aqueous solutions. In the "real" world her first position was at Exxon Production Research Company in Houston where she continued work on mineral/solution reaction kinetics, but also investigated clay reactions using a new tool called an atomic force microscope. This type of microscope can image the morphology of small mineral particles and even the atomic-scale topography of mineral surfaces. Surface reactions can be monitored in real time while the mineral is immersed in solutions. Given her great interest in microscopic topography, it is easy to understand why she moved to New Mexico to work at Sandia National Laboratories. After a day on the microscope, the macroscopic topography of the Sandia Mountains was indistinguishable from the microtopography of dissolving micas, proving that weathering features at the Earth's surface are truly fractal. However, over time she came to realize that there was even better topography for visual imaging, hence her (final) move to Boulder.

Kathy will be teaching aqueous geochemistry, senior paper, and undergraduate geochemistry among other courses. She looks forward to continuing her work with students and post-docs on mineral/solution interactions with applications to environmental remediation, weathering and soil formation, petroleum exploration and production, and materials science.

Peter Robinson

The first Vertebrate Paleontologist in the CU Geological Sciences Department was John Clark who was here from 1936-1938. He was followed by Robert Wilson, 1938-1946 and Harold Koerner 1946-1971. All of these men specialized in fossil mammals of the Tertiary.

Peter Robinson was hired by the Museum in 1961, and Judith Harris was hired by the Museum in 1972. Both have graduate appointments in the department. (She retired in 1995). Robinson's research interests are also in Tertiary fossil mammals and Harris' in paleoecology and fossil fish.

The first student to be interested in VP at CU was George Gaylord Simpson, who was an undergraduate here for two years in the early twenties before transferring to Yale. The first masters students were Wallace Stegner and Ray Alf (1938). Alf became a high school science teacher at the Webb School in California and sent many students to college with a determination to become paleontologists. In 1996 he received the Morris F. Skinner prize of the Society of Vertebrate Paleontology for his contributions to educating paleontologists.

Another early masters student was Don Baird (1947) who eventually became a faculty member at Princeton. The first Ph.D. in the Department was Nikos Solounias (1979), now head of the anatomy department at the New York College of Medicine in Old Westbury, NY (Believe it or not, many medical schools get their anatomy taught by bonediggers as the M.D.s do not want to teach it.) Other Ph.D.s have been Allen Kihm (1984) who has just finished a stint as department head at North Dakota State at Minot., Logan Ivy (1994) currently working at the Denver Museum of Natural History along with Ken Carpenter (1996), and Peter de Toledo (1996), head of the Ecology Section of the Museum Goeldi, Belem, Brazil.

Mark Rowan

Mark Rowan was appointed to the faculty as an Assistant Research Professor in structural geology in 1996, but his history in the department goes back a decade to when Larry Warner wrote his profile of the department in 1986. He has had a slightly unique perspective of the department during that time, starting out as a graduate student and passing through several evolutionary stages to end up as a faculty member. He usually manages to convince himself that it's an example of evolutionary progression rather than regression.

Mark came to the department in 1986 from an early career in petroleum exploration and structural consulting. He worked towards his doctorate under the supervision of Roy Kligfield, studying the geometry, kinematics, and strain partitioning of folds in the Helvetic Nappes of Switzerland. Having the opportunity to spend two summers tramping around beneath the Eiger and the Jungfrau had nothing to do with his decision to work with Roy, of course. It was hard, though, to keep his eyes on the rocks underfoot. Luckily, the bratwursts and beer found at many mountain passes made up for the hardships of doing fieldwork in the Swiss Alps.

In 1989, Mark took the opportunity to move to Glasgow, Scotland, to work with Alastair Beach Associates as a consultant in structural geology (he completed his dissertation from afar and received his degree in 1991). While in Scotland, he worked on a variety of projects for the petroleum industry. Most were centered on the North Sea and offshore Norway, but others involved data from the Canadian Rockies, the Upper Magdalena Valley of Colombia, the Spanish Pyrenees, the Romanian Carpathians, and the Witwatersrand Basin of South Africa. Much of this was seismic- or computer-based structural analysis, which was probably a good thing since there was a real danger of growing webbed toes doing fieldwork in Scotland. There was, however, some field work in Egypt along both sides of the Gulf of Suez.

In 1992, Mark returned to CU as a research associate in the EMARC program established by Paul Weimer and Roy Kligfield. Roy was leaving the department and Paul needed someone to take care of the structural aspects of the Gulf of Mexico research project. After years of thinking that fold-and-thrust belts and rift basins were complex, Mark discovered that salt tectonics made the others look simple and proceeded to scramble his brain trying to visualize salt evolution in 3-D. Luckily, he was just in time to take advantage of, and become a part of, a real revolution in understanding salt-related deformation. The success of the initial four-year industrial consortium opened the doors to many new opportunities, including consulting, teaching short courses for industry, joining the faculty, and initiating a research program in the Eastern Cordillera of Colombia. More importantly, it led directly to a new, three-year consortium on salt tectonics that started up in the past year and is funded by over 22 oil companies (Paul Weimer and Bruce Trudgill, a research associate, are also involved). Trying to run this consortium and the Colombian project, teach classes, advise students, and actually carry out some research has left him gasping for air, especially given the associated decrease in physical exercise, but he seems to love it and keeps on (over) committing himself to new endeavors.

Part of what keeps Mark going is his impression that his decade in the department has been an evolutionary progression. However, in observing the department from his many vantage points (graduate student, post-doc, and faculty), he has come to agree with the assessment of the true department power structure cited by Larry Warner in his book. Thus, his secret desire is to evolve ultimately into the department secretary.

Don Runnells

Don joined the Department in1969, beginning his career at CU by co-teaching a summer course in petrology with Jim Munoz. Don came from the Department of Geology at the University of California, Santa Barbara, where he had taught for two years. Prior to that, he spent four years in geochemical research with Shell Development Company in Houston, Texas and Coral Gables, Florida.

Don's starting salary at CU (with a Ph.D. from Harvard and 6 years of experience) was $12,000 per year; he obviously wanted to teach at Colorado pretty badly. He taught economic geology for several years, but gradually built a program in low-temperature geochemistry and withdrew from teaching and research in economic geology. Don then chaired the search committee that hired Bill Atkinson to teach economic geology. Some of the best memories Don has from his years at CU are the students on the numerous field trips that he led to ore deposits throughout the western U.S., including one night with 20 people in one motel room in the Black Hills during a springtime blizzard. Another great memory from those ore-deposit field trips was the time Don tried to sleep under a table at a highway rest stop in New Mexico during a spring downpour, and being awakened during the night by a stranger who was trying to push Don out from under the table so that he could also crawl in to get some sleep.

Don retired from CU at the end of 1993, after nearly 25 years of service. During those years at CU he went through the ranks, from Assistant Professor to Professor, and finally to Chair of the Department. He directed and supported 49 graduate students to successful completion of their Master's and Ph.D. degrees. For at least 20 years he taught introductory geology for non-majors, including classes as large as 600 students (in the old Flatirons Theater on the Hill). During that time he wrote a popular guidebook on the history, architecture, and geology of the Boulder area, entitled "Boulder - A Sight to Behold," which was sold throughout the area for many years. He was nominated twice for the Outstanding Professor award, and he published about 75 technical papers in geochemistry, mineralogy, and ore deposits. He even enjoyed playing Santa Claus at the Departmental Christmas parties.

The most vivid memories Don has of the changes in the Department relate to two main things: (1) the change in emphasis from classical geology to laboratory and theoretical geology, and (2) a shift in emphasis from the Department as the center of research and teaching activity to an emphasis on research and teaching within the research institutes. Those changes reflect similar changes in the earth sciences in universities throughout the United States, as well as the changing job market and the need for greater specialization by graduate students. As a small example of that transition, Don was one of the first people in the Department to acquire a microcomputer for his office; the brand was a Cromemco (long since gone), with 64K of memory and a 10 megabyte hard disk that cost a mere $6995.

Included in the good memories that Don has of the Department is the collegiality that was enjoyed among the faculty and graduate students. It was a good place to work, and it was fun to be part of a dynamic, friendly, constructive group of people. In particular Don remembers the warmth and good humor of his fellow professors and the support staff within the Department. Don always considered his primary professorial mentors to be the great gentlemen of Larry Warner, Bruce Curtis, Bill Bradley, and Don Eicher.

Like several Chairs before and after him, Don worked hard with the University staff and with alumni to raise money and other support for the new building, and it will be a pleasure for him to watch the move of the Department into that new facility. The new building will represent the completion of the transition of the Department from classical geology to laboratory and theoretical earth sciences but, hopefully, retaining its deep roots in the "reality-check" of field geology.

After retiring from the University, Don went to work for a private engineering and environmental consulting firm in Fort Collins. In his new career he has successfully built a large business unit within the company, specializing in geochemical and hydrological services for the mining industry.

Don left the University with good feelings, good memories, and happy thoughts. It was a fine way to spend nearly 25 years, and Don is grateful for having had the wonderful opportunity to work at the University of Colorado.

Anne Sheehan

Anne F. Sheehan (B.S., 1984, University of Kansas; Ph.D., 1991, Massachusetts Institute of Technology) joined the faculty in the Fall of 1993, following postdoctoral work at the Lamont-Doherty Geological Observatory and a Research Seismologist position at the University of Nevada, Reno.

Since joining the faculty in Boulder, Anne has taught courses in both introductory and advanced geophysics, including seismology, geodynamics, and geophysical inverse theory. Anne has developed a course in Field Geophysics and has greatly enhanced the teaching pool of geophysical instrumentation through purchases funded in part by an NSF Undergraduate Instrumentation and Laboratory Improvement Grant. Sheehan has a strong commitment to undergraduate research, and has involved many undergraduates in her research, resulting in undergraduate authorship on professional meeting presentations and publications, independent study theses, and senior honors theses.

Sheehan's major research interests are in earthquake seismology, geophysics, and crust and mantle structure. Specific areas in which she has contributed include the scale and mechanism of lateral heterogeneity in the oceanic upper mantle, seismological field studies of continental lithospheric structure and evolution, high resolution imaging of deep mantle discontinuities, and seismic source and network studies. A new research area in which Sheehan is beginning to work is in geophysical exploration of the shallow subsurface, largely as a result of her involvement with the geophysics field course.

Sheehan has served on many national and international committees, including the International Ocean Drilling Program Lithospheric Panel, the U.S. Seafloor Observatory Program and Ocean Seismic Network Program, and the Incorporated Research Institutions for Seismology Global Seismic Network Standing Committee. In 1996 Sheehan was honored with an NSF CAREER Award, which includes a four-year grant for her research and teaching activities.

Joseph Smyth

Joseph R. Smyth is a mineralogist and crystallographer with wide interests in the physics and chemistry of the Earth's interior. He was educated at Virginia Polytechnic Institute earning a B.S.(1966)in Geology, and at the University of Chicago, earning S.M. (1968) and Ph.D. (1970) degrees in Geophysical Sciences under direction of Joseph V. Smith. At Chicago he was introduced to the delights of pyroxene crystal chemistry and developed new methods for high temperature crystallographic studies. He pursued his interest in pyroxenes as Research Fellow in Geology with Charles W. Burnham at Harvard University (1970-72). As staff member at the Lunar Science Institute (now Lunar and Planetary Institute) (1972-1976) he worked on application of crystallographic methods to the study of lunar and meteorite samples. Concurrently, he was Senior Lecturer at University of Cape Town (1975) and Wissenschaftlisch Mitarbeiter at Phillips-Univeritaet, Marburg, Germany (1976). At Cape Town he found that crystallographic methods could yield new insights into high pressure rocks from the mantle and discovered and described the first coesite-bearing mantle assemblages.

In 1976 he joined Los Alamos National Laboratory as staff member in Geosciences Division. At Los Alamos he worked on geothermal energy, zeolite assemblages and stabilities at the Yucca Mountain radioactive waste site. He joined the faculty at the University of Colorado, Boulder in 1983. At Colorado, he operates the Mineral Structures Laboratory with facilities for high and low temperature and high pressure crystallographic studies. He was Japan Society for the Promotion of Science Fellow at the University of Tokyo in 1991 and visiting Faculty at California Institute of Technology in 1996. At Los Alamos and at Colorado his theoretical work on mineral structures led to a precise method for prediction of oxygen isotope fractionation between mineral phases. Current research interests center on the crystal chemistry of volatile-bearing phases at high pressures. He is the author of more than 100 refereed publications on mineralogy, crystal chemistry, and petrology.

The Mineral Structures Laboratory at CU is one of three labs in the US equipped for high pressure single crystal X-ray diffraction studies of minerals. These studies yield information on the equation of state of minerals (pressure-temperature-volume relation and seismic velocity) that may compose the mantle of the earth. Current work focuses on volatile-bearing phases at pressure. Recently, two new structures were discovered in the laboratory at CU that can contain up to ten ocean volumes of water in the transition zone (400-670km depth) incorporated in solid silicate phases. This raises the possibility that the volume of liquid water on the surface is buffered by a large reservoir in the interior.

Hartmut Spetzler

After nearly a quarter of a century at CU, it is a good time to look back over my checkered career. The curiosity, which led to my becoming a scientist, is probably rooted in what now seem strange circumstances. When I was about six years old, at the end of the Second World War, our family left a little village where we had been living during the war years and returned to my hometown, Nuremberg, Germany. There, as the oldest of what were to become 6 siblings, I benefited from understanding parents and the incredible riches of a play ground made up of bombed out houses and factories. Somehow my parents (we were lucky, my father returned from the war) managed to provide well for us and my memories are mostly of good times and building things from the magnificent supply of ruble. Add to this the America House, where I took advantage of the opportunities provided and built a kayak out of old skis, wooden slats and an old army tent, and my further path becomes more understandable, to me at least. My lack of understanding physics and my love of the outdoors derailed my science career for some time. At age 7 I was racing my little green bicycle quite successfully against boys twice my age. (small bicycle, close to ground, easy cornering) They were almost as impressed as I was and invited me on their graduation trip from grade school. We visited a monastery with a museum depicting wildlife and missionaries in Africa. I was so moved and on the spot decided to become a missionary. Before age ten I had persuaded my parents of my calling and was allowed to enter the Monastery, just to run away 15 months later. At age 13 when I had finished grade school, I wanted to become a forester, taking care of wildlife and forests. There were too many students with the same ideas for the number of trees in Germany, so I chose to follow my love for creating things and became an instrument and watchmaker instead. Upon completing the 3-years of schooling, I came to the US, soon entered high school, and worked part time at my trade. High school was hard since I had not learned English yet. After my high school graduation I went to a junior college with the intent of becoming an engineer. I ran out of money after one year and, with the draft looming, joined the US Airforce; a 4 year stint. While in the service, I was trained as an electronics technician, took courses from three universities simultaneously, and graduated with bachelors and masters degrees in mathematics from Trinity University in San Antonio, Texas. It was during this rather busy time that Ria and I met and got married. After working for a year as a physicist in Pasadena, California, I became a graduate student in Physics at the California Institute of Technology. After one year, being disillusioned with the prospects of chasing single particles at big accelerators, I finally found geology (masters) and geophysics and planetary science (Ph.D.). After working five years at Sandia Laboratories in Livermore, California, I found my way back to academic life. I greatly enjoy teaching at all levels, whether it be the challenge of fascinating the non-science majors and instilling some curiosity about our world in them, or being challenged by our bright undergraduate or graduate students. Ivan Getting, a close colleague since 1976 in the Cooperative Institute for Environmental Sciences and I have worked with post-docs, graduate and undergraduate students in developing new instrumentation and making measurements on Earth materials to better understand the composition and dynamics of Earth's interior. In one of our research projects we have recently received some very exciting data on rocks with partial fluid saturation. It appears that trace amounts of chemicals in the fluids can substantially alter the physical properties of these rocks. Chemical reactions especially on the crack surfaces within the rock are altering the physical behavior of the fluids within the rock. We are exploring these findings with a view toward the possible remote detection of contaminants in ground water and toward a better understanding of seismic signals from regions where water, gas and oil coexist below ground.

During the last quarter of a century, I have been able to observe many changes in our department. It has changed from a rather small very congenial group of teacher/scholars and their students, to a larger more diverse group of teacher/research-scientists and their students. While I generally believe that this transition was beneficial and necessary for survival, I lament the loss of intimacy which existed when we were smaller. Thus is the price of growth. I was privileged to serve as chair during the mid eighties and to some extent was responsible for those changes. During this time the first issue of Larry Warner's book came out, the Advisory Board was started and two giants, Ted Walker and Bill Bradley retired. The reader will find a contribution from Bill else where in this book, but Ted and his wife, Barbara, are too busy skiing, bicycling all over the world and just being retired. Rumor has it that Ted is doing research on Red Beds at home, for the pure joy of it. He has no intention of publishing the results; a true gentleman scholar.

Early in 1988 my family and I had to make a tough decision. I had received a near irresistible offer for a position at the Bavarian Research Institute for Experimental Geophysics and Geochemistry in Bayreuth, Germany. It was a dream job in many respects; many well-funded research opportunities with lots of gadgets and a little teaching at the graduate level. By declining the offer I was prompted to make a new commitment to CU. It was almost like starting new in mid career. Ivan Getting and I initiated new research projects and I developed several new courses. My relationship with the German institute remained very good and I spent the larger part of my last sabbatical there, the financing being part of an Alexander von Humboldt Senior Research Prize.

I have just taken on the task of advising our first and second year undergraduates and find it very fulfilling. I welcome the opportunity to use my long experience in academia in mentoring some of our junior faculty members and advising students. With retirement looming in the not all too distant future, I have the luxury of giving these activities the highest priority while my research continues. It is a wonderful phase of my professional life at a University.

James W.C. White

My teaching interests at the undergraduate level focus on Global Change and general geosciences. I have a continuing and strong commitment to undergraduate education in this area. I teach the second semester of a large lecture class, Global Change: an Earth Science Perspective (GEOL 1070). This course deals primarily with global biogeochemical cycles (water, carbon, nitrogen, sulfur and oxygen) and is populated primarily with non-science majors. I also supervise a companion lab to this course, GEOL 1110, that gives hands-on instruction on such subjects as water usage and the hydrologic cycle. Mathematical and graphing skills are stressed. In addition, I teach a large upper level undergraduate course, GEOL 3520, Environmental Issues. This course deals mainly with energy, the carbon cycle and future climate change. At the graduate level, I teach courses in Global Change Literature, in which the basic papers in the relatively new but growing area of research into human impacts on the Earth are discussed, as well as my research specialty, stable isotope geochemistry and biogeochemistry.

My research interests are broad, but all revolve around the use of environmental stable isotope ratios. I operate and maintain a laboratory for the analysis of stable isotope ratios of carbon, hydrogen, nitrogen, oxygen and sulfur. The lab contains five mass spectrometers and several automated and computer operated sample preparation systems. Numerous other graduate students and faculty use the facility. Research funds coming into the lab, in the form of grants, contracts and sample charges for myself and other researchers primarily using the lab, totaled about one million dollars in 1996. My specific areas of research interest include: modeling the global carbon cycle using isotope ratios in atmospheric CO_2; development of techniques for measuring isotope ratios in atmospheric gases; reconstructions of paleoenvironmental conditions using isotopes in ice cores; reconstructions of past climate and carbon dioxide levels from isotopes in peats, and tracing of ground water flow and recharge. These research programs produce exciting and newsworthy results. Recently, we have found new evidence that major climate changes in the past have occurred in discreet steps of 5 degrees C or more, with each step often lasting only a few years. Also, evidence from isotopes in atmospheric CO_2 has shown the existence of a large sink, or removal mechanism, for CO_2, located somewhere in the terrestrial biota of the temperate Northern Hemisphere. This means that some process such as forest regrowth in North America, or warmer spring temperatures in Russia, or perhaps shallower tilling in farmlands in the US, is having a large, positive effect in removing excess CO_2 produced by fossil fuel burning.

I am also the Director of the Environmental Studies Program in the College of Arts and Sciences. This is a large (>500 majors) interdisciplinary program granting a Bachelor's degree. As the sole faculty member responsible for this Program, my duties include overseeing the day to day operation of the major, advising students, chairing committees for Honors students, overseeing the Internship Program, which places 20 to 30 students per semester in companies in the Boulder/Denver area for job experience in environmental fields, revising the curriculum, and meeting regularly with the undergraduate majors to ensure that the program is meeting the needs of the students. Recently, I have also been active in establishing an interdisciplinary environmental teaching program at CU-Boulder, with the goal of putting our teaching efforts on the same level as our research efforts in this important new field.

Max Wyss

A Tale of Mistaken Identity

Passengers emerge from Gate 24. The flight from Los Angeles to Denver carries skiers headed for the mountains, business travelers, and families returning from vacations. I'm looking for a Japanese scientist, fortyish with glasses, who will do research in my lab for a few months. I have met him before. Once, in Japan, and in a group of other Japanese. When he wrote that he had received an award for senior scientists to conduct research abroad and wanted to come, I was not quite sure which one he was. The many oriental faces I met were hard to distinguish. I know his published work, he's a well known expert in his field, but I don't know his person. To make sure I wouldn't miss him, I move up to the front of the waiting crowd. It's difficult to find a spot where I'm not blocking the view of a lady or a child looking down the gangway. There seem to be no Japanese on this flight. As the stream of disembarking travelers thins, I begin to wonder whether he missed the flight. Ah, finally, a Japanese man. Clearly not an American, but he does not look like the one I'm expecting. It's not him. Or could it be, after all? I really am uncertain what he looked like. Just to be sure not to make a mistake I ask:

"Are you Dr. Yoshida?"

"Huh?"

"Are you Dr. Yoshida?"

"Yes, yes." He bowed.

"I'm here to pick you up."

"Ooh, is that so? Thank you very much."

"Okay, let's get your bags."

As we walk down to the carousel I discover that it's difficult to have a conversation with my visitor. His English is poor. But of course my Japanese is non-existent, so I won't complain. It's just painful to do an entire charade to find out how his trip went, whether he had a good view of the mountains, and what the weather is like in Tokyo this time of year. My visitor has a boney head with a round face. I imagine Koreans look like that. But what do I know about oriental faces? I can't tell a Japanese from a Chinese, except by their clothes and mannerisms, perhaps. My visitor is wearing a gray suit with a conservative blue tie. The heels of his black leather shoes drag a bit on the floor. They have no laces, so he can get them on and off quickly, as required when entering computer labs or restaurants in Japan. My guest grabs a suitcase and we head for the parking area.

"Excuse me, may I have my suitcase." The irritation in the blond skier's voice is thinly veiled as he steps up behind us and reaches for his suitcase. My guest is perplexed. He looks at the label below the handle, and as the suitcase is pulled from his grip he realizes his mistake.

"Sorry, so sorry."

"It was a long trip," I explain. "So many suitcases look alike." We manage to laugh and wish the rightful owner a good day. My guest digs his luggage stub out of his carry-on bag. After his suitcase finally emerges from the guts of the airport, we lug it to my wife's Beetle convertible. She let me have it to pick up the illustrious guest, instead of using my beat up heap. He drags his heavy suitcase along the crosswalk, and in the middle of the thick airport traffic spills the contents of his carry-on bag. He had left it open after the hunt for the tag. I help him pick up his stuff. The suitcase is so large that the famous scientist almost dismantles the passenger seat trying to put it in the back.

"Please allow me to help you. I know this car."

Soon we are on the road leading out of the city in the direction of Boulder. The pressure to conduct a conversation is off. The fresh spring air tugs at my hair. The sunglasses dampen the intensity of the glare. Skiing is still good. We're getting closer to the snow capped mountains.

"Lovely day, isn't it?" I try to play my role as a host.

"Yes. Huh?"

"Beautiful weather. Sun. Nice." Pointing to the blue sky with it's puffy clouds I try to explain my words.

"Yes."

He seems to have trouble with his seat belt. He still hasn't succeeded in fastening it. I reach over with my right hand and buckle him in. I sure don't want to end up with an injured guest of honor.

"Do you ski?" Stupid of me to try more conversation. Since his face looks puzzled I repeat: "Do you ski? Snow, mountains."

I have my free hand do a slalom down from the rag top to the stick shift. My other hand has to come off the steering wheel and my whole body has to get into the slalom. It's a bit difficult to convey the notion of speed, strapped into a seat behind the wheel. Without noticing, I step on the gas to get the idea of speed across. The needle climbs past the seventy mark. To no avail. Or, yes, perhaps after all he understands. It's hard to tell, but he certainly has a good time. He grins from ear to ear, then abandons himself to a gale of laughter. He has to hold on to something to steady himself. He reaches up to a white lever. Laughing he leans back into the seat, and then doubles over, pulling it down. Oh, no! "Dr. ...!" The rag top flies open before I can do anything about it. My hand reaches for the top that has disappeared from above my head, my foot hits the break, the other hand steadies the wheel. I manage to regain control of the car with its sail up, and bring it to a halt on the highway shoulder.

"Wow, Dr. Yoshida, that was a close call."

His bewildered face said as much.

"See, that's not a handle for passengers. It's the roof lever." I explain as I pull down the roof and try to fasten it again. "This piece here should not be touched while driving." It seems the roof isn't damaged. Luckily. My wife would be most displeased if something happened to her beloved Super-Beetle.

"Sorry, so sorry."

"It's okay, it's okay." We pull back onto the highway. Observing the speed limit now. "No damage done, we were lucky."

We're both a bit embarrassed. No more conversation for the time being. He tries to get comfortable in his seat. His right hand searches for a resting place. Without thinking, like others would scratch their head, he reaches for something to grip. "Dr. Yoshida, please. That's not a handle." This time I'm quicker. For the rest of the trip I will have to watch him. And I do. I also watch the mountain peaks. Instead of spending half a day picking my famous visitor up at the airport, I might have enjoyed the slopes. I probably would have encountered quite a few students cutting class. I spend all my time in my lab. My wife is right. I'm a fool. Perhaps I could still ski this afternoon. My guest must be tired. He will need to rest in the hotel. Yes, I think I will do it. I will spend all weekend at the lab anyway. That will more than make up for an afternoon spent on the slope.

"This is Boulder. The university is over there. Those large buildings."

"Yes, yes." He nods. His enthusiasm is back. He smiles. We're both happy we have arrived without another incident. I pull up to the hotel entrance. Before I can get his suitcase out of the back seat I have to unfasten his seat belt. Somehow his thumb and forefinger got stuck down there. We get them out too. I wrestle the heavy suitcase from the back seat.

"Are you tired? Do you wish to rest?" I hope he will say yes, so I can go skiing.

"Yes, I rest now. Please wait."

Instead of checking in, he opens his great suitcase right there in the lobby. A few items spill out. His hand hunts through his underwear, then through his shirts on the other side. What is he looking for? He lifts some books and folders, and from underneath he brings out a small package which he offers me with both hands and a beaming face.

"Thank you very much for airport pick-up."

"Oh, thank you." I'm a little embarrassed by the gift. Of course I would pick up my honored guest. "May I unwrap it?"

"Yes, please."

I take off the colorful wrapping paper and open the little box. A wooden cow with a bobbing head emerges. Before I have time to look too puzzled he explains. "This animal called 'Ushida.' My name 'Ushida'." He points to the writing on the belly of the cow, and is very pleased to have a calling card in the form of a knickknack that will go on the mantle piece of the driver who picked him up.

My jaw drops: "Your name is Ushida, not Yoshida?!"

"Yes, I am here for IBM conference." Seeing my bewildered look, he explains: "Computer. IBM. Ushida from Tokyo."

Thunderstruck, I grab his hand: "Good luck to you Dr. Ushida, good luck." I rush over to the telephone booth and dial my home number. One ring and the phone is picked up.

"Is it you?" she asks.

"Yes."

"Where have you been? Your important guest from Tokyo is at the airport."

"Oh Gosh, I just delivered the wrong Japanese to the hotel." Her silver laughter rings in my ears as the mountains get smaller and smaller in the rear view mirror on my way back to the airport.

A Recollection

by Don Eicher

As the Department prepares to move to an elegant new building with a hand-wave to the old one, I recall with some fondness the days when the old one was greatly enlarged and renewed for, as it turned out, the last half of the twentieth century. As a new undergraduate transfer student in 1952, I first laid eyes on the Geology Building. Warren Thompson was Department Chairman, and the members of the faculty were in good spirits. Their building was in the final throes of a massive upgrade, supported by gifts from alums and friends, complemented by funding from the state. Modern laboratories and offices had just been added in an entirely new east wing, and a large new lecture hall was being completed on the west. The middle, original part of the building had received major renovation. As classes began in mid-September (they began at a civilized time in those days), workmen were feverishly installing sinks in labs, plastering walls, and doing finish work. The initial sessions of many classes were held in impromptu places, but the disarray seemed minor. There was a lot going on and enthusiasm was high. The students and the faculty in that Autumn of 1952 were reveling in their new facility and putting it to its first use.

The catalyst for the new east wing was a large gift from one alum, Mr. Ellis A. Hall, who met an untimely death before it was completed. His gift had encouraged others, and together their impressive support helped to convince the University and the state of Colorado of the merit of a renewed building.

The designs for the additions and renovations had been supervised by Waldo Brockway, who was in charge of buildings on campus. Waldo was a congenial, white-haired, old chap who would probably acknowledge in retrospect that he was responsible for many student's strained necks through the years because he had decided that architects were a waste of money and that the way to hold up a ceiling was to put a pillar in the middle of the room. As a result, the larger rooms got pillars. But never mind; all was new, the pillars were a minor item, and the newly-enlarged building had space to spare. Members of the Geography Department occupied the first floor offices of the new wing, and Zena Hunter, the lone female member of the faculty, had lobbied successfully for a ladies lounge on the first floor, separate from the ladies room, where co-eds could lie down when they felt faint.

Parking near the building in 1952 was hardly a problem. Anyone could use the new parking lot east of the building, at least for a time. Broadway, a two-lane street, was lined both sides with parking spaces. During the day cars filled most of these spaces and when Harrison ("the bird") Murray assigned a Brunton compass traverse as the first exercise in field geology, many of the designated stations were on the sidewalks near these cars, which introduced major errors in the Brunton compass readings.

I spent a wonderful, formative, three years, from 1952 to 1955, as a student in the Geology Building. Later, in 1958, I was honored to be invited to join the faculty and to teach geology under that roof which, by that time, covered only Geology faculty. As it turned out, the new and renewed facilities had been completed only a few years before wave upon wave of new technology swept through the geological sciences. The need for modern facilities grew, as did faculty and student numbers, and the Geology Building, although it received patching and enhancing through the years, became ever more inadequate.

The new Benson Earth Sciences Building is a dream come true and a significant endorsement of support from alums and friends, and from the University. Like the renewed building of 1952, its reality stems from the vigor and generosity of one key alum, Bruce Benson, who's family made a large gift and encouraged many others to help. Unlike the experience with the renewed building of 1952, Fall classes will not be held there amidst final plastering and tiling. Although occupation of the new building begins in the Fall, the first classes there will be taught in the Spring of 1998. From a personal perspective, this timing is a stroke of good fortune because the Spring of 1998 is scheduled to be my last semester of teaching, and I get to do it in the new building. What an attractive prospect it is to close a 46-year circle and to be part of the group that puts the new Benson Earth Sciences Building to its first use.