CU Geology NEWS Spring 1989

FROM THE DEPARTMENT OF GEOLOGICAL SCIENCES, UNIVERSITY OF COLORADO AT BOULDER

THE STATE OF THE DEPARTMENT

The Department continues to grow and flourish at a time when many have written of the decline of "geology" as a discipline. This perception is, of course, related to the current status of the petroleum and mining industries in the United States. However, other branches of geology are flourishing, most notably hydrogeology and engineering-environmental geology. The geological sciences are also key players in several major national and international endeavors, including such important societal issues as acid rain, toxic-waste disposal, oceanography, and global change.

John Andrews, Departmental Chair

Last year we hired two new faculty members through our association with research institutes on campus. Together with INSTAAR we hired Jim White (PhD, Columbia) to establish a light isotope laboratory on the East Campus. Jim is involved in teaching a 1000-level course on Global Change, and will teach a 3000-level course in environmental problems, plus a 5000-level course in light stable isotopes. As of the time of writing we believe that the Center for Geochronology and Jim have raised sufficient funds for two mass spectrometers. Bruce Jakosky (PhD, Cal. Tech.) is a joint hire with the Laboratory for Astrophysics and Space Physics (LASP) (see his article in this Newsletter).

Research continues to be a major interest at the University and in the Department. Alumni may not realize this, but the State of Colorado only finances about 30% of the University financial needs; another third is provided by tuition, and the final third comes from overhead (indirect costs) on research grants and contracts. Most of this overhead money goes toward support of a multitude of elements of the University, but each Department does get some "recharge" from this source. Last year the faculty in our Department raised over $3,000,000 in grants and contracts. This means that an increasing number of our graduate students are being supported as Research Assistants on a variety of projects, and we trust that this trend will continue!

We are currently in the market for two new faculty members. The first one, in Petroleum Geology, is discussed elsewhere in this newsletter. The other position is another joint hire, this time with the Center of the Study of Earth from Space (CSES), and we are seeking a surface hydrologist with interests in global aspects of cycling and movement of water.

Thus, by the beginning of the 1989-1990 academic year the faculty of our Department will number about 30. This number should allow us to improve the quality of our teaching (i.e. smaller classes) and continue to broaden our program. The results of our "employment survey" (see Newsletter) indicates that we are doing an excellent job in providing high-quality graduates to a variety of specialized fields within the geological sciences. We continue to be one of the largest departments of geology in the United States.

In addition to our emphasis on research and graduate education, we continue to seek ways of improving the undergraduate program, especially in terms of "one-on-one" interactions with faculty and other professionals. For example, the opportunity for talented undergraduates to do an Honors Thesis is serving this end. In addition, we have just introduced an "Internship" program for our undergraduates. This will allow them to work for a private company, the USGS, NOAA, etc. and get course credit IF an agreement can be worked out between the employer, the student, and the Department for a project.

As the Department continues to grow and develop, the restrictions imposed by the old (1911) building and the low quality of much of the space in the building become ever harder to bear. However, we always welcome alumni back to the Department to see what is new and to learn how we are coping.

On behalf of all of us I wish you a happy and successful 1989. ■

John Andrews
Chairman

STUDENT AWARDS IN 1987-1988

Each year awards are given to outstanding undergraduate and graduate students. This year we are happy to report the following:

Rocky Mountain Association of Geologists Award to Top Senior. At the RMAG Luncheon on May 13, 1988, a geologic pick was given to **Bradley Simson.**

Isabelle S. Tour Scholarship awarded to **Robin Madel** in the fall of 1987.

Association For Women Geoscientists awards given to:
Kerstin Williams (PhD), **Ann Creighton** (MS), and **Robin Madel** (BS).

Fellowships awarded to outstanding students include:

Michael Celaya	$3750
Maria Montour	$3750
Andres Asian	$1000
Tom Doyle	$1000
Peter Harries	$1000
Alan Lester	$1000
Daniel Levish	$3000
William Little	$1000
Bill Manley	$1000
Jeffrey Snyder	$3000

Don Rodbell (PhD candidate) received a Fulbright Award. This will fund him for a year of study in Peru, split about half-time between field work in the Andes and lab work in Lima.

Two CU students were co-winners of the Geological Society of America Mackin Award. The award is given by the Division of Quaternary Geology and Geomorphology for the best research proposals received. This year **Don Rodbell** and **Jay Noller,** office-mates in the building, tied for the PhD award. Both are working in Peru: Don on the glacial geology in the Cordilleras Central and Blanca, and Jay on the long-term impact of El Nino on development of soils along the coast. ■

BILL BRADLEY RETIRING

Three years ago Bill Bradley took the first step toward retirement by going on half-time status. In May, 1989, after completing his 34th year at CU, he will take the other step. At his request, there will be no formal event to honor his retirement. Instead, the Department will assemble a retirement book for Bill, composed of whatever items people wish to send in, such as letters, cards, photos, drawings, etc. It will be easiest to bind this material if it is kept at normal page-size. If you would like to contribute to Bill's retirement book, please send your material to Prof. John Andrews at the Department of Geological Sciences by the *end of March, 1989.*

Bill Bradley, soon to retire

(A personal note from the Editor. It goes without saying that everyone in the Department will hate to see Bill retire. He is a real gentleman and a good friend. He has been a stabilizing influence throughout the many years that he has been here, in times of tranquility and chaos. While others of us tend to spin off into outer space over some perceived wrong or injustice, Bill has the knack of bringing calm and reason back into the discussion. Besides that, he is a wizard at the barbecue grill! Bill, we will miss you.) ■

GRADUATE STUDENTS FROM OVERSEAS

One of our new students this fall is from South Africa. **Mkhuseli Jobodwana,** from East London, arrived in August. Fortunately for those of us who speak English, he says that "Mkhuseli" is too formal, and prefers to be called "Jobs." Xhosa is his native language; the "X" is a tongue click. The Xhosa-speakers are the second largest group in South Africa, after the Zulus.

Last spring, the office of the President of the University called Prof. Mary Kraus, then Chair of the Admissions Committee, and Prof. Bill Atkinson to a meeting. There, they were told that the Institute of International Education(IIE) had contacted the University of Colorado, asking for matching funds to sponsor a Master's degree student. Because CU has had a program, paid in part by our students, to support university education of black South Africans, it was possible to arrange a cooperative scholarship. The IIE had a specific student in mind, who wished to study mineral deposits, which was why Bill Atkinson had been called.

Jobs attended Fort Hare University in the Republic of Ciskei, where he started studies in civil engineering. He was required to take a course in geology, which sparked his interest, and he switched majors. Since graduation, he has served as an instructor in geology at Fort Hare for the last three years. He would like to work for a mining company for a few years for experience, then teach at a university.

Fort Hare is a black university founded by the government. Many of the geology students are not from Ciskei, however, but from Johannesburg, where there are opportunities for employment in the mining industry.

Jobs has had a chance to enjoy a bit of our local geology. He has taken part in field trips to the Laramie Complex, to the Powderhorn carbonatite complex, to the Black Canyon of the Gunnison, and to the Jamestown Mining District. This has been a welcome change from the flat, monotonous sedimentary geology of Ciskei.

He says that the strangest thing here is the food. A basic staple of his homeland is "samp" (an English word, in case you don't know!), which is crushed boiled corn, often cooked with beans. Fat, pepper, chopped meat, onions, tomatoes and potatoes may also be added. Another staple is millet porridge, eaten with sour milk, called "mphokoqo." This semester, Jobs is enrolled in a tough program, taking ore deposits, thermodynamics, and crystal chemistry.

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We wish him lots of success and good times. We are happy to have him here at CU!

Tsering Tashi is a graduate student from India. Tashi is a geologist in the state of Sikkim, located in the Himalayas between Nepal and Bhutan. He has generally been working on metamorphic petrology and economic geology, as they relate to engineering projects and exploration for minerals.

Tashi was born in Tibet. In his youth it was not unusual for him to cross the borders into Nepal and India. However, when the Tibet-India border was closed in 1959-1960, he was in India, and there he stayed.

Several years ago Tashi decided to start studying environmental geology, as problems of erosion, loss of soil, and mass wasting are widespread in Sikkim. He applied for and received a prestigious scholarship from the Indian government and came to CU. He is concentrating on Quaternary studies. He thesis involves the soil-geomorphic relationships of a small drainage in the Front Range just north of Boulder, under the direction of Pete Birkeland. He should complete his studies by spring, 1989. He will then get involved in similar work in Sikkim. We are quite sure that Pete will not sign off on the thesis until Tashi gets him a visa for future work in the Sikkim Himalaya!

Paul Manega is head of Tanzania's Department of Geology and Antiquities and a doctoral student at CU. Paul is working with Research Asst. Prof. Robert C. Walter (Center for Geochronological Research) to date volcanic deposits from Olduvai Gorge in the East African Rift Valley of Tanzania. Paul and Prof. Walter are constructing a laser-activated potassium/argon mass spectrometer, with the ability to determine the age of a single grain of sediment. The CU laboratory will try to improve on similar techniques recently developed at the University of Toronto and the Institute of Human Origins in Berkeley, California. Tanzania is a poor country, but excellent research is done by people like Paul Manega working in association with scientists in other countries. ■

CUPID STRIKES AGAIN

One of our most respected faculty members, Prof. Ted Walker (alias, "The Match-Maker") has developed a new avocation, that of finding mates for his children. On April 30th of 1988, Ted's son Scott, married one of our graduates, the former Valerie Prescott Kindred. Ted takes full credit for introducing the happy couple. Following that successful effort, Ted introduced his youngest child, Ann, who is also a graduate in geology from our Department, to Assistant Professor David Budd. Ann and David now plan to be married in May of 1989. So, if you have any unwed children who may wish to meet the right person, just give Ted a call. We don't know what his rates are for this new service. ■

The "Matchmaker," Ted Walker

DEGREES AWARDED IN 1986 AND 1987

In the Newsletter for 1987, we listed the graduate students who had received degrees from the Department in 1986 and 1987. Unfortunately, we missed some of the names, and we apologize for the oversight. Those who were overlooked are:

1986
Master of Science
Harrington, Robert J.
Lawrence, William W., Jr.
Stanton, Peter T.
Wineteer, Craig B.
Jennings, Anne E.
Vallance, James W.
Wassem, Donald K.
Zamudio, Joseph A.

Doctor of Philosophy
Forman, Steven L.
Stravers, Jay A.

1987
Master of Science
Davis, John W.
Doll, Petra M.
Ellerman, Pamela J.
Frank, Joseph R.
Hearty, Paul J.
Hon, Kenneth A.
Howe, Brigitte M.
Huang, Zhongxian
Jones, Sandra L.
Kempton, John H.
Kwicklis, Edward M.
Rader, Kathleen
Rosol, Michael J.
Shaw, Christopher
Walter, Marianne

Doctor of Philosophy
Charles G. Lee

GRADUATE DEGREES AWARDED IN 1988 (THROUGH AUGUST)

Bode, Joyce Lent	Mining Wastes of the Florida Phosphate Industry: An Industry Overview and Potential Regulatory Impacts of RCRA Subtitle D	MS
Bove, Dana Joseph	Evolution of the Red Mountain Alunite Deposit, Lake City Caldera, San Juan Mountains, Colorado	MS
Campbell, Greg Tyler	Depositional Environments, Biofacies, and Paleoecology of the Aptian-Albian U-Bar Formation, Little Hatchet Mountains, New Mexico	MS
Creighton, Ann	Taphonomy and Occurrence of Early Eocene Terrestrial Gastropods from the Willwood Formation, Bighorn Basin, Wyoming	MS
Crifasi, Robert	Stratigraphy and Alluvial Architecture of Laramide Orogenic Sediments: Denver Basin, Colorado	MS
Geirsdottir, Aslaug	Sedimentological Analysis of Diamictites and Implications for Late Cenozoic Glaciation in Western Iceland	PhD
Gibota, Thomas J.	Evaluation of Thixotropic Effects on Hydraulic Conductivity of Compacted Clay Soils	MS
Laymon, Charles Alan	Glacial Geology of Western Hudson Strait, Canada, with Reference to Laurentide Ice Sheet Dynamics	PhD
Wahli, Catherine	The Electromigration of Copper and Sulfate Through a Porous Medium as a Potential Method for Ground Water Remediation	MS
Walters, James Ettore	Glacial Geology of Countess of Warwick Sound, Baffin Island, Arctic Canada	MS
Weissmann, Gary S.	Alluvial Architecture of a Sheet Sandstone, Willwood Formation, Bighorn Basin Wyoming	MS
Williams, Kerstin M.	Late Quaternary Paleo-Oceanography of the Baffin Bay Region, Based on Diatoms	PhD

HONORS LIST, SPRING, 1988

Edward Field (magna cum laude): The Characterization of Cracks in Glass Plates.

Robin Madel (magna cum laude): Crystal Structure Refinement of a Fluorine-bearing Spessartine Garnet.

Daniel Stone (magna cum laude): An Investigation of the Integrity of the Kadin Lake Ice Dam.

OUR OFFICE STAFF

Four permanent employees make up our office staff and see to it that things continue to function in the Department. These ladies are Edith Ellis, Kay Fox, Betty Taylor, and Sarah Hatch. We want to tell you a little bit about three of these ladies (See a separate article on Sarah Hatch elsewhere in the Newsletter).

Edith Ellis is still at the helm after serving the University for 22 years and working in the Department for the past 20 years. Edith is the staff assistant in the Department and has responsibility for handling financial records, grants, proposals, and working with the Chairman on other administrative tasks.

Edith now has seven grandsons and is considering the possibility of managing her own major league baseball team! Edith is married to George Ellis. They enjoy annual vacations to the western slope, Las Vegas, and occasionally, to visit family in Kansas.

Edith reports that she is always happy when you alumns stop by the office to say "hi." She says to please continue to do so, and to keep those cards and letters coming in with your new addresses. She wishes each of you a happy, healthy, and prosperous 1989.

Kay Fox handles the graduate applications in the Department. She was born on a farm near Sedalia, Missouri, taught school for five years and moved to Michigan where she married and helped raise three step-children. She and her husband, Bob, had three more children before moving to Colorado in 1972. Bob died in 1974. Kay has a degree in Education from Central Missouri State University. She started working at CU in 1981.

Kay's six kids, of whom she is justifiably proud, include Bruce, Carol, Lois, Gretchen, Burton, and Julie, and now she has nine grandchildren. In addition to her duties at CU, Kay teaches 20 or so piano students and sings in the First Presbyterian Church Choir in Boulder. Kay is looking forward to going to Washington, DC, in November, 1989, for her daughter Julie's recital in Kennedy Center as first violinist in the Montclaire String Quartet.

Betty Taylor is the newest of our staff members. She was born in Indiana and attended Indiana Business College. Betty reports that she has been happily married for 28 years, to the same guy, Paul, and that they have two sons. One of their sons is married, but no grandchildren yet.

Betty and Paul live up Coal Creek Canyon, southwest of Boulder. Her hobby is photography. Betty has worked at CU for nearly three years. Within the Department she handles most of the tasks dealing with enrollments, scheduling, drop-add, and so on. She says "I really do like working in the Department!" ■

Three of the most important people in the Department: (left to right) Betty Taylor, Edith Ellis, and Kay Fox

ALUMNI SUPPORT FOR THE DEPARTMENT

The Department of Geological Sciences is privileged to have one of the best levels of alumni support in the College of Arts and Sciences. I would like all alumni to understand that your financial gifts, of whatever size, are vital to the well-being of the Department and are truly appreciated. Your contributions allow us to do a great many things that would be absolutely impossible without your generosity. Two major examples of such gifts are noted in this Newsletter—one for the library and one for analytical facilities. In addition, the Department used $20,000 of the money that Gary Grauberger gave to us two years ago to fund field research for graduate students in 1988.

I would like to make special mention at this time of the Warren O. Thompson Fund. This fund represents a memorial to a former professor in the Department, a man who was respected and loved by all who knew him. Money from the Warren O. Thompson Fund is specifically earmarked for support of graduate students. Many graduate students in the late 1960's and through the 1970's received support from this fund. However, the fund is now nearly depleted. I wish to make a personal appeal to all of those former graduate students who received help from the Warren O. Thompson Fund to now contribute to assist in rebuilding the fund *to a level where we can again use it for* meaningful support of current graduate students.

Over the past 18 months the Department has been fortunate to work with Judy Walker, from the University of Colorado Foundation, on matters of alumni support. Her energy and enthusiasm are largely responsible for our increased awareness and understanding of alumni concerns. I wish to publicly acknowledge the help that Judy has given to us.

Thanks again to all of you who support the Department with your financial contributions. Your gifts really do make a significant difference, especially to the students. ■

John T. Andrews
Chairman

DEPARTMENTAL ADVISORY BOARD

Two years ago a Departmental Advisory Board was created to offer guidance, assistance, and support to the Department. The Board consists of rotating group of alumni and friends of the Department, each of whom is willing to devote precious time and energy in the eternal quest for Departmental excellence. In the past two Newsletters we have presented biographical information on Gerald Loucks, Timothy Grove, Omer Raup, Fred Tietz, Vic Baker, David Eggler, Howard Lester, John Rold, Tommy Thompson, Robert Graebner, and Elwin Peacock. This year we take pleasure in presenting to you, Jon Connor, Stanley Dempsey, Gary Grauberger, Eric Johnson, and John Masters.

Jon J. Connor

Jon Connor—Dr. Jon Connor is a geologist with the USGS in Denver. Jon received his BS from Ohio State and his PhD from CU, the latter in 1963. He has been with the Survey since leaving school, working in such diverse areas as uranium resources, ground water, trace elements in health, and mineral resources. From 1972 through 1977 he served as Chief of the Regional Geochemistry Branch. Jon belongs to a number of professional societies, including the GSA, International Association of Mathematical Geology, Society for Environmental Geochemistry and Health, and the Society of Economic Geologists.

Stanley Dempsey—Stan is Chairman and Chief Executive Officer of Royal Gold, Inc., a mining company based in Denver. He received a BA from the Department in 1960, followed by a

Stanley Dempsey

degree in law from CU in 1964. He topped off his education by going through a program for management development in 1969 at Harvard University. Stan has had an incredibly varied series of jobs, including independent mine operator, Engineer at Climax Molybdenum, Vice President of AMAX Inc., Partner in the large law firm of Arnold and Porter, and CEO. Stan is one of the few people we know who has served in the technical, legal, and business portions of the minerals industry.

Gary Grauberger—Gary Grauberger received his BS from the Department in 1971. He has always been interested in exploration for mineral deposits, and since leaving CU he has discovered a number of major gold deposits. His most notable discovery was the Montana Tunnels deposit, near Helena, Montana. Montana Tunnels went into

Gary Grauberger

production in 1987, with a production of about 12,000 ounces of gold per year and an annual payroll of $6.6 million. Gary was a founder and president of U.S. Minerals Exploration before U.S. Minerals merged with Pegasus Mining Company of Vancouver, Canada. Gary now acts as an independent consultant in exploration for precious metals through his own firm, Auco, Inc.

Eric C. Johnson—Eric obtained a BA in Geology and a BA in Chemistry from CU in 1982. Since graduation Eric has been employed by Victory Oil Company, an independent exploration and production company founded in 1934 and headquartered in Long Beach, California. He has held positions ranging from well-site geologist and reservoir geologist, to Manager of Engineering and Operations, to his current position as Managing General Partner.

Eric C. Johnson

He also serves on the Board of Directors of AroChem International, a refining and petrochemicals firm, and he is CEO of Cru Industries, a manufacturer of lead-tin closures for the wine industry. Eric is a member of several professional associations, including the American Chemical Society and the Society of Petroleum Engineers. He is President of the Crail Johnson Foundation, a private charitable organization supporting the sciences.

John A. Masters—John received his BA in economics from Yale University, followed by a Master's in geology from CU in 1951. He began his career as a geologist with the U.S. Atomic Energy Commission, where he made important contributions to the early understanding of Plateau-type uranium deposits. He then worked for Kerr-McGee Corp. uranium and oil exploration. At Kerr-McGee John was involved in the discovery of the giant uranium deposits at Ambrosia Lake, New Mexico, and the first oil field in Arizona (Dineh-bi-Keyah). In 1973 he became President of Canadian

John Masters

Hunter Exploration Ltd., where he discovered Elmworth, the largest gas field in Canada. John is surely one of the few geologists to make giant discoveries in both minerals and petroleum. In 1988 John was awarded the Distinguished Service medal of the American Association of Petroleum Geologists for contributions to the science.

Honorary Member—Judy Walker—Judy Walker (JD, 77) from the University of Colorado Foundation, is a helpmate and inspiration to the Department. Judy carries much of the load in our ongoing efforts to improve the quality and distinction of the Department by

Judy Walker receiving certificate from John Masters and others of the Advisory Board

means of fund-raising and contacts with the Alumni. The photo shows John Masters giving a plaque to Judy from the Advisory Board, with the following inscription: "University of Colorado. Be it known to all that Judy Walker has been granted the Honorary Degree of MOST POPULAR GEOLOGIST for signal accomplishments in turning an earthly science into a jazzy experience." Two quotations are also inscribed on the plaque: "Money is found first in the minds of men" by Wallace Pratt, and: "Judy has a significant effect on men's minds" by the Advisory Board. ■

NEWS ON TWO RECENT GRADUATES

Petra Doll received her Master's degree from the Department in 1987. She is German, and she had come to the University to study geochemistry and hydrology. While at Boulder Petra obtained a strong combination of courses in geology and hydrology (the latter all taken in the Department of Civil and Environmental Engineering). Her thesis involved the development of a computer model for flow of ground water.

Upon receiving her degree, Petra returned to West Germany to look for a job. She had six interviews and received six job offers. She accepted a position with the Geologisches Landesamt Hamburg (a state geological survey). She was initially assigned to two projects. The first was to model the hydraulics and transport of contaminants in an aquifer beneath an industrial area of Hamburg, and ultimately to come up with a scheme for reclamation. The second project was to simulate the long-term downward movement of heavy metals in the vadose zone, including field-testing at the site. Petra describes one interesting difference between the Hamburg Survey and a typical state survey in the U.S. At the Hamburg Survey, most of the gathering of data and writing of reports is done by outside consultants, while most of the interpretation of the data is done in-house by employees of the Survey. Petra closed her letter by sending greetings to her friends and professors in Boulder.

Sandra L. Jones received her Master's degree in aqueous geochemistry. Sandra's thesis was on geochemical modeling of the interaction between stream sediments and waters along the Orinoco River in Venezuela. She received financial aid for the work from Prof. William Lewis in the EPO Biology Department. Some of her research work will be published in a forthcoming special volume on the Orinoco.

Sandra tells us that because of family ties, she decided that she wanted to stay in the Denver area after graduation. After making that decision she interviewed with Woodward-Clyde Consultants and was offered a position as Staff Scientist in the Hydrology Group. Her initial assignments have been in the evaluation of geochemical data and in technical editing. Sandra had previously worked in scientific editing and is pleased to be able to again work in that general field.

As an interesting sidelight, Sandra tells us that she joined two other recent

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graduates from CU on the staff at Woodward-Clyde, J. Houston Kempton (MS, 1987) and Dave Bright (MS, projected 1989). Houston and Dave both specialized in aqueous geochemistry at Boulder. ■

THE "NEW" EARTH SCIENCES LIBRARY

Students, faculty and staff arrived for the Fall 1988 semester to find a very different library than the one they left in the spring. Carpet (yes, carpet!) had been installed and the configuration of the shelving and seating had been drastically altered. A new public service area, which would eventually contain the reference office, the reference collection, and the unbound periodicals, was still under construction. By mid-September the process was complete except for a few minor items. Comments from those using the library have been favorable, even with the noise of construction, smell of carpet glue and paint, and relocation of everyone's favorite titles to new shelves.

The changes took place for several reasons. In February, Suzanne Larsen was named Earth Sciences Librarian. For many years the library had been under the administration of the Science Librarian in Norlin Library. The on-site operations were carried out by a very dedicated and knowledgeable staff. The Earth Sciences Library has now been given full branch-library status and the librarian is a department head within the University Libraries system. The position was originally a half-time appointment but was increased to full-time on August 15, 1988.

The changes were accelerated by a gift to the Library from the Crail-Johnson Foundation. In April, 1988, Eric Johnson ('82), President of the Foundation, approved a proposal which designated that the money be spent in three main areas. Those are: (1) increase collections in areas showing weakness or new interest, (2) purchase a computer for on-line bibliographic searching and create a reference center around it in the library, and (3) subsidize on-line searching, in GEOREF for example, for students and faculty in the Geological Sciences Department.

In addition to Suzanne Larsen, the Library staff consists of Terrie O'Neal and Anne Maziar. Terrie, a Library Technician, has been in the Earth Sciences Library since 1983 and is responsible for much of the progress made by the library during those years. Anne Maziar joined the library last fall as a Library Assistant, but worked here as a student before that. ■

ACTIVITIES OF CURRENT GRADUATE STUDENTS

Bruce Geller, a PhD candidate in the Department, is studying the gold-telluride ores of Gold Hill, Boulder County. He presented a poster on his work at the national meeting of the GSA in Phoenix in 1987, and at the 1988 Centennial Meeting in Denver. He and Prof. Bill Atkinson led a field trip to his thesis area. The field trip was heavily oversubscribed, so Bruce led a second trip after the meeting. He is also teaching two courses at Metropolitan State College in Denver.

Outside of his research and other academic pursuits, Bruce became a father with the birth of a son in February, 1988.

Mary McMillan is a PhD candidate in the Department. This summer Mary travelled to a land of blackened trees and lightning storms to investigate soil erosion in the Ouzel Lake burn area of Rocky Mountain National Park. Ouzel Lake is in Wild Basin, on the east side of the park, near Allenspark, Colorado. The burn area is accessible only by back-pack trail.

Mary McMillan (graduate student) preparing to do a bit of field work

The project began last summer, when at Pete Birkeland's suggestion, Mary contacted the Park Service and got the initial permits. Pete and Margaret Berry (PhD student) visited the area last August, inspected the soil pits, and made suggestions for this summer's work. With Park Service approval this spring, it became possible to do a full summer of work. A grant from the Colorado Mountain Club supported part of Mary's research.

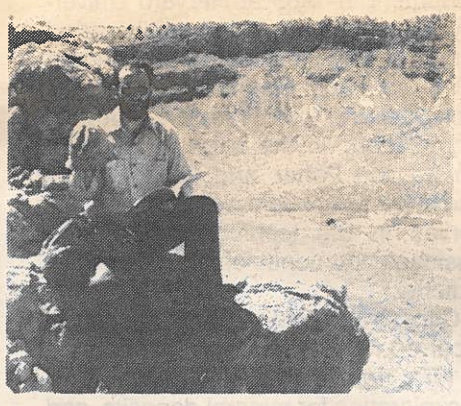
Typically, the erosion measurements are recorded in kg/hectare, or cm/1000 years. Therefore, in this study, it was necessary to choose a standard area (one hectare), and to collect samples for bulk density measurements. In this way, a certain thickness of horizon can be converted to mass. The estimates obtained for slope lowering will be based upon erosion for the past ten years, and so will be a single point, giving a straight line estimate for values which are actually a curve. Erosion is greatly accelerated for the first one or two years after a fire, and then it decreases rapidly. Therefore, much of the erosion documented in this study could have taken place very soon after the fire. The presence or absence of the thin surface horizons are what allow Mary to document this loss. ■

NEW FACULTY MEMBER–DR. BRUCE JAKOSKY

Last year the Department joined in a nationwide search for a faculty member in the general field of planetary sciences. The search was conducted in close association with the Laboratory for Atmospheric and Space Physics (LASP) at CU, with all of the financial support, including future salary, coming through LASP. After having three of the top candidates visit the campus and give talks in their areas of specialization, the joint faculties of the two units offered the position to Dr. Bruce Jakosky. Bruce joined the Department in August of 1988 as an Assistant Professor.

Bruce Jakosky, new faculty member

Bruce's speciality is planetary geology and geophysics. He graduated with a BS in Geophysics and Space Physics from UCLA in 1977 and a PhD in Planetary Science and Geophysics from the California Institute of Technology in 1982. Since receiving his PhD Bruce has been with LASP, and he will continue that association as a member of the Department of Geological Sciences. His specific research interests are in the areas of remote sensing of planetary surfaces, the interaction and evolution of those surfaces and atmospheres. A large part of his research has been related to the surface and climate of Mars. He is an Interdisciplinary Scientist for the Mars Observer spacecraft mission, scheduled for launch in 1992. He is also co-convenor for the Fourth International Conference on Mars, to be held in Tucson in January; he will co-edit a book on Mars as part of the University of Arizona Space Science Series.



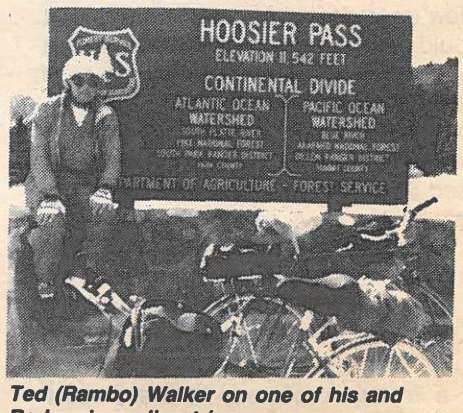
Prof. Bruce Jakosky at Meteorite Crater in northern Arizona. Bruce will be leading field trips to this feature with his students.

Bruce will bring a new area of teaching to our Department. He will teach graduate courses in planetary science and remote sensing of planetary surfaces, and an undergraduate course in planetary geology. The latter course will be at a level that is appropriate to fulfill a natural science requirement for non-majors.

We are pleased to have Bruce with us, and we wish him the best of success. (See a separate article in this Newsletter describing some of his research.) ■

WHAT HAPPENED TO TED (RED-BED) WALKER? WHAT WENT WRONG?

Most of the readers of this Newsletter who know Prof. Ted Walker would probably bet that Ted would spend his semi-retirement spare-time staring through a microscope at his beloved arkosic sediments. However, you would have been wrong. Several years ago Barbara (fair wife) bought a bicycle for him and it was not long before they were hitting the open road. Now they are challenging high mountain passes, as well as pedalling through Vermont as the trees change color in the fall. Recently they completed a Century Ride (100 miles—count 'em) in one day. The next day Ted was back in the office, but sitting down most of the time.



Ted (Rambo) Walker on one of his and Barbara's cycling trips

With the winter snow, Ted puts away the bike and takes out the skis. He and Barbara have discovered downhill skiing in a big way. They ski mainly at Loveland (he is still a bit cheap, taking advantage of the best senior discount), gliding down the hill in great fashion. This is not a minor activity, as they demonstrated by going skiing about 50 days last winter.

So, Ted made quite a transition from a microscope freak to some physical animal; he is now as hard as a nail, a veritable Rambo. What's next? Well he could take up running and try the Boston Marathon. ■

REMOTE SENSING OF MARS

The surface of Mars shows many of the same types of geological features as are seen on the Earth, yet its mass is only about a tenth that of the Earth and its atmospheric pressure is only about a hundredth. By using remote-sensing techniques which are sensitive to the uppermost microns to meters of the surface, in conjunction with imaging observations taken by orbiting and landed spacecraft, we can begin to understand the dynamic processes which act on the martian surface. Eventually, this will lead to a better understanding of the evolution of the martian surface and climate over the planet's entire geologic history.

Figure 1 shows a picture of the surface of Mars as seen from orbit, with a best resolution on the order of fifty meters. Figure 2 shows the same area as seen from the surface, with a best resolution of millimeters to centimeters. As seen at close range, geologic processes such as eolian erosion and deposition, chemical and physical weathering, and possible ice-related activity act to produce the observed surface. These processes all operate at physical scales up to meters or even tens of meters in size, while the best global imaging shows features which are no smaller than about 100 meters in size. Therefore, in order to understand how the processes which are evident at the surface have acted on a global scale, it is necessary to use remotely-sensed information which can provide global information on these scales.

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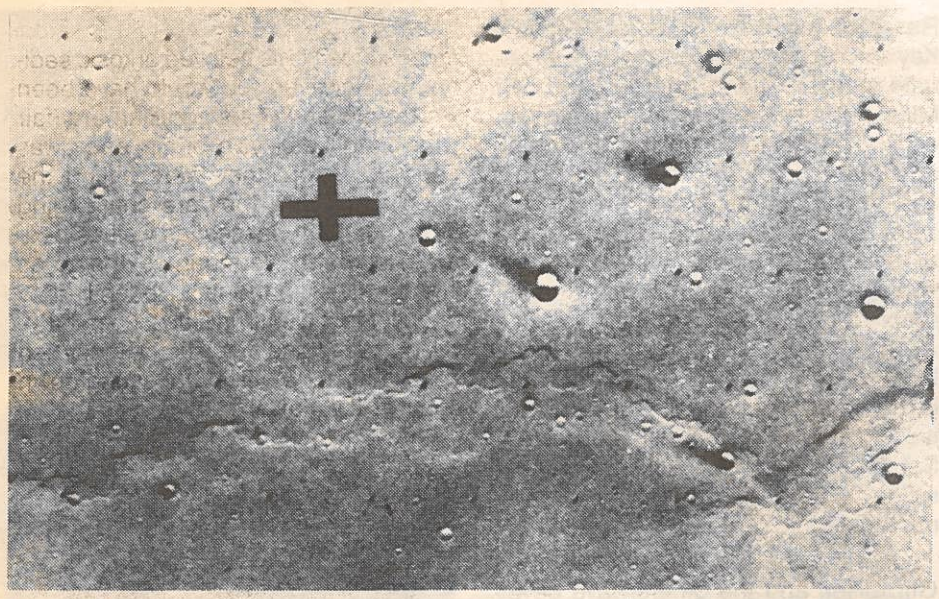

Figure 1. (top)
Viking spacecraft image of the landing site (from orbit).
Figure 2. (bottom)
Viking spacecraft image of the landing site (from the ground).

Remote-Sensing Observations of Mars. Remote-sensing provides a method of obtaining information on the physical, chemical, or mineralogical nature of the martian near-surface layer without having to be physically present at the surface (either in person or by proxy in the guise of an automated spacecraft). The techniques involve sampling and analyzing radiation that has been emitted, reflected, or scattered from the surface; the most-useful techniques for Mars involve radar reflection and scattering, thermal-infrared or microwave emission, and solar reflection. The experiments have been done from Earth-based observatories and from space craft orbiting Mars.

As an example, consider the measurements of the surface temperature of Mars. Thermal emission in the infrared portion of the spectrum is generated within the uppermost few hundred microns of the surface and is indicative of the kinetic temperature there. Observations at several times of day tell us how large the daily swing in surface temperature is; this is a function of a parameter called the thermal inertia, which depends primarily on the thermal conductivity of the surface material and secondarily on the bulk density and specific heat. Materials with a low thermal inertia undergo large temperature swings over the course of a day, and those with a high thermal inertia have moderated temperatures. The thermal conductivity at the low atmospheric pressures on Mars depends primarily on the size of the particles within the regolith; low-conductivity materials are composed of small particles and high-conductivity materials of larger particles. Thus, the map of thermal inertia shown in Figure 3 can be interpreted in terms of the particle size. The broad regions with low inertia are deposits of dust with sizes between about 1 and 30 fm; this dust probably deposits as a result of the global dust storms which occur each year and which can nearly completely obscure the surface features. The regions of high inertia must be dust free, and are composed either of larger particles (up to a few millimeters in average size) or of smaller particles which have been bonded together to increase their conductivity.

We can help distinguish between these last two possibilities using radar observations. The total energy returned in a radar experiment (the cross section of the surface) depends on the bulk density of the surface. Various experiments suggest that the density of the surface varies spatially from about 1 to 2 g/cm^3. Figure 4 shows a comparison between some of the radar cross-section measurements and the thermal inertia; there is a significant correlation, with low values of each parameter occurring together and with high values occurring together. This suggests that materials with a low thermal conductivity also have a low bulk density, consistent with the above interpretation in terms of a loose, unconsolidated dust deposit. Materials with a higher thermal conductivity would then have a higher bulk density; this result is consistent either with having larger particles in these regions or with the idea that some cementation of grains occurs in these regions.

Observations from the Viking Landers. We can compare these global remote-sensing observations with what is seen up close at the two Viking landing sites. Both sites have a boulder-strewn surface with abundant fine material, and they show abundant evidence for the occurrence of eolian processes. About 10% of each surface is covered by rocks larger than 5 cm, but there is a paucity of rocks smaller than a few centimeters in size. Rocks at both sites have a number of different textures and appear to come from a variety of sources.

One site contains numerous large drifts of fine material (shown in Figure 2), in some cases encroaching on and partly covering up large rocks and what appear to be outcrops of bedrock. Although it has abundant fines, a second site has none of these large drifts. Evidence for ongoing eolian activity at both sites includes ridges or ripples of fine material, sculpting of rocks reminiscent of ventifacts, deposits of fines in the lee and scouring of fines on the windward side of obstacles, and possible lag deposits left upon removal of fines. Some features were observed to change during the three Mars years (six Earth years) of observation by the Viking landers, indicating that eolian processes are active at the current epoch.

Trenching operations show that the fine material beneath the surface at both sites is darker than the surface, suggesting the presence of a thin veneer of bright dust. In addition, deposition of additional dust onto the surface was observed after the global dust storms; this added dust appears to have been eroded away at one site in a subsequent year by a relatively rare wind event.

A duricrust is present at both lander sites, consisting of a case-hardened bonding of the fine materials. The bonding is present at the surface in some areas and beneath a thin layer of unbonded fines in others. Numerous small clods or clumps at both sites also appear to consist of duricrust. Based on X-ray fluorescence analyses obtained by the landers, the cementing agent appears to be a sulfur-rich salt.

While this work currently relates to Mars, much of the same physics can go on to various degrees on the satellites of Jupiter or Saturn and on the surfaces of comets. Bruce and his colleagues are also analyzing remote-sensing data and modeling the processes on these objects; this will provide new information on their physical states and on the ongoing geologic processes there. ■

HIGH LATITUDE MARINE GEOLOGY AT CU-BOULDER

Alumni of the Department may be surprised to learn that there is an active program in marine geology in the Department, that is, in addition to the well-known research of Erle Kauffman, Bill Hay, and Don Eicher. The focus of this program is on high-latitude marine processes and paleo-oceanography

For several reasons (oil industry, defense, academic) the last decade has seen a significant increase in the study of high-latitude marine processes and sediments. These high-latitude regions consist of a wide variety of shelf morphologies; they are backed by regions that have experienced fundamentally different climatic histories during the Neogene. For example, some areas have been heavily glaciated whereas others have been relatively little affected by continental glaciation. These differences greatly influenced both the rates and processes of transfer of sediment from land to the deep-sea. Re-

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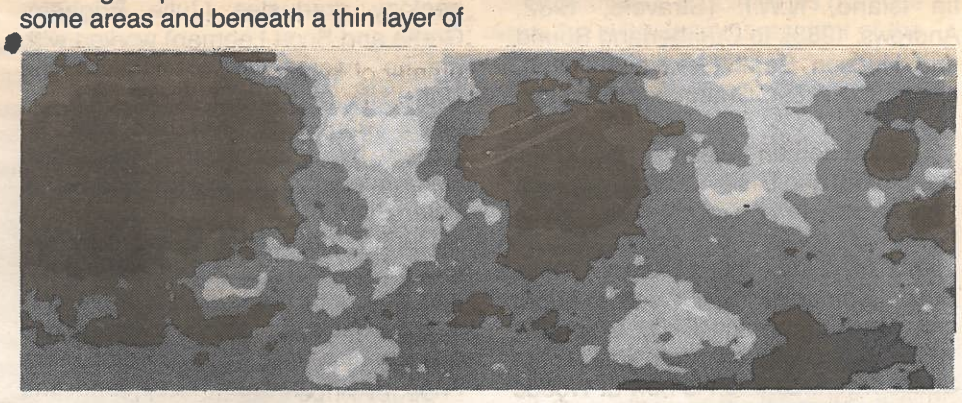


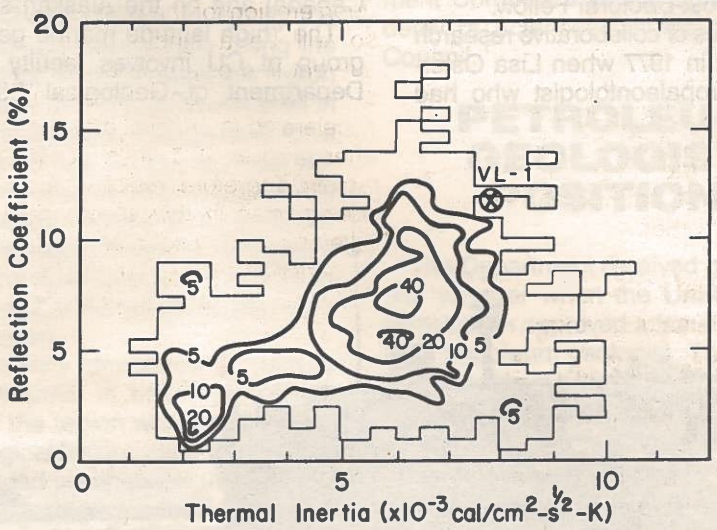
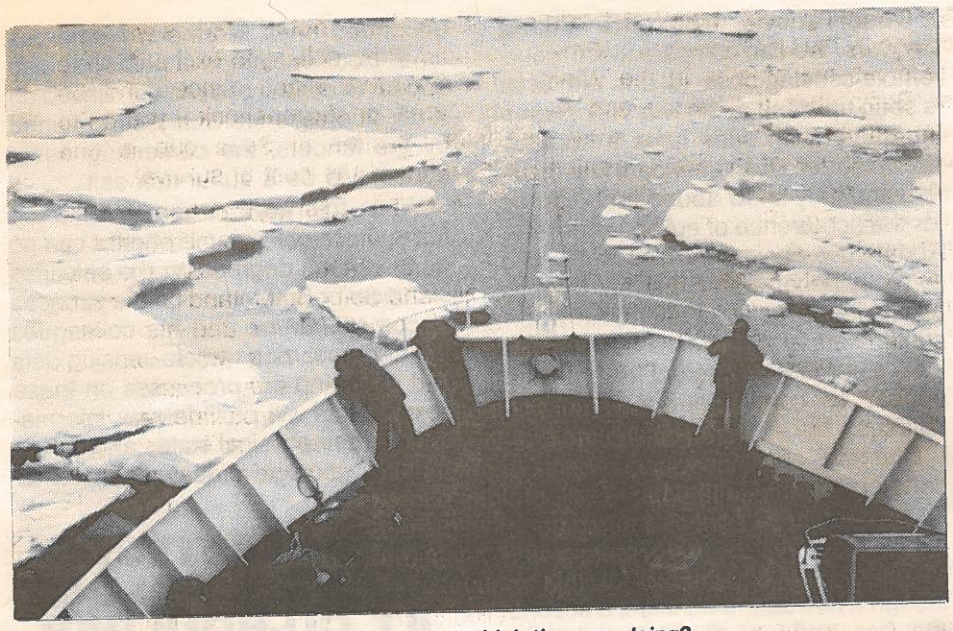


Figure 3. (top)
Map of the thermal inertia of the martian surface. Image extends from −60° to +60° latitude and from 180° to 180° longitude. Dark areas have a low value of thermal inertia and light areas have a high value.

Figure 4. (bottom)
Comparison between the radar reflection coefficient and the thermal inertia of the Mars surface. Each point on the surface was placed into the appropriate bin, and the number of points per bin was then contoured.



Scientists on the CSS Hudson. What do you think they are doing?

gardless of these differences, all high-latitude marine areas are influenced by a variety of ice-dominated processes that make the architecture of the sediment different than those from temperate and tropical areas.

The program in high-latitude marine geology developed as an outgrowth of research on the terrestrial Quaternary geology of the eastern Canadian Arctic and Spitsbergen, and it has expanded to include studies on the East Greenland shelf and Alaskan shelves. The program has developed strong research ties with a number of marine-oriented groups, including the Atlantic Geoscience Center (Bedford Institute of Oceanography, Dartmouth, Canada), the Quaternary Geology Department (University of Bergen, Norway), Norsk Polar Institute (Oslo, Norway), and Woods Hole Oceanographic Institute (Massachusetts). Graduate students and faculty have been on research cruises on the Canadian vessel CSS Hudson to the fiords and shelf of Baffin Island, N.W.T. (Stravers, 1982; Andrews, 1983), to Cumberland Sound and Hudson Strait (Jennings, 1985), and to the Arctic Channels (Jennings, 1988).

In 1988 Kerstin Williams (PhD, Colorado, 1988) and Lesley Evans (MS) were participants in a Woods Hole cruise from Iceland to the East Greenland shelf. Giff Miller (PhD, Colorado, 1975), Scott Lehman (PhD, Colorado, 1988) and Steve Forman (PhD, Colorado, 1986) are working on cores adjacent to Spitsbergen. Lehman is now at Woods Hole as a Post-Doctoral Fellow.

The process of collaborative research commenced in 1977 when Lisa Osterman, a micropaleontologist who had worked on material from the Antarctic for her MS, came to CU to work on her PhD (Osterman, PhD, 1982). This led John Andrews to obtain an NSF grant to study the biofacies and sediment in a series of "Hudson" cores. The initial work expanded in 1981/1982 when he became involved in the S.A.F.E. (Sedimentology of Arctic Fjords Experiment) project. Masters' theses (Jennings, 1986; Williams, 1984) and PhD dissertations (Williams, 1988; Jennings, in prep) stemmed from this work, which has expanded in the last two years to include a major study of the southeastern Baffin Island shelf and the adjacent floor of the Northwestern Atlantic Ocean. This research has been funded by the National Science Foundation and the Office of Naval Research, with considerable "in kind" support from the Atlantic Geoscience Center (AGC). Jennings spent 1987-1988 in Dartmouth/Halifax, working with researchers at Dalhousie University and with those in the AGC. In a similar vein, two CU geology graduates (Julie Brigham-Grette and Scott Lehman) worked with marine micropaleontologists at the University of Bergen during two different years. The favor has been returned by "sabbatical" visits from Bergen faculty (J. Magerud and Hans-Peter Sverup).

During the formative years of the group Dr. J. E. Kravtiz, then with NOAA and now with the Office of Naval Research, was a source of knowledge and experience related to his research in the Kane Basin (between Greenland and Canada) and on the Alaskan shelf.

The "high latitude marine geology" group at CU involves faculty in the Department of Geological Sciences Research and Associates of INSTAAR. Key elements, as always, are the graduate students. John Andrews and Giff Miller represent the Departmental interest and largely focus on sedimentology and dating problems. Within INSTAAR, Drs. W. W. Briggs, Jr. and Kerstin Williams work on the fauna (ostracods and foraminifera) and flora (diatoms) of both surface sediments and cores. Considerable work on grain-size and mineralogy is headed by the Sedimentology Laboratory of INSTAAR, where Rolf Kihl is the Senior Technician. Available facilities include X-radiography equipment, Sedigraph and settling tube for particle sizing, X-ray diffraction equipment, and micropaleontological facilities.

Over the last decade John Andrews, Giff Miller, and the others have developed a "network" of international contacts who assist them in specific aspects of their research. For example, stable isotope measurements are currently obtained from Dr. H. Erlenkeuser, Kiel University, Germany, and they are doing some experimental work involving beryllium-10 dating with a group in France (Dr. Grant Raisbeck). Andrews and the others are hopeful that in the near future they will be able to conduct our own in-house research on light stable isotopes when the laboratory of Jim White (new faculty appointment, 1988) is up and running.

An important facet of the research is that of geochronology. The high-latitude group is currently working closely with the University of Arizona where they routinely obtain radiocarbon dates on as little as 2 mg of foraminifera or small shells, using the accelerator mass spectrometer. This new technology is radically improving their ability to date significant paleo-oceanographic changes over the last 45,000 years. ■

Prof. John Andrews

AIRMAIL POSTAGE STAMP PICTURES CU-BOULDER SCIENTIST'S MAP

The Earth as it looked when dinosaurs lived is depicted on an airmail stamp issued by France using a global map constructed by marine geologist William W. Hay of the University of Colorado at Boulder Museum.

France issued the stamp to commemorate the 10th anniversary of the Deep Sea Drilling Project in the South Atlantic, an international effort to understand land and ocean conditions in the Mesozoic era, roughly 180 million years ago. At that time the oceans were filled with warm, salty water.

About 10 years ago, Hay and his colleagues drew the map with the aid of a computer from evidence produced by offshore drilling and by comparing the geology of the continents. Soviet colleagues played an important role by confirming the existence of certain fossils found in the Antarctic.

The map shows the southern continents of India, Africa, Australia, South America and Antarctica together as one continent, named Gondwanaland. In the Mesozoic, Antarctica and Australia were drifting away from South America and Africa.

Hay says the stamp uses his ideas on the relative positions of Africa, South America and Antarctica, but incorporates more recent information for the position of Madagascar.

The stamp shows the two ships used to drill near the Kerguelen Islands, a French possession in the South Indian Ocean. Hay believes the stamp will be used on airmail from Kerguelen and Antarctica to France. The dark blue stamp has the value of 16 francs and 80 centimes printed in yellow lettering. Worth $2.70 in U.S. currency, it measures 1½ inches by 2½ inches.

Prof. Bill Hay holding the French commemorative stamp (photo by Ed Kosmicki, CU Office of Public Relations)

Hay and others were given the stamp, encased in plastic and mounted on a small pedestal, at a recent dinner given by Joint Oceanographic Institutions (JOI) Inc. in Washington, D.C. JOI is manager of the Deep Sea Drilling Program.

Hay is a former JOI president, a position he left to join the CU Museum as director in 1982. Last year he resigned to devote full time to teaching, research and writing at CU-Boulder.

He is acknowledged as an expert on continental drift, early climates, landforms and fossils, and is a noted teacher and scientific author. ■

WORD-PROCESSING AND THE SOUND OF MUSIC—SARAH CROOM-HATCH

Sarah Croom-Hatch joined the Department as Word Processor in September, 1986, while she was working on a Doctoral degree in music at CU. In May, 1988, she received the Doctor of Musical Arts degree from the College of Music. Her study of the piano was primarily with Professors Larry Graham and Paul Parmalee. The focus of her research was relationships between recent neurological/neuropsychological research and piano performance. This led to her Major Document entitled: *Continuous Audiation as the Mental Focus for the Experienced Pianist in Memorized Solo Performance.*

Sarah began her study of piano at the age of four, and at age eight she gave her first full recital. During her childhood she studied with Bernice Frost of the Juilliard School of Music. She later studied with Lucien Stark and Sascha Gorodnitski of the Julliard faculty, and with concert pianist Guiomar Novaes.

For two summers Sarah was a teacher and performer at the Temple Univer-

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Research vessel CSS Hudson

Sarah belts one out for the folks at the Little Russian Cafe.

sity Festival/Institute in Philadelphia, Pennsylvania. She also taught for seven years in universities in the south and west. For over 20 years she maintained a private studio. In the Spring of 1989 Sarah will play recitals at the Stanley Hotel in Estes Park, Colorado, in Denver, and in the Oklahoma City area. She will present works by Scarlatti, Mozart, Liszt, and Leon Kirchner.

In addition to handling many of the word-processing tasks in our Department, Sarah plays the piano two nights a week for the pleasure of diners at the Little Russian Cafe on the Mall in Boulder. ■

FACULTY NOTES AND NEWS

Dr. Phil Choquette, Professor Adjoint and Research Associate, joined the Department in January, 1987, after a successful career at the Marathon Oil Company's research laboratory in Littleton, Colorado. No sooner had he arrived here than he departed for the academic year as a Visiting Professor at the State University of New York, Stony Brook, on Long Island. His research there involved the development and evolution of porosity and microporosity during the progressive dolomitization of carbonates that were rich in limestone mud, as seen under cathodoluminescence and by scanning electron microscopy. The work is finished for the time being and is being summarized for publication. It was done in part with some of Phil's former colleagues from Marathon, and the company provided helpful analytical and logistical support.

Phil returned in August of 1988, having been awarded a two-year grant from the Petroleum Research Fund of the American Chemical Society for study of regional diagenesis in the Phosphoria Formation (Late Permian) of western Wyoming. The study will concentrate on a regionally widespread terminal cycle, the Ervay cycle, in an area of outcrop and in the subsurface which includes the Powder River Basin. Ervay carbonates contain substantial reserves of oil in the Big Horn Basin, where aspects of the petroleum geology and sedimentology are being studied by Prof. David Budd and by the USGS in Denver. Proven reserves are smaller in the Wind River Basin, but that basin and its environs comprise a longer swatch across the strike of the Late Permian paleoshelf, from redbed facies in the east (Goose Egg Formation) to shelf-margin and deeper marine chert-phosphorite-carbonate facies in the west. Phosphoria cycles vary markedly across the paleoshelf and are bounded by seismically-expressed disconformities of regional extent. A major objective of the study will be to relate significant diagenetic events in the Ervay cycle, to Permian and later events that affected the region. To identify the diagenetic events Phil will be using "cement stratigraphy" (seen by cathodoluminescence), isotope-ratios, and minor-element compositions. Findings of the study could help clarify the sea-level history of the Permo-Triassic boundary and the paleohydrology of the Late Permian in the region. Phil anticipates some fruitful interaction with Prof. Dave Budd and other members of the Department. He is being assisted by Mr. Eric Hiatt, a Graduate Research Assistant who is supported by money from the research grant.

A book on *Paleokarst*, co-edited by Phil and Noel James of Queens University, Ontario, was published by Springer-Verlag in late 1987 and has gotten generally good reviews. It is primarily a reference work that includes articles on the processes and products of present-day karst terrains, followed by well-documented case studies of ancient karst, some of which host petroleum or Mississippi-Valley type of sulfide deposits.

On other fronts, Phil sings with the Denver Symphonic Chorus and can occasionally be found on a tennis court or a ski slope. He commutes between the Department and his home in Littleton.

Prof. Carl Kisslinger spent June and July of this year in Japan, at the Observation Center for Earthquake Prediction of Tohoku University, in Sendai. His visit was supported by a grant from the Tokyo Marine Kagami Memorial Foundation, which was founded to support earthquake-related research. The principal reason for going to Tohoku University was to enable Carl to work first-hand with the excellent data set that they have assembled with their seismograph network. This network monitors all of northeast Japan, including the very active subduction zone along the Japan Trench. In many ways this region is analogous to Carl's research area in the central Aleutian Islands, and for a long time he has wanted to make detailed comparisons of earthquakes in the two places. He now has a much better understanding of earthquake generation in the Aleutians and it is time to try to generalize his results to other subduction zones.

He was very impressed by visits to local museums, in which the human history of the region was embedded in the geological history. Japanese visitors are reminded continuously that geology has set the stage for their lives. Carl especially recommends the museum of the Geological Survey of Japan, in Tsukuba. As they trace the history of the Earth with rock samples, they go from the oldest known rocks, from Greenland, to the "youngest" Japanese rock, a bomb from the Izu-Oshima eruption of 1986.

One final note: Carl says that although the dollar-yen exchange rate has improved slightly since June, be prepared for sticker-shock if you go to Japan. Coffee at $4 a cup is one measure of the cost of survival.

Prof. Pete Birkeland had a busy year. In addition to the usual assortment of courses (Quaternary Stratigraphy, Soils, and Soil Lab. Methods), he got a bit of writing done. He and Bud Burke finally finished their work on soil catenas in the Sierra Nevada. Pete, Bud, and Jim Benedict finished their study of iron in alpine soils, and Pete and Ed Larson turned in the manuscript for the 5th Edition of "Putnam's Geology" to Oxford University Press, to be published in the spring of 1989.

For the summer, Pete and Sue travelled to Peru to check on student thesis work; they loved it because prices have never been so low! Finally, on returning to the U.S. Pete learned that he had been awarded the 1988 Kirk Bryan Award in Geomorphology of the Geological Society of America for his book "Soils and Geomorphology." As Pete's former students have said, "Serves him right; now he will have to change his jokes."

Prof. Don Runnells received the honor of being elected as second vice president of the Association of Exploration Geochemists (AEG.). The AEG is a professional organization about 20 years old, organized to strengthen and support the discipline of exploration geochemistry for mineral deposits. It includes about a thousand members, scattered throughout the world. The AEG sponsors an international symposium each year, together with a variety of regional meetings and short courses. In 1989 the XIIIth International Exploration Symposium will be held in Rio de Janeiro, Brazil, and in 1990 the XIVth Symposium will take place in Prague, Czechoslovakia. If Don keeps his nose clean, he will become president of the AEG in 1990.

During the year Don's other activities included editing the Departmental Newsletter, as well as teaching graduate courses in low-temperature geochemistry, aqueous geochemistry, and the computer modeling of the chemistry of waters. Five of Don's graduate students finished Master's degrees during the school year 1987-1988.

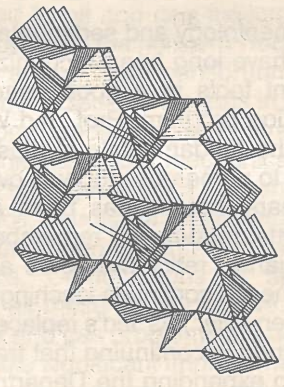
Don also served a second year on the Ground Water Modeling Assessment Committee of the National Academy of Sciences/National Research Council. ■

Dr. Timothy Grove (MIT) and Prof. Joe Smyth (mineralogy) at the 1987 meeting of the Advisory Board

NEW COMPUTER FOR MINERALOGY

Prof. Joseph R. Smyth was awarded an NSF grant of approximately $18,000 to match a contribution from the University for the purchase of a computer workstation. The new computer will be used for crystallographic and petrologic calculations. The funds were used to obtain an IBM 6150 computer with 12 Mbytes RAM and 185 Mbytes disk space, plus a high-resolution color monitor. The computer is capable of handling up to five simultaneous users. It is being used to store a large database of crystal structures with extensive programs for the drawing of crystal structures (see accompanying illustration), modeling, and energy calculations.

The computer has been used to characterize anion sites in a large group of silicate minerals, and it appears that the electrostatic site potentials of these sites form a near-perfect linear correlation with oxygen isotope fractionation factors. It thus appears possible to predict fractionation of oxygen isotopes among various mineral phases as a function of temperature, based simply on crystal structures. This obviously opens up numerous possibilities for new geothermometers based on oxygen isotopes. ■



Crystal structure of quartz

PETROLEUM GEOLOGIST POSITION

The Department received good news last summer when the University Administration approved a faculty position for a petroleum geologist. The Department has been without a regular faculty member in petroleum geology since the departure of Bruce Curtis in 1982. In the interim, Janell Edman was hired but left for private industry after spending just two years at CU. A subsequent attempt to hire a petroleum geochemist in 1985 failed. With the help of the Alumni Advisory Board, Departmental Chairman John Andrews was able to successfully convince the administration that the institution must maintain a petroleum

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geology program. The present downturn in the industry is considered the perfect time to find an experienced explorationist willing to make the transition to university teaching and research.

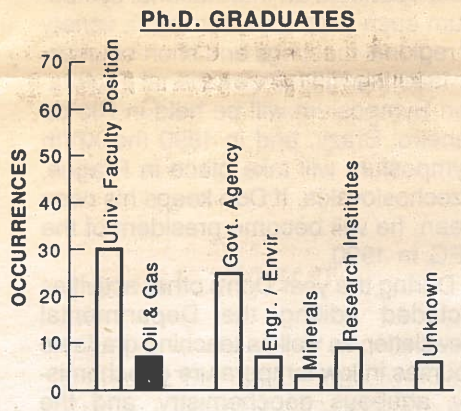
The search for our new petroleum geologist is being conducted by a committee of six faculty members with David Budd chairing the committee. John Masters, president of Canadian Hunter Petroleum and a member of the Departmental Advisory Board, is assisting the committee in their efforts. ■

Prof. David Budd

WHERE ARE THEY NOW?

The growth of the Department in the last 15 years has resulted in a tremendous increase in the breadth and diversity of our programs. An analysis of the employment trends of our MS and PhD students illustrates this development. Over the ten-year span from 1977 to 1987, the Department of Geological Sciences produced 214 MS and 86 PhD graduates. The frequency histogram below shows the diverse number of fields that these individuals have gone into.

Approximately ⅓ of the PhD recipients are teaching at other universities and slightly less than ⅓ are employed as geologists for governmental agencies (USGS, BLM, or state). The remaining are dispersed between public research institutions, the petroleum and mineral industries, and environmental or engineering consulting firms.



Graph

Recipients of the MS degree show a similar diversity in terms of their post-CU endeavors. Approximately ¼ of our MS graduates have gone into the petroleum industry, another 1/5 have gone on for PhD degrees at other universities or at CU, another 1/5 have gone to work for various governmental agencies, and about 1/5 are unaccounted for. The remainder are mainly in either environmental consulting or the minerals industry.

As might be expected, the downturn in the petroleum and mineral industries has resulted in fewer of our recent graduates going into those fields. However, the increased demand for geologists in the environmental sciences, in particular with respect to groundwater contamination, has partially offset this trend. Our close proximity to the USGS in Denver also continues to serve us well as both a source of good graduate students and as a strong employer of our products. ■

Profs. Erle Kauffman
and David Budd

PETROLEUM-RELATED RESEARCH PROJECTS IN STRUCTURAL GEOLOGY

Exploration for hydrocarbons has always made extensive use of the methods of structural geology in this country and abroad. The discovery of oil and gas within anticlinal traps at the beginning of this century was one of the milestones in advancing the credibility of structural geology as science in the petroleum industry. Many giant oil and gas fields within structural traps were discovered and exploited using the classical techniques of structural geology: cross-section construction, down-plunge projection of stratigraphic and structural data from geological maps, correlation of strata between boreholes, interpretation of fault and map patterns, etc. In a regional sense, the structural geologist has also played a fundamental role in providing the geological framework with which the explorationist is able to evaluate his prospect. Thus, terms such as thrust-belt play, salt-dome play, and en-echelon anticlinal play have become associated with their tectonic settings including back-arc thrust belts, rift basins, and wrench regimes, respectively.

During the last 10-15 years, great advances have been made on the theoretical side of structural geology in topics such as folding, faulting, stress-strain relationships, the flow properties of rocks and minerals, and in our understanding of deformation mechanisms. The routine application of these new theories is often possible only with the aid of micro- and mainframe computers, which were unavailable only 15 years ago. The purpose of this article is to explain how some of these recent advances in structural geology research can be applied to the petroleum industry, and to provide a number of examples of how CU faculty and students are actively involved in this endeavor.

With support from the National Science Foundation, the American Chemical Society's Petroleum Research Fund, and industry sources, a team consisting of PhD students Mark G. Rowan and Robert Ratliff, MS student William Babcock, and Prof. Roy Kligfield, is systematically examining two areas of immediate application in the petroleum industry: 1) cross-section construction, restoration and balancing and 2) the relationship between folding, strain, deformation mechanisms and enhanced oil recovery.

Cross-section construction, restoration and balancing have traditionally been done by hand. With the wide availability of the microcomputer and computer-assisted graphics, it is now possible to perform these time-consuming tasks very rapidly on an interactive computer system. For research purposes, we have been given access to proprietary computer software by Geo-Logic Systems, Inc., which enables students and faculty to combine many of these construction tasks with our fieldwork. Our fieldwork is aimed at investigating the relationship between fold-geometry obtained from mapping at the surface and subsurface fold-geometry in three dimensions. Ongoing fieldwork in the Bear Creek anticline in southeastern Idaho by Bill Babcock is investigating the relationship between observed fold geometries and the structure at depth. Proprietary seismic data have been provided to us for this project so that our predictions can be compared with the known industry database. The structures which Bill is working on in Idaho, along with those being examined by other students in Wyoming and Switzerland, are geometric analogues to giant hydrocarbon producing fields, such as Anschutz Ranch, Whitney Canyon, and Yellow Creek in the Rocky Mountains. We hope that our geometric observations, and the lessons we learn from detailed studies in well-exposed surface structures, will provide rules for interpreting between wells in subsurface fields elsewhere.

Doctoral candidate Robert Ratliff has spent the last two summers examining outcrops in the Wyoming-Idaho thrust belt in an effort to determine the types of deformation mechanisms present and their distributions. Another PhD student, Mark Rowan, has been roaming the Helvetic nappes of Switzerland where the superb topography of the Swiss Alps provides an exceptional opportunity to study both the three-dimensional fold geometry as well as the deformation mechanism distribution of these thin-skin structures. Our efforts in these and other regions are directed at describing quantitatively how change in shape occurs due to folding, and which deformation mechanisms allow it to do so. Thus, we are busily measuring the relative proportions of shape-change due to brittle failure mechanisms, ductile deformation mechanisms, and pressure solution effects. In order to do so we make extensive use of our excellent computer laboratory for finite and incremental strain analysis, as well as the Department's newly expanded analytical facilities. It is our expectation that once we have a firm understanding on how structural heterogeneities are a function of fold geometry, we will be able to apply these lessons to folded reservoirs in the subsurface. ■

Prof. Roy Kligfield

STUDIES OF CARBONATE RESERVOIRS

Sedimentology and sedimentary petrology have long been recognized as important tools in a good petroleum exploration program. Prof. Ted Walker taught the fundamentals of these disciplines to numerous students over the 35+ years that he has been at CU (Newsletter readers will remember that Ted began to retire two years ago although he still continues teaching in the spring semester.) As Ted's replacement, David Budd is continuing that tradition and also expanding the Department's breadth into the field of carbonate rocks and reservoir heterogeneity.

The study of depositional facies, stratal geometries, and pore network evolution via diagenesis in carbonate rocks is a major part of David's teaching and research efforts. David joined the faculty in January, 1987, after spending 3½ years with ARCO Exploration & Production Research. Much of David's work at ARCO was in reservoir description and analyses of reservoir heterogeneity in carbonate rocks (limestones

David Budd

and dolomites). Carbonate reservoirs can be extremely complex because many of the pores in carbonate rocks are of a secondary nature; that is, they formed after deposition by diagenesis as opposed to primary pores between grains that exist at the time of deposition. David and two graduate students, Tim Garfield and Bill Clark, are currently investigating the nature of such heterogeneities and also are trying to improve the techniques used to quantify these complexities. The need for such work is widely recognized in industry as a prerequisite for good reservoir evaluations, production simulations, and the continued assessment of strategies for management of reservoirs.

Garfield's MS research and Clark's PhD research are both focused on the Phosphoria Formation in five producing fields in the Big Horn Basin, Wyoming. Marathon Oil Company operates all five fields and was instrumental in setting up both studies, providing data, and providing numerous other services and support. Each project involves the examination of cores, logs, thin-sections, petrophysical data, and production histories to describe the physical nature of the reservoir rocks, to identify the rock units which serve as flow units for the hydrocarbons, and to determine the origin of the geological heterogeneity in rock properties. Studies of nearby outcrops that contain the same rock units (and are often on the same structural feature) are also being incorporated to investigate the finer scales of lateral heterogeneity in facies, bedding geometries, fractures, and diagenesis that cannot be derived from the subsurface data. The Department's new image-analysis system, funded in part by a gift from Shell Oil Company, is proving especially helpful to Tim's and Bill's efforts.

In the future, funding opportunities through the U.S. Department of Energy and the Western Earth Sciences Technology Consortium (WEST) (see article elsewhere in this Newsletter) will hopefully allow the expansion of the research program to other stratigraphic units in other basins. A successful search for a new petroleum geologist (see article elsewhere) should also expand the opportunities for collaborative teaching and research opportunities. Regardless of the cyclic nature of the petroleum in-

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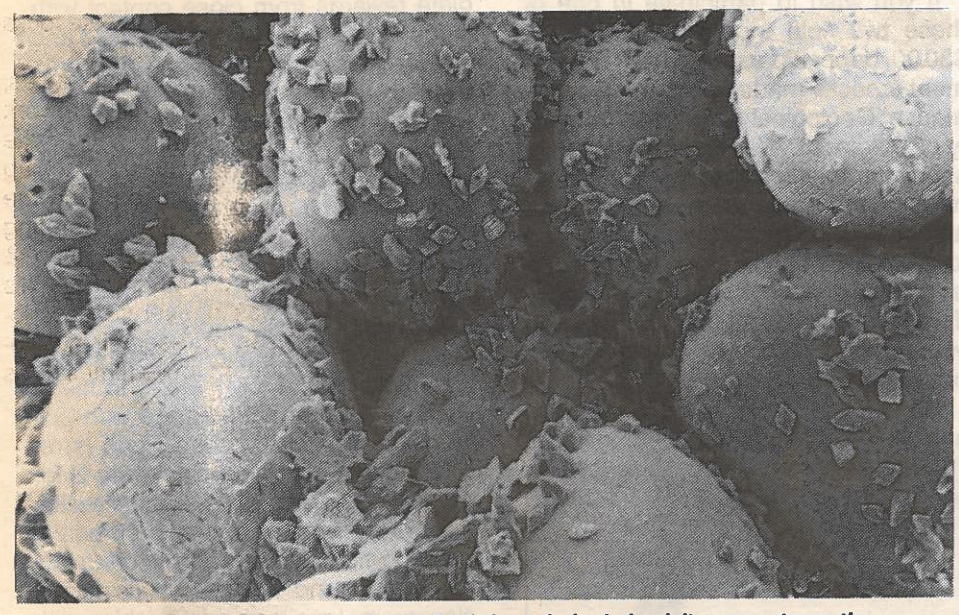


Scanning electron microscope photograph of rhomobohedral calcite cements on the surface of oold grains. Sample was collected from below the water table on a small, 700-year-old island in the Bahamas. (David Budd)

dustry, good students with solid backgrounds in the fundamentals of geology and experience solving subsurface problems will always be in demand as long as ours is a hydrocarbon-based economy. ■

Prof. David Budd

WEST CONSORTIUM

One of the problems facing faculty who wish to conduct research in petroleum geology has been the reluctance of conventional funding agencies, such as the National Science Foundation, to fund so-called "applied research." On the other hand, the current economic crisis in the petroleum industry has precluded faculty from approaching industry for funds, as has been practiced in the past. Only a very limited number of groups, such as the American Chemical Society's Petroleum Research Fund, have been willing to provide research grants in the petroleum field.

With these problems in mind, a broad, diverse group of geoscientists affiliated with Rocky Mountain universities decided to organize a consortium, the major purpose of which would be to obtain funding for the members to carry out fundamental research in the energy field. In this article we will describe the WEST consortium.

Background—the ERAB report: In December, 1985, the U.S. Secretary of Energy, John S. Herrington, requested that the Energy Research Advisory Board (ERAB) undertake a review of the nation's energy-related geoscience research needs and the status of Department of Energy (DOE) geoscience research and development (R&D) programs. In January 1986, ERAB created the Solid Earth Sciences Panel, which examined the following topics as identified by the Secretary of Energy: 1) The future energy-related geoscience needs of the nation; 2) existing DOE geoscience R&D areas relative to the identified national requirements and within the context of related programs being carried out by other government agencies, universities, and industry; 3) opportunities for change and prioritization in existing DOE geoscience programs, and 4) new geoscience research and development initiative.

In February of 1987, the ERAB report to the Department of Energy entitled "Geoscience Research for Energy Security" was issued. Quoting from the report, the ERAB committee stated: "In light of the current and near-term National energy requirements, federal budget constraints, and the diminished R & D efforts from the domestic energy industry, the Board recommends that DOE: 1) Assign highest geoscience research emphasis to shorter-term energy priorities of the nation, particularly advanced oil and gas exploration and production technologies; 2) Establish in DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities; and 3) Increase oil and gas research funding by an initial annual increment of $50 million."

WEST and the academic community's response. Between May 1987 and August 1988 a series of eight meetings were held in Laramie, Salt Lake City, Denver, Boulder, and Sun Valley by scientists interested in organizing themselves into a Rocky Mountain consortium to meet the ERAB challenge. Initially, the consortium developed from the leadership of scientists from the University of Wyoming, University of Utah and University of Colorado; subsequently, participation in the organizational meetings widened to include other universities in the Rocky Mountain region, the U.S. Geological Survey, some of the national laboratories, and participants from industry. The result of the organizational meetings was the formation of Science Technologies (WEST)—a consortium of Northern Rocky Mountain Universities conducting research in Petroleum related geosciences. The following universities are founding members of WEST: Boise State University, Colorado School of Mines, Colorado State University, Idaho State University, Montana State University, University of Colorado at Boulder, University of Idaho, University of Utah, University of Utah Research Institute, University of Wyoming, and Utah State University.

The stated purpose of WEST is to conduct interdisciplinary research on engineering and geoscience problems related to oil and gas exploration and production in the northern Rocky Mountain area. This consortium brings together research scientists in structural geology, sedimentology, stratigraphy, geochemistry, rock mechanics, seismic reflection geophysics, borehole geophysics, petroleum engineering, chemical engineering, and applied mathematics. Combinations of specialists such as these in cooperative research on oil and gas problems are necessary to make significant improvements in oil and gas exploration and production. WEST seeks to accomplish its goals through alliances with the petroleum industry, the U.S. Geological Survey, representative state organizations, and other research organizations dedicated to solving the same problems.

A secondary, but equally critical goal of the WEST consortium is to provide the educational environment to meet the future manpower needs of the petroleum industry. The students of tomorrow cannot be educated as were the students of yesterday. An interdisciplinary approach to education and training is necessary to meet the challenging questions and needs that the petroleum industry will face in the near- and long-term future. Solid backgrounds in geology, mathematics, geophysics, computer science applications, organic and inorganic geochemistry, fluid movement, petroleum and reservoir engineering are necessary. These educational goals can be met in the process of also obtaining significant research advances.

WEST Science Plan. WEST geoscientists have decided to focus their efforts into two major directions: 1) analyses of reservoir properties and input of geologic data into more sophisticated methods of reservoir characterization, and 2) integrated regional and local-scale studies of the frontier areas of the Rocky Mountain region.

Industry involvement

One of the fundamental premises by which Congress is willing to fund research in the petroleum field is that of obtaining matching funds and/or participation from the private sector (i.e. industry). WEST's plans for the analysis of reservoir properties and heterogeneities is based on the premise that an integrated study of surface analogs to Rocky Mountain producing hydrocarbon fields will produce important results which can be directly applied to enhanced oil recovery in existing Rocky Mountain Reservoirs. To this end, WEST is seeking active industry involvement by our integrated university-based consortium in working on subsurface data and field interpretations. As WEST's science plan calls for active cooperation with industry, WEST will be gauging the level of industry support and their willingness to contribute to joint scientific studies during our first year of feasibility studies.

University of Colorado participation

Our membership in the WEST consortium has been financially supported by both the Department of Geological Sciences (John Andrews, Chairman) as well as by the University Office of Research (Risa Palm, Associate Vice Chancellor for Research). As our interests are interdisciplinary, it is expected that participation in WEST will extend beyond the Department of Geological Sciences to include CIRES and faculty within the College of Engineering.

The Department's representative to the Board of Directors is presently Roy Kligfield, with David Budd acting as alternate. On the scientific level, CU investigators' research in the WEST project include the following: Roy Kligfield (the variation and heterogeneity of deformation mechanisms throughout reservoirs; the geometry and kinematics of anticlinal reservoirs; measurement of deformation fabrics within reservoirs), David Budd (diagenetic heterogeneity within reservoirs, relationship between diagenesis and deformational fabrics in folded reservoirs, use of stable isotopes to trace fluid-rock interaction within reservoirs), Hartmut Spetzler (effect on seismic velocity and attenuation of reservoir heterogeneity, design of seismic experiments to view reservoir heterogeneity), Lang Farmer (use of isotopes to study sources of carbonate cements within reservoirs), and Erle Kauffman (high resolution stratigraphy as a correlation tool within reservoirs).

Alumni involvement

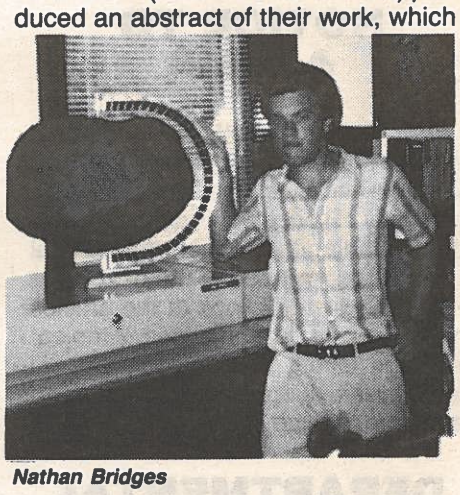
What can you, the alumni, do to help our efforts in research in the petroleum field? At the fundamental level, you can help by keeping open communication links to faculty members working in these fields. The faculty needs help in establishing contacts at industry labs and research groups in the Rocky Mountain area. Equally important is establishing such links within production groups working on Laramide Basin fields and fold/thrust belt fields.

Your representatives on WEST's Board of Directors would like suggestions of qualified and respected scientists from industry who would be willing to serve on WEST's Technical Review Committee. Names of suitable candidates along with a brief description of their talents could be sent to Prof. Roy Kligfield and he will forward them to WEST's executive director for consideration. Finally, if you have occasion to discuss energy issues with your state and federal representatives, we urge you to discuss WEST with them. ■

Profs. Roy Kligfield and
David Budd

NATHAN BRIDGES, UNDERGRADUATE STUDENT, OBTAINS INTERNSHIP AT LUNAR AND PLANETARY INSTITUTE

Nathan Bridges is an undergraduate in geology in the Department. In the summer of 1988 he was awarded an Internship at the Lunar and Planetary Institute (LPI—affiliated with the Johnson Space Center, Houston, Texas). During the course of the work, he and his advisor at LPI (Dr. Nadine G. Barlow) produced an abstract of their work, which



Nathan Bridges

should lead to a publication next year. The title of the abstract is "Variation of Martian Rampart Crater Ejecta Lobateness in Comparison to Latitude, Longitude, Terrain, and Crater Diameter." In essence, what Nathan was trying to determine was whether or not the morphology of the ejecta that comprise the ramparts of craters on Mars can be cor-

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related in any way with latitude, longitude, terrain, or crater diameter. All single-lobe craters larger than 8 km (a total of 1960) were mapped, together with the ejecta patterns. The perimeter and area of the ejecta were measured with a digitizer, and the "lobateness" was determined.

Nathan found that lobateness increases with increasing diameter of craters up to 33 km, above which data are too scarce to draw conclusions. Higher lobateness ejecta are concentrated in the southern hemisphere of Mars, but lobateness does not show a trend with latitude or longitude. This was the most comprehensive study done to date on lobateness, but future work is necessary for double-lobe and multiple-lobe ejecta.

We think the readers will agree that this type of experience is invaluable for a student, especially for an undergraduate. ■

QUATERNARY STUDIES IN PERU

Four members of the Department continued their studies in Peru. Don Rodbell (PhD student) used a Fulbright Award to work on the glacial geology. He completed work, begun in 1986, in the Cordillera Central, then he began studies in the Cordillera Blanca. Many cores from lakes and bogs have been collected, and Don will spend the winter in Lima analyzing the cores.

Dan Miller (PhD student) worked with Don Rodbell in the Cordillera Central. Basically, Dan collected a suite of soils across a climatic gradient in the high mountains. Little is known of the properties of the Andean soils and how they relate to the glacial geology. Dan's work will help close that gap.

Jay Noller (PhD student) continued his work on development of desert soils along the coast from south of Lima north almost to Ecuador. The overall goal is to see if El Nino events are recorded in the soils and, if so, to track the extent of the events N-S along the coast and back in time.

The fourth person in Peru was Prof. Pete Birkeland. The three people mentioned above are some of Pete's advisees, so he was there to oversee the work and to help out. As Pete said, "Somebody has to do it." ■

NOTICE TO ALUMS

Hey, you out there!! We need some articles regarding your professional and scientific activities. The "gossip sheet" that many of you return is great, but how about sending in a longer professional article to be included in the next issue of the Newsletter? Look at the articles in this issue to get some idea of the appropriate length and content. We will consider anything, and we will publish (almost) anything. ■

DEPARTMENTAL FIELD TRIPS

(if interested, contact Professor Hartmut Spetzler)

We have decided to re-establish an old tradition in having official Departmental field trips. We plan to hold two of these per year, one during each semester. The main purpose of these Departmental trips is to encourage all faculty and students to learn geology in the field from each other and to foster an atmosphere in which faculty and students can get better acquainted amongst themselves and with each other. We would also like to invite our alumni to participate in these trips. A limited number of places will be reserved for you and will be allocated on a first-come, first-served basis. It is a chance for you to get re-acquainted with your alma mater and refresh some of your knowledge or, who knows, learn something new.

(Top) Prof. Bill Atkinson (seated) argues some fine point of geology with graduate student Ted Scambos. Mkhuseli Jobodwana (South Africa) takes notes.
(Bottom) Scenery near Gunnison on the fall Departmental field trip

The faculty has enthusiastically endorsed this idea and many faculty members have proposed various field trips and have volunteered to lead them. It was difficult to make a selection and to choose a time. By the time you get this paper, the fall '88 trip to the Black Canyon of the Gunnison and the Powderhorn carbonatite complex, led by Profs. Bill Atkinson and Ed Larson, will be history.

In the spring we will probably go to the Rio Grande Rift Zone right after commencement, starting on May 13 and returning on May 16 or 17.

Tentative plans call for a fall '89 trip, leaving on Friday, September 22 and returning on Sunday the 24th.

We will ask you to pay the actual cost which, if you remember the budgets of students, will be quite low. (Should you wish to use this opportunity to help the Department to defray part of the cost for the students, you may make a tax deductible contribution directed toward the field trip.)

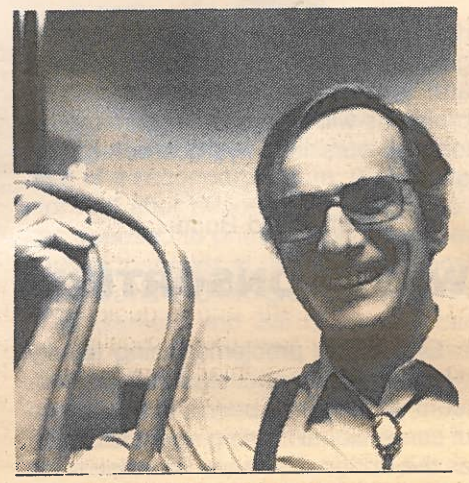
If you wish to participate in one of these two field trips, please send a $30.00 deposit/person to the Department (checks made out to the Department of Geological Sciences, University of Colorado). We will notify you very soon after the receipt of the check if we have room for you or return it with our apologies if we don't. Should you need to cancel, please let us know as soon as possible. We will return your money if we have not yet incurred expenses on your behalf, being sorry that you could not make it.

Should you have special requests such as a soft bed, please let me know, and I (Professor Hartmut Spetzler) will see what I can do. We hope that you will take advantage of our efforts to welcome you and include you in some of our activities.

Please express your interest as soon as possible so we may send you more detailed information. In the meantime, mark your calendars: Spring–May 13-17, 1989, and Fall–September 22-24, 1989. ■

A LETTER FROM A FORMER CHAIRMAN, PROF. HARTMUT SPETZLER

Time flies much too fast. It was only a little over a year ago that John Andrews took over the reins of the Department as Chair. I was to return to my professorial duties full-time, i.e. teaching, research and a moderate amount of service (in that order). Sometimes it is difficult for me, and I presume for some of my colleagues, to keep the priorities straight. Teaching brings many immediate rewards from close contact with students in the classroom, the field and the laboratory. One's efforts and successes, however, are very difficult to measure and quantify for official recognition by our colleagues and the administration. With research it is quite different. While it is still difficult to quantify both the quality and quantity of research, a good effort is likely to result in recognition from within the university as well as nationally and internationally. Once a good reputation is established it is likely, with a lot of work, to last a lifetime and the interchange with colleagues from all over the world is rewarding and satisfying. The rewards for active researchers are many: the excitement of being at the forefront of creating new knowledge, being able to bring this excitement and current results to the classroom, long-term relationships with ex-students, recognition by colleagues, invitations to present one's work and



Prof. Hartmut Spetzler, former Chair of the Department, holds up a chair for us to see.

join in projects, etc. Through research grants, faculty members can pay salaries and thus invite graduate and undergraduate students to join them in their research. Their own salaries can also be covered during the summer months.

With so many measurable rewards for the active researcher and so few tangible rewards for the dedicated teacher, it is difficult for professors to establish priorities whereby the students, especially the undergraduate students, don't get short-changed. For conscientious professors it is a life-long struggle to find a good balance between their dedications to teaching and research. For the most part the faculty in our Department has found a good balance. It is still a Department known for its dedicated teachers. The students gain from this dedication to teaching and the ever greater involvement of the faculty in high-quality research. With the recent decline in oil prices and the accompanying decline in student numbers, we can devote more time to the individual students, teach fewer and smaller classes and be involved in more research.

The return to professorial duties for me started with a sabbatical year. The University administration must have recognized my need to take a reprieve from administration and awarded me a Faculty Fellowship. With such a fellowship the University pays the salary for the academic year and the faculty member is free to pursue scholarly work. I decided to spend the majority of the time with my research group which had been so neglected over the previous few years. Instead of doing research in foreign lands, we were able to invite visitors to Boulder for joint work.

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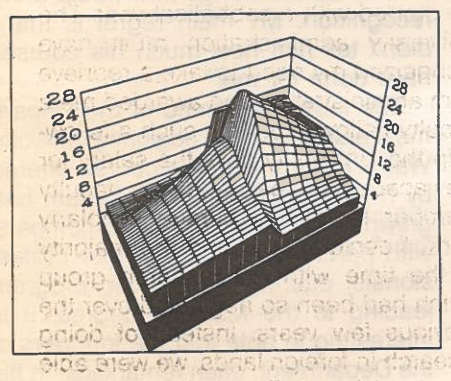
Laser interference pattern on surface of a crystal. See topographic display in following diagram.

We continued our research in rock-fracture mechanics in which four Soviet and two German scientists participated. In these studies we are looking to understand the physics and the chemistry which are involved when rocks break. I say physics and chemistry because we believe only by understanding the basic processes will we be able to extrapolate the results from our laboratory investigations to the real earth and to geologic times. In the course of these investigations we use instrumentation involving electronics optics and computers.

We measure the deformation of our rock samples with optical holography. This involves superimposing two three-dimensional pictures of our rock samples and looking for the deformation which occurred between the exposures. The accompanying pictures illustrate this procedure. An earthquake (really a stick-slip event) occurred on a natural fault in our sample. One exposure was taken before the event and one after. By superimposing the two images which were created by the two exposures, we obtain the interference pattern shown in the first picture. The dark lines are interference fringes and should be interpreted as contour lines showing the surface uplift which occurred as a result of the quake. The other picture shows a view of the uplift generated from a similar event by a computer. Using this geometric information and seismic signals recorded by a megaherz seismometer (a laboratory instrument developed by us which can faithfully record surface deformations up to several million vibrations per seconds) we learn about the energy partitioning in dynamic faulting. One of the German visitors was a young graduate student who is now using the techniques which he learned here to study the stress state in rocks recovered from what the Germans hope will be the deepest hole ever drilled into Earth's crust.



Topographic display of deformation shown in accompanying photograph. Units are each 10^{-5} inches.

This brings me to my first love, in my professional life that is, teaching. "Our Dynamic Earth," a course for non-science majors and a graduate course "Rock Physics" for geophysicists give me an exposure to the two extremes of our student body during the semester. With the graduate students we are exploring the physical processes as we are beginning to understand them from laboratory and mine experiments and are applying then to processes in Earth. It is challenging and satisfying to work with bright and interested young minds on the forefront of knowledge. During lectures in "Our Dynamic Earth," the large lecture room (Geology 121) is filled, with some students sitting on the floor They are not all as eager as the graduate students, having to fulfill some general science requirements and finding this course perhaps as one of the lesser evils. It is at this level where we have an opportunity to influence the educated and voting public. I take it as a real challenge to bring to class some of the excitement which I feel for science in general and the Earth sciences in particular.

Last year (1987) six members of my research group (including one undergraduate, two graduate students, one post-doc (Ivan Getting, a colleague for 11 years), and I traveled to Vancouver in British Columbia to attend and present results from our research at the meeting of the International Union of Geodesy and Geophysics. My wife and I traveled a non-direct route and enjoyed the West by motorcycle. We went via the Grand Tetons, Yellowstone and Glacier National Parks. Since I had made a commitment to present a paper at a meeting in Potsdam in East Germany during the week following the meeting in Vancouver, Ria and I flew to Frankfurt and left the motorcycle with friends in Vancouver. We rode the train from Frankfurt to East-Berlin, attended the meeting there and went on by train to Warsaw for a weekend with friends. The interaction with scientists and friends in the east-block countries can be very rewarding but also very frustrating. (I will be happy to tell you more on a field trip.) Ria returned from Warsaw to Frankfurt while I traveled on by train to Moscow and from there by four-wheel drive to a research station 350 km to the north near the Volga river.

Traveling through relatively back-country of Russia and stopping on occasion was fascinating. The roads were so bad that we averaged about 30 miles per hour. Mud was often knee-deep, and cars, trucks, and busses were all stuck. I feel that these conditions will soon improve because it is now possible for city dwellers to buy homes in the villages. Because city dwellers have much more clout in Moscow, they will surely exert the necessary pressure to get improved roads.

Our motorcycle was still in Vancouver at the beginning of August. Ria and I flew there and returned it home to Boulder. As we traveled (Cascades, Columbia River Gorge, Snake River, Salmon River, Sawtooth Mountains Craters of the Moon, Flaming Gorge, Dinosaur National Monument) I once again had a lot of time to explore and think. It occurred to me how much better this trip could have been had geologic structures been explained by Bill Braddock and Roy Kligfield, the evolution of the granites by Lang Farmer, the tectonics by Roger Bilham, Carl Kisslinger and Max Wyss, the landforms by Bill Braddock, the glaciers and alpine environments by Mark Meier, John Andrews and Giff Miller, the volcanics by Ed Larson, the igneous chemistry, mineralogy and petrology by Jim Munoz, Joe Smyth and Chuck Stern, the mining deposits and their history by Bill Atkinson, and the sediments and ancient climates by Ted Walker, Mary Kraus and Bill Hay, the soils by Pete Birkeland, the chemistry and behavior of waters by Don Runnells, the animal and plant world by Don Eicher, Erle Kauffman, Peter Robinson and Judith Harris, and the formation of carbonate rocks and petroleum by Dave Budd. Alex Goetz and Bruce Jakosky would give us near-surface, global, and extra-terrestrial views of many of the observations we make on the ground. ■

CENTER FOR THE STUDY OF EARTH FROM SPACE (CSES)

The Center for the Study of Earth from Space (CSES), a part of the Cooperative Institute for Research in the Environmental Sciences (CIRES), has been operating for over two years under the direction of Professor Alex Goetz. In that time the center has grown from four staff members to over 20 staff members and graduate students. Its focus is on developing and applying remote sensing techniques in researching problems in the earth sciences. Data from laboratory, field, air, and space-based instruments are used in studies in such diverse fields as geology, biology, and archeology.

One example of on-going research is found in the September 1988 issue of National Geographic. It describes the use of an imaging spectrometer which Dr. Goetz was instrumental in developing at NASA's Jet Propulsion Laboratory. By measuring infrared reflectance in detail over 872 contiguous channels from 0.45 to 2.5 micrometers, this instrument is capable of resolving enough detail in the electromagnetic spectrum to be able to discern between mineral species such as calcite and dolomite. This non-destructive technique was used in a project funded by National Geographic to analyze Mayan jade museum pieces. Most were found to be composed of jadeite and nephrite, but diopside and serpentine are other minerals comprising parts of some artifacts.

Various other projects are underway at the center. Last spring, Professor Bill Atkinson received a three-year $243,000 grant from NASA to study the Dolly Varden Mountains in Nevada using remote sensing techniques. Graduate student Joe Zamudio (see photo) is involved in unraveling the tectonic history of this small range. Professor Art Snoke from the University of Wyoming is also contributing to the effort. Landsat images have been digitally processed to enhance linear features which are now being field checked. Some of these features may prove to be faults that were active during the Mesozoic. The goal is to reconstruct the tectonic history of the Dolly Vardens from the Mesozoic in late Tertiary time. Aircraft imaging spectrometer data that has higher spatial and spectral resolution than the Landsat data is being used to produce mineralogical maps of the area. In the final synthesis, maps will be produced that show some areas where alteration minerals such as montmorillonite and tremolite are prevalent as well as defining areas where various igneous, volcanic and carbonate rocks are found.

Research associate Fred Kruse and graduate student Dan Taranik are studying data from flights over two areas, one in Nevada and one near Cripple Creek, to evaluate NASA's latest remote sensing instrument. Their aim is to detect subtle mineralogical variations in rocks and soils in these semi-arid climates.

One goal of other related research at CSES is to be able to state quantita-

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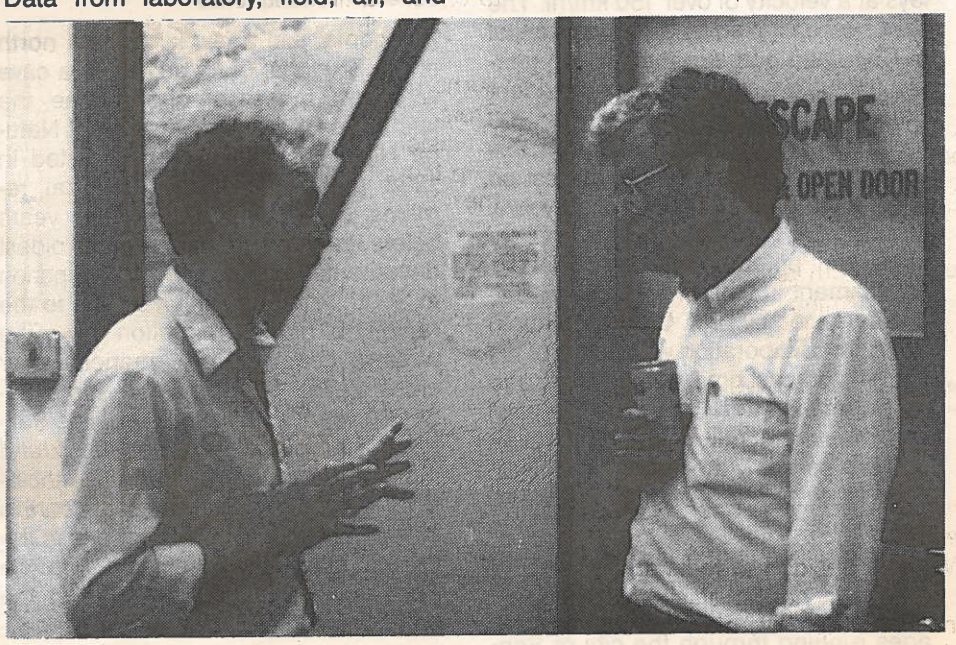

Prof. Max Wyss (geophysics) and Prof. Alex Goetz (Director of CSES) discuss a multi-fingered topic.

tively how much of the surface area in a particular picture element (pixel) of a scene is composed of a certain mineral. Graduate student Joe Boardman and others are involved with the development of algorithms that analyze data quantitatively for end-member materials within individual pixels. For example, when this work is completed, one will be able to say how much of the ground in some area is covered by mineral A and how much is covered by mineral B.

Graduate student Joe Zamudio with PIDAS (Portable Instantaneous Display Analyzing Spectrometer) in the field near Cuprite, Nevada

Scientists and other citizens around the world are finally beginning to recognize the effect that man's activities has upon his surroundings. As various earth sciences study the changing patterns of the earth's environment, remote sensing is the tool of common use, whether measuring ultraviolet, infrared, or microwave wavelengths. It is important that many disciplines study the processes of global change which will have a direct effect on our quality of existence into the next century. ■

Joe Zamudio
PhD candidate

THE GEOPOLITICS OF CHILE

Political activity in Chile has recently been making news in the U.S., but this would be of little significance if the Maipo volcano (see photo) were to erupt again, as it did a few hundred thousand years ago. At that time about 500 cubic kilometers of rhyolitic pyroclastic flows poured out of this volcano and flowed down the Maipo River and nearby valleys at a velocity of over 150 km/hr. The area now occupied by Santiago, capital of Chile and home to four million people (including soon-to-be ex-president Pinochet), was covered under 100 meters of hot material. Although this eruption was one of the ten largest on this planet during the last million years, its existence, size, age, and the implications for potential volcanic hazard assessment in Chile were only recently determined by Prof. Charles (Chuck) Stern, in collaboration with some of his current and past graduate students, and in cooperation with Chilean geologists. Chuck's work is part of a research project sponsored by the National Science Foundation on the origin of Andean volcanism.

Chuck's results so far indicate that Maipo is only one of three large stratovolcano/caldera centers that feed drainages running through the city of Santiago. It appears that explosive rhyolitic

Maipo Volcano, Chile

eruptions from such centers are repetitive events. It also appears that even smaller eruptions on these snow-covered peaks, among the highest in the Andes, could generate mud flows that would be disastrous for Santiago. Such mud flows have certainly occurred in the past. Nevertheless, Chile, like Columbia, has no volcano-monitoring facilities to evaluate any of its over 200 volcanos. Politics!

Despite the potential socio-political significance of explosive eruptions of Chile's many stratovolcanos, Chuck has recently been receiving much more support from the National Science Foundation and the National Geographic Society for research on the less-dramatic Pali-Aike volcano (see photo). This small, extinct basaltic spatter cone is in the southernmost plains of

Pali-Aike Volcano, Chile

Patagonia, just a few kilometers north of the Straights of Magellan. In a cave within the inner wall of this cone, the late Junis Bird of the Museum of Natural History in New York excavated in 1938 prehistoric human cultural remains dated as about 11,000 years before the present. It is one of the oldest documented sites of human occupation in South America, which attests to the rapidity of human migration down the western coast of the Americas after crossing the Bearing Strait some 20-25,000 years ago. In a 1976 visit to Pali-Aike, Chuck and his wife Alex found mantle-derived garnet peridotite inclusions; these are fragments of the earth's interior transported to the surface in the basaltic magmas associated with the Pali-Aike cone. Such samples of the earth's mantle are common in diamond-bearing kimberlite pipes, but such deeply derived mantle xenoliths had never before, or since, been reported in association with a basaltic eruption. These samples provide a window through which to study the processes of generation of basaltic magma and the evolution of the continental lithosphere in a region with a very different history than those in which kimberlite pipes form. Many of their initial results were presented in 1986 at the 4th International Kimberlite Conference in Perth, Australia. The Department's new microprobe should allow them to improve by an order of magnitude our understanding of these unique rocks.

More recently Chuck has begun again to focus on the anthropological implications of the occupants of the Pali-Aike cave, and with support from the National Geographic Society has started analyzing the composition of obsidian artifacts from Pali-Aike and other Patagonian sites. His goal is to trace trade and migration routes, particularly the nature of the interchange between the plains and coastal peoples; only the latter had direct access to the sources of obsidian to the Andean volcanos. Chuck is now asking the National Geographic Society for funds to actually follow some of the proposed migration and trade routes of these ancient people, and just in case he gets it, let him say good-bye now! ■

Prof. Charles Stern

THE BIRTH OF THE DEPARTMENT

The University was founded in 1877, with two faculty members and 44 students. The first president of the University, Dr. J.A. Sewall, taught six courses in several disciplines, including a course in Mineralogy and Assaying. However, the Department of Geological Sciences at CU began officially in 1902 with the arrival of N.M. Fenneman as its first full-time faculty member. Fenneman, who stayed just one year before going to the University of Wisconsin and then to the University of Cincinnati, later became one of the most famous of American geologists for his pioneering work in physiography. Fenneman was replaced by Russell D. George in 1903, who remained until his retirement in 1933. In addition to his job as Department Head, Dr. George 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 Great Depression. In 1904 Dr. George recruited R.D. Crawford, who later obtained his PhD at Yale. Dr. Crawford was admired and respected by students and professional peers alike. His course load included crystallography, mineralogy, petrology, ore deposits, and field methods. Crawford conceived the notion of a northeast-trending Colorado Mineral Belt, related to an alignment of Tertiary intrusives extending from the Four Corners area to the mountain front at Jamestown. Many of Crawford's early ideas have been proven correct by later researchers. When Crawford joined the faculty, the Geology Department was housed on the fourth floor of Hale Science Building, which had been completed in 1893 and named for the second president of CU. Several tons of rocks, minerals, and fossils, housed in huge oak cases, were hauled up three flights of winding stairs in Hale. Soon after his arrival, Crawford began to work long hours on plans for a new geology building. The building was completed in 1911 and still houses the Department!

A third faculty member, Philip G. Worcester, arrived in 1912. He completed a PhD at Chicago in 1924 and became a full professor. Dr. Worcester's specialty was geomorphology, but his interests were wide and varied, both professionally and personally. He worked for the Colorado Geological Survey from 1912 to 1927 and was a consultant for Canadian Exploration Company for many years. He also served as Dean of the Graduate School from 1946 until he retired in 1953. A fitting tribute to his stature as a teacher is contained in a letter sent to the Department by Dr. David Harris (PhD, 1959): "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."

The formative period of the Department ended with the beginning of World War I. From the single course offered by President Sewall, the program had grown to include three faculty members, with part-time help from other professionals, offering a balanced program leading to the Master's degree. It is interesting to note that the founders of the Department, each remarkable in his own right, were contemporaries of Fran-

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cis 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), all names that were subsequently memorialized in structures on the campus.

Some other clearly-defined periods in the history of the Department were World War I, the Roaring Twenties, the dismal thirties, World War II, and the post-war period. (The above information was taken entirely from Larry Warner's book "Profile of a Department: Geological Sciences.") ■

DEPARTMENTAL HISTORY, BY LARRY A. WARNER

In 1986, Professor Emeritus Larry Warner wrote a 77-page history of the Department of Geological Sciences. Larry is a wonderful writer, and anyone who has ever had any contact at all with the Department will enjoy reading this book. It covers the entire evolution of the Department, from the arrival of the

Larry Warner, author of **Profile of a Department: Geological Sciences**

first professor of geology, N.M. Fenneman, in 1902, up to 1986. The book is hard-cover, maroon in color, with many wonderful photographs and illustrations. To obtain a signed copy, send $12 to Mrs. Edith Ellis, Department of Geological Sciences, University of Colorado, Boulder, CO 80309-0250. ■

NEW ANALYTICAL FACILITIES

An alumnus gift of $35,000 enabled the Department to expand and renovate analytical laboratory space on the first floor of the building, expanding from 640 to 2000 square feet. Included in the new facility is a state-of-the-art electron microprobe. The probe cost approximately $500,000, with half of the money coming from the University and alumni gifts, and half from a National Science Foundation grant. Dr. John Drexler is in charge of the analytical facility. He points out that the new probe is largely computer-based and will allow a great many analyses to be performed that were not possible with the old instrument, including the very light elements. Examples of some of the first projects to use the new facilities include the analysis of superconductors and computer disks, sources of metal contamination from old smelter slags, and the determination of the composition of dinosaur eggs. ■

METEORITE HIT MAY HAVE SCOURED THE GULF

Profs. Thor Hansen of the University of Western Washington and Erle Kauffman of CU have suggested that a massive ocean wave, perhaps as high as 300 feet, crashed against the Texas coast 66 million years ago. The wave may have been triggered by a large comet or asteroid that hit the ocean. Masses of sediment, including shark's teeth, were deposited in a creek bed in Falls County in central Texas. The deposit is at the Cretaceous-Tertiary boundary. The scientific details of the work were published in late 1988 in *Science* magazine. ■

A NOTE FROM YOUR EDITOR

In 1987 the Departmental Advisory Board recommended that we change the Newsletter from the old, typewritten style to this new newspaper format. This is the third issue in the new style, and I can tell you that the response has been overwhelmingly positive and most heartening. It is a lot of work to edit and publish the Newsletter, but it is also a lot of fun. Perhaps the thing that makes it most enjoyable is the information that we receive, and publish, from the students and alumni.

The Editor: Don D. Runnells

Unfortunately, this year we did not receive any professional or scientific articles for publication from alumni. Last year we had two or three such articles. Please, if you have any item that you think might be of interest to your fellow geologists or geophysicists, send it in for publication. After you finish reading this Newsletter, you will recognize that an article does not have to be very intensive or very rigorous to merit publication. We are simply looking for interesting items. How about giving us a hand next year?

A special word of thanks to Prof. Bill Braddock for taking many of the photos that you see in this issue of the Newsletter.

Thanks very much for your letters and notes. We really appreciate your suggestions and comments. ■

Prof. Don Runnells
Editor

THE MAURICE EWING MEDAL TO WOLFGANG H. BERGER

Wolfgang H. Berger received his Master of Science degree from the Department in 1963. He then went on to obtain a PhD from Scripps, where he now works as a Professor of Oceanography. At the meeting of the American Geophysical Union in December, 1988, Wolf received the Maurice Ewing medal for his research in marine geophysics. The medal is awarded jointly by the American Geophysical Union and the United States Navy. Wolf is probably best known for his use of biogenic sediments to reconstruct the history of the ocean basins. Perhaps the best description of the reasons for the award comes from the citationist, Robert C. Douglas: "In searching among the more than one hundred and twenty or so papers that Wolf has produced, I rediscovered that they contain not a few but a nearly constant flow of ideas and innovations that have challenged and inspired us." We add our congratulations to this distinguished alumnus. ■

IN MEMORY

A good friend, **Audrey Eicher,** wife of Prof. Don Eicher, died August 30, 1988. Audrey received her PhD in Education from CU in 1983. She was 56 years old. She and Don returned from a trip to Kenya only a few weeks before her death. She was a gracious and kind lady, and she will be sorely missed by all of us who knew her.

Robert L. H. Regout died of a heart attack on the 3rd of August, 1987. He was in France at the time. His wife lives in Brussels, Belgium. ■

ALUMNI NEWS

Here is everybody's favorite part of the Newsletter, the news and gossip from your old buddies! (Next year we hope to publish a few photographs of the alumns in this section. If you have a recent photo handy, please include it when you send in the summary of your activities; we will publish as many as space permits.)

Lawrence Anna—BA 71—Exploration Geologist, Bass Enterprises Production Co., Denver. Obtained his MS in 1974 from South Dakota School of Mines. Married to Ruth (Journalism, 71), with two grade-schoolers. Several publications on structural controls on sedimentation in Rocky Mountain basins. Reports that his boss is Michael Lane (CU geology, about 1961), and that several others in the office graduated from CU. (Let's hear from them also next year, huh?)

Dale Anderson—BA 77—Senior Consulting Engineer with Precision Visuals, Boulder. Company develops color graphics software. After six years in geological exploration, Dale went back to CU-Denver to learn to talk to computers. He then spent five years developing geologic software. Still single and living in Boulder.

Vic Baker—PhD 71—Vic is a member of the Departmental Advisory Committee. He has a new book out, edited with R.C. Kochel and P.C. Patton, on Flood Geomorphology. Vic was recently named one of the first nine Regents' Professors at the University of Arizona; this is a great honor, recognizing both his innovative research and excellence in teaching.

Fred Barnard—PhD 68—Consulting mineral exploration geologist. In 1987 worked in Asia, Africa, Europe, South America, and North America. Gave invited paper on "Gold Deposits of China" at Northwest Mining Assoc. meeting in 1987. Wife Nancy working on PhD in English at CU. Two children.

Joe G. Barnes—BA 61—Retired in Grand Junction, CO. Married to Thelma in 1983. Spent 30 years in engineering geology with U.S. Bureau of Reclamation. Worked on investigation and planning of numerous dams and other structures in western Colorado and Utah. Still active as a consultant.

Scott M. Barton—BA 82—Obtained his MD from Tulane in 1986. Working at CU Health Sciences Center in Denver. Specializes in obstetrics and gynecology. Married to Laura, with one child. Lives in Boulder.

Richard J. Batt—PhD 87—Visiting Assistant Professor, Hope College, Holland, MI. Is looking for a permanent position in teaching and would appreciate any leads. Most recent publication is on distribution of ammonite shell morphotypes in the Western Interior Greenhorn Sea. Lives in Holland, MI. Involved in competitive classics dance roller skating; he is upset that the event is not yet included in the Olympics.

Allan G. Bird—MS 58—Semi-retired. Living in Lakewood, CO. Author of two books: "Silverton Gold" and "Bordellos of Blair Street." The latter is the story of the red-light district in old Silverton. He was general manager of the Sunnyside Mine at Silverton from 1971 to 1977.

Thomas M. Berg—BA 62, MS 67—Associate State Geologist and Chief, Geologic Mapping Division, Pennsylvania Geological Survey. Living in Dauphin, PA. Has several Atlas Reports, one County Report, 1980 Geologic Map of Pennsylvania, Stratigraphic Correlation Chart of Pennsylvania, and other publications. His wife Betty is working on her Master's degree in nursing. Three of their five children are married.

Willson W. Bell—BA 52—He and his wife joined the Peace Corps in June, 1985 and spent 26 months in Sierra Leone, West Africa. They were involved with a program in rural water supply; they had a wonderful time and highly recommend the experience to anyone. Living in Englewood, CO.

William H. Bird—MS 67—Changed companies in May, 1988. Now Chairman of Palomar Capital Corporation. Living in West Vancouver, Canada.

Terence C. Blair—Living in Boulder, Colorado. (Terry—We would like a bit of news from you next year!)

Dudley W. Bolyard—MS 56—Chairman of Bolyard Oil and Gas, Ltd. In 1955 Dudley completed the ascent of all of the 14,000+ peaks in Colorado. Received Honorary Member status in Rocky Mountain Association of Geologists in 1986; he is past-president of the Association. In 1986 organized the Denver Earth Resources Library for the RMAG. Lives in Littleton, CO.

Whitney A. Bradley—BA 50, MS 52—Worked for 16 years for Marathon Oil Company throughout Rocky Mountains. Resigned in 1970 and went

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to work for the USGS, Minerals Management Service, and for the Bureau of Land Management. Received the Department of Interior Superior Service Award in 1988. Living in Casper, WY.

Julie Brigham-Grette—MS 80, PhD 85—Assistant Professor, Dept. of Geology and Geography, University of Massachusetts, Amherst, MA. Had Post-Doc fellowships in Norway in 1983-1984 and Canadian Geological Survey, 1985-1987. Married to Roger Grette, CU Alum, 1982 in geology. Working on projects in Alaska, funded by NSF.

Jack H. Brown—BA 35—Age 77. Retired back to Colorado in 1977, and moved to Green Valley, Arizona, in 1981. Consultant in Kansas for 25 years. In his words: "Had a great profession; had a great time (still am). Married over 50 years (still am)." (Good for you, Jack!).

Joe F. Brown—BA 49—Retired in 1981 from Exxon after 32 years. Living in Lindale, east Texas, halfway between Dallas and Shreveport, off I-20. Time spent in golfing, fishing, dancing, and bridge.

Robert H. Butcher—BA 60, MS 62—Civil Service Claims Examiner, Office of Personnel Management, Washington, DC. (Note: He says that his position makes him a "Running dog of Yankee Imperialism." That's what he said, folks; don't blame the editor!). Remarried, 1985. Formerly president of Queen City Exploration, Inc., Denver; accepted reality in October, 1986 and closed the office (That's what he said, folks!)

Newell Campbell—MS 66—Department of Geology, Yakima Valley College, Yakima, WA. Several publications on structure and stratigraphy along the margin of the Columbia River Basalt area, central Washington. Co-chaired symposium on oil and gas in the Columbia Basin, WA.

Susan H. Cannon—MS 85—Engineering Geologist, Colorado Geological Survey, Denver. Published articles in 1988 on a model for the rate of motion of debris flows, and on lag rates as a method for determining distances of movement of debris flows.

Diana Grunig Catalan—BA 71—Geologist, secretary, handyman, and treasurer for Hayes Petroleum Co., Rangely, CO. Married last year to Chilean native. Guesses that she will have to learn more about volcanic rocks and other things rarely seen by a geologist in Rangely.

Karen P. Christopherson—BA 77, MS 79—Resigned from Standard oil to become a consulting geophysicist, working primarily in Papua New Guinea and Australia. Still single and looking. She lives in Evergreen, Colorado.

Rob Cifelli—BA 83—Hydrogeologist, Industrial Compliance Inc., Golden, CO. Received his MS in hydrogeology from West Virginia University in 1986. Lives in Boulder, CO.

Jon Clark—BA 86—Currently finishing his MS degree at the University of Oklahoma. Interest in geochemistry, with thesis topic in maturation of oils and source rocks in Rainbow area of Alberta, Canada. Travelled to eastern Europe for his honeymoon in July.

Julie Clark—BA 83—Exploration Petroleum Geologist for Bounty Developments Ltd., Calgary, Canada.

Peter Clark—PhD 84—Assistant Professor, University of Illinois, Chicago. Publishing on subjects in glacial history and subglacial dispersal of sediment. Enjoys the architecture in Chicago, but misses the Flatirons. Working in midwest and Labrador.

Margaret Aeschback Combs—BA 25—Received an MA from Columbia Teachers College. Retired and living in Durango. One of three women in her class in 1925.

Charles S. Content—BA 74—Retired in 1975 from Bechtel Corp. Doing some consulting in engineering geology for power companies and water-resource companies. Wrote the booklet "A Geologist's Sketch Book." First wife, Mary Carolyn Warren of Boulder, died in April, 1987. Spends two weeks each year in Punta Vallarta, Mexico, in condo at Costa Vida. Lives in Danville, CA.

Marshall (Marsh) K. Corbett—PhD 64—Senior Hydrogeologist, Northern Engineering and Testing, Helena, MT. Married, with two daughters and one grandson. Seventeen years in teaching at university level. Spent five years as Senior Explorationist for Williams Exploration Co. and Amerada Hess Inc. in Denver. Took 12 graduate credits in applied hydrology and then accepted present position.

John M. Coss—MS 84—Senior geologist, Conoco, Midland, TX. Married with two sons.

Mark Davis—BA 69—Mineral Resource Chief, Colorado Geological Survey, Denver. Mark also obtained an MS from the University of Utah and an MS in Civil Engineering from the CU, Denver. Lives in Arvada, Colorado.

P. Thompson (Tom) Davis—PhD 80—Associate Professor of Geology, Bentley College, Waltham, MA. Works and publishes in Quaternary geology and hydrology.

Paul H. Dawson—BA 52—Retired in 1987. Was head of Geology Dept., College of the Siskiyous, Weed, CA. At COS for 25 years. Married to Priscilla, with five grown children (two geologists, two teachers, one mechanical engineer). Past president of the Western Section, National Association of Geology Teachers. Presently enjoying research on Mt. Shasta, writing, and flying his own plane.

Norm DeHart—BA 80—Manager, Land Seismic Operations, C.G.G. American Services, Denver, CO. After graduation he spent six years supervising geophysical exploration working in the western U.S. and Alaska.

Donald T. Deininger—BA 70—Supervisor of Production Geology and Geophysics, Mobil Oil Corp., Producing Dept., Denver. Married, no children.

Sharon Fay Diehl—BA 74—Currently enrolled in MA in Basic Science. Geologist for USGS, Branch of Risk Assessment. Married in 1985 to Michael Chornack. Two dogs, no kids. Present work is on Nevada Nuclear Waste Storage projects. Lives in Boulder.

Petra Doll—MS 88—Research Hydrogeologist with Geologisches Landesamt Hamburg, Federal Republic of Germany. (See separate article about Petra in this Newsletter.)

Greg R. Doubek—BA 81—Mine Geologist, Nevada Gold Mining, Inc., at the Sleeper Mine, Winnemucca, NV. Single, with one Springer Spaniel. Has worked for AMAX and its subsidiaries since graduation. Says the drill chips are loaded with gold.

Russell F. Dubiel—PhD 87—Geologist, USGS, Branch of Sedimentary Processes, Denver. Married and living in Boulder. Presently working on the Triassic Chinle Formation of the Colorado Plateau. Interests include sedimentology, trace fossils, and paleoclimates.

Essi Esmaili—PhD 83—Senior Hydrogeologist for Dames and Moore, Geosciences Group. Living and working in Anaheim, CA.

Gwyn Fivemer—BA 88—Works for Computer Sciences Corporation. Telescope operator for the International Ultravideo Explorer at NASA's Goddard Space Flight Center. Works with astronomers using America's only orbiting telescope. Lives in Laurel, MD.

Richard Flower—BA Geology, BS Finance 85—Still thinking about looking for a job! Lives in Boulder.

W.A. Friley, Jr.—BA 78—Senior geologist with Morgan Hydrocarbons, Inc., Calgary, Alberta, Canada. Married, with two children.

R. Medley Gatewood—BA 62—Graduate of US Air Force Command Staff College. Retired from USAF in 1986 after 24 years as fighter pilot. Saw geologic wonders of the world from sea-level to 45,000, with 4,000 hours in the seat of a fighter. Presently working for Logicon, Inc. (aerospace/computer applications), in Albuquerque, NM.

Mary Alice Scott Gaunt—BA 25—Retired. Taught science in Brighton, Colorado, School District from 1925-1927 and 1955-1964. (She didn't tell us what happened during the intervening 28 years. Next time, Alice?) Living in Brighton.

Paul B. Gillier—BA 84—Project Specialist for So-Deep, Inc. (utility-locating company). Married in 1986 to Katherine Melendez. Plans to go back to school in environmental engineering and geology.

Mike Glaze—MS 83—Senior Hydrogeologist and District Manager for Environment and Ecology, Inc., Los Angeles. Mike tells us that one of the most important things he learned in graduate school was how to write a report.

Sarah Gray—BA 83—PhD candidate in Earth Sciences, University of California, Santa Cruz. Specializing in geological development of Pacific atolls and coral reefs. Doing research on the effects of El Nino on atoll lagoons.

Peggy Guccione—PhD 82—Assistant Professor, University of Arkansas. Publication on geology of Crowley's Ridge in GSA-DNAG series. Also working with education of earth science teachers in Arkansas and Missouri with funds from the NSF and the State of Arkansas. Lives in Fayatteville, AR.

James R. Guilinger—BA 73—Senior Geologist, Kendall Ventures, Lewistown, MT. Married with four children. Currently involved in developing the reserve base for opening a heap-leach gold operation in Montana. Lives in Arvada, CO.

Paul E. Hammond—BA 52—Associate Professor, Department of Geology, Portland State University, Portland, OR. PhD from University of Washington, 1963. Married since 1955. Served as Department Head, 1984-1987. Continuing field work in Cascade Range.

Paul J. Hearty—PhD 87—Assistant Professor, Duke University Marine Lab., Beaufort, NC. He is developing strategies for dating sediments collected in piston cores from lakes in the African Rift Valleys, with the goal of determining climatic and tectonic events in Late Pleistocene. Also working on coastal stability and changes in sea level in Mediterranean and West African regions.

Mary Hill—Living in Santa Fe, New Mexico. (Come on Mary, how about a little news next time?)

William L. Hiss—PhD 75—Stock broker and Associate, Hambrecht and Quist, largest venture capital organization in U.S. Living and working in Palo Alto, CA. Bill has a number of publications on the ground water of the Permian Capitan aquifer of southeastern New Mexico and West Texas, Rio Grande Valley, and Gallup Navajo area of western New Mexico. Has taken a serious interest in ballroom dancing; tells us that there is nothing like the Argentine Tango to remind one to stay single.

Vance T. Holliday—PhD 82—Assistant Professor, Department of Geography, University of Wisconsin, Madison. Recent publications in *Geology, Quaternary Research,* and several of the GSA-DNAG volumes. Elected to offices in American Quaternary Association and the Quaternary Division of the GSA. Vance recently received an NSF grant to study valley fills and paleoenvironments on the southern High Plains.

Zhonguian Huang—Institute for Crustal Dynamics, Bejing, Peoples Republic of China.

Karen Marie Charles Hussey—Retired and living in Denver. (Please, Karen, a bit more news next year?)

Jeffrey L. Hynes—BA 72, MS 74—Senior Engineering Geologist, Colorado Geological Survey, Denver. Married, with three kids (youngest is 17). Current chairman of the Rocky Mountain Section of the Association of Engineering Geologists. Member of State Hazardous Waste Regulation Committee. Member of Highway Geology Symposium National Steering Committee.

Dana Isherwood—PhD 75—Senior Legislative Analyst for Director, Lawrence Livermore National Laboratory, Livermore, CA. Served as Science Congressional Fellow working for Senator Albert Gore. Now interpreting science congressional staff and interpreting legislation for scientists. In 1987 she and her husband, Bill, climbed Aconcaqua, the highest mountain in the western hemisphere at 23,000 feet. Living in Orinda, CA.

William Isherwood—PhD 76—Project Manager, Environmental Production Dept. and Geophysicist in Earth Sciences Dept., Lawrence, Livermore, CA.

Richard D. Jaeger—MS 69—Science teacher in Tulsa public schools. Married, with three children. Living in Tulsa.

Kurt W. Johnson—BA 82, MS 85—Exploration Geologist, Shell Offshore, Inc., New Orleans, LA. Married, with one child. (Says he is surviving in the south, but hopes to move back to America someday. *He* said it folks; don't blame the editor!) (Answer to your question Kurt. If you want to buy a Geology T-shirt, just drop a note to the President of the Geology Club, at the Departmental address.)

Sandra L. Jones—MS 88—Staff Scientist for Woodward-Clyde Consultants, Inc. Living and working in Denver. (See a separate article on Sandra elsewhere in the Newsletter.)

William R. Judd—BA 41—Consultant and construction arbitrator. Professor Emeritus of Civil Engineering, Purdue University. After leaving CU he worked for the US Bureau of Reclamation, Colorado Water Conservation Board, Denver and Rio Grande Western Railroad, and Rand Corporation. Bill joined the School of Civil Engineering at Purdue in 1966. He is co-author with D.P. Krynine of the book *Principles of Engineering Geology and Geotechnics*, which has undergone some 15 reprintings since publication in 1957.

Dawn S. Kaback—PhD 77—Environmental geochemist with the DuPont Company, Savannah River Laboratory, Aiken, South Carolina.

Brian G. Katz—MS 75—When last heard from, Brian was married and working as a hydrogeologist with the USGS in Maryland. He was also working on his PhD in geochemistry at Johns Hopkins University.

James Michael Kelly—BA 64, MS 67—Vice President of Atlas Minerals, Grand Junction, Colorado. Received his PhD from Wisconsin. Married, with two teenage children. From 1972 through 1984 he was with Getty Mining Company, finishing up as Exploration Manager, U.S.A. Lives in Grand Junction.

Karen Duttweiler Kelley—BS 79—Geologist, USGS, Denver. Received an MS from Macky School of Mines, Reno. Married in 1986 to David Kelley, also with USGS in Denver. Lives in Lakewood, CO.

J. Houston Kempton—MS 88—Hydrogeologist with Woodward-Clyde Consultants, Denver.

Roy C. Kepferle—BA 50—Professor, Dept. of Geology, Eastern Kentucky University, Richmond, KY. Lives in Cincinnati, OH. MS from South Dakota School of Mines and PhD from Univ. of Cincinnati. Married, with seven children and five grandchildren. Recently returned from lecturing in Egypt. Primary research interest is in Devonian black shales and the clastic wedge. Teaches summer field camp, headquartered at Western Montana College, Dillon.

Ralph L. Langenheim, Jr.—MS 47—Professor of Geology, University of Illinois, Urbana. Ralph regularly leads field trips to the Colorado Plateau for undergraduates from the University of Illinois. He was also co-leader of a wonderful four-day G.S.A. field trip from Las Vegas to Denver, to commemorate the early surveys by Hayden, Wheeler, and Powell. Your editor had the good fortune to be able to go on that trip. (Ralph has indicated that he would be willing to lead the trip again if sufficient people express an interest. If you think you might enjoy such a trip, contact Ralph directly at the Department of Geology, University of Illinois, Urbana, IL 61801. Highly recommended!).

James Leithead—BA 50—Assistant General Counsel, Cities Service Oil Co., 1970-1979. Now in private practice, Tulsa, OK.

Steve Ludington—MS 69, PhD 74—Serving as Associate Chief, Branch of Resource Analysis, USGS, Menlo Park, CA. He is presently involved in technical assistance programs in gold exploration in Costa Rica and Venezuela. Lives in Palo Alto.

Michael K. Madan—BA 77—Worked for Minatome Corp. in uranium exploration 1977-1979. Now Vice president and general manager of Madan Plastics, Inc., Cranford, NJ. Married to Linda Strovel, with three children. Still playing Bluegrass and old-time music on the mandolin, guitar, and now, the fiddle. He says that he misses geology and the mountains.

Terry J. Mather—MS 67, PhD 70—Co-owner of Lariat Exploration, Inc. Married to Anne, with two children. Lives in Littleton, CO.

James R. McElroy—BA 51, MS 53—Consulting petroleum geologist, Brandon, Mississippi. Lives with wife, Dot, and five children. Four grandchildren scattered around the country. Trying desperately to lower his golf handicap.

Spencer Charles McIntyre—BA 82—Presently an attorney with Perkins Coie, Seattle, WA. Received his Juris Doctor from Georgetown University in 1988. Married to Eleanor Durham in 1986.

Robert E. Murphy—BA 30, MA 32—Retired in 1972 from Mobil Oil. Now Living in Roswell, NM, with continuing consulting activities. Bob was born in 1907.

Frederick N. Murray—MS 62, PhD 66—Geological consultant working in coal, oil, and gas in the midwest. Currently President of the Oklahoma Section of the A.I.P.G. Says he has recently had several calls for copies of his thesis map from western Colorado. Lives in Tulsa.

John J. Musser—Grad. student, 54-56—Has been with USGS for 32 years. Now Associate Chief of the Louisiana District of the Water Resources Division. Married to Nancy for 35 years. Has publications in the field of mining hydrology and acid-mine drainage. Enjoys living in Baton Rouge. No plans to retire in near future. Still playing tournament-level chess.

George Newmarch—BA 52—Engineering Geologist, California Dept. of Water Resources. Lives with his wife, Cindy, in Sacramento. Publications on Delta Subsidence Investigation. Currently directing installation of extensometer and global positioning system networks to measure subsidence in the Sacramento-San Jaoquin Delta, California. Portions of the delta may be subsiding at rates up to three inches per year.

Kim Thomas Nordstog—MS 82—District Geologist, Enserch Exploration Inc., Denver. Two daughters—Tess and Dara. Lives in Denver.

D. Kirk Nordstrom—MS 70—Aqueous geochemist with USGS, Water Resources Division, Menlo Park, CA. Co-author with Prof. Jim Munoz of the textbook "Geochemical Thermodynamics."

Patricia Nott—BA 83—Worked for Chevron, in the Alaska Exploration Department before switching to selling real estate for Miller and Associates in Tahoe City, CA. Engaged to Chris Werfel. Skis on snow and water.

Mark Oldcorn—BA 87—Field Engineer, Geotechnical Consultants of Massachusetts, North Andover, MA. Going to Thunderbird School in Phoenix, Arizona, to combine background in geology with a business degree. Lives in Wellesley, MA.

Anne Snyder Peper—BA 43—Partner with her husband Bob in a small gold mine in Mores, Chihuahua, Mexico. Traveled in 1987 to Kenya, South Africa, and Namibia. Looked at deposits of tantalite and diamonds. She and Bob spend time every February at the Tucson Gem and Mineral Show. Living in Orem, Utah.

Heidi Pearlman—BA 83—Graduate Research Assistant at CU, Denver. Working on a Master's degree in Information Systems. Prior to going back to school she worked in seismic data processing and interpretation for four years. She and three others started a small company, Exploration Development.

Alan Reid—BA 58—Chairman of the Board and Chief Executive Officer of ERC Industries, Inc., Houston, TX. (Please, Alan, send a little more information next year about yourself and your activities. Thanks.)

Gerald M. Richmond—PhD 54—Senior Geologist, Central Regional Geology Branch, USGS, Denver. Project Chief for Quaternary Map of United States. Has completed field work and map of Quaternary Glaciation of the Wind River Range, west of the Divide. Working on Tertiary geology of northern part of upper Green River Basin.

Charles S. Robinson—PhD 56—Chief Executive Officer of Mineral Systems, Inc., since 1981. Does consulting in mining geology, mineral exploration, and engineering geology. He has more than 40 publications in a variety of fields of geology. Charles is a member of numerous professional societies, and serves as Editor of the journal *Engineering Geology*, Elsevier Press. Living in Golden, CO.

James G. Ritchie—MS 65—Project Geologist/Manager with Dames and Moore Consulting Engineers, San Francisco. Married in July, 1988. Involved with CU Alumni Rugby Club, which he started; now organizing their next tour for spring, 1989. Living in San Mateo, CA.

Donald T. Rodbell—MS 86—Don is a PhD candidate in the Department. (See a separate article regarding Don's activities and awards in this Newsletter.)

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Thank you.

John W. Rold—BA 48, MS 50—Director of the Colorado Geological Survey (CGS). Married, with four children and two grandchildren. Perhaps the most important thing to happen recently to John was the result of the Governor's Task Force on the Colorado Geological Survey, in which they concluded that: "The mission and responsibilities of the CGS to the economic, environmental, and social well being of Colorado are too important to neglect." John is a good friend of the Department and serves as a member of the Advisory Committee.

Ann F. Rosen—BS 81—Director of Marketing for Sam's Wine Co., Chicago, IL. She travels around the world, sipping as she goes. She says it really beats "that rock-business."

Marcia Rottmann—PhD 77—Senior research specialist at Exxon Production Research, Houston, TX. She describes herself as "A plankton ecologist with a PhD in geology who went to work for an oil company to do seismic stratigraphy and turned into a developer of interactive geophysical interpretation software." Single, with a daughter, Terri, who graduated from the University of Washington in 1987.

Lee W. Row, III—BA 87—Lee manages a worldwide database on earthquake engineering, in the Cooperative Institute for Research in the Environmental Sciences at CU. He is nearing completion of the first-ever data catalog for earthquake engineering, to be used on personal computers. Lives in Arvada, CO.

Richard D. Rubright—BA 40, MA 41—and **Mary Jo (Bledsoe) Rubright**—BA 40—Both retired. Married for 46 years. Three children and five grandchildren. Richard was resident geologist for U.S. Smelting and Refining in the Bingham District for 31 years. He has published on the geology of the Bingham, Utah, District in the Graton-Sales Volume (Ore Deposits of the United States) and on the Ophir Mining District (in Utah Geological Association Publication 7). Mary Jo taught elementary school in the West Jordan District, southwest of Salt Lake City, for 21 years.

David C. Shelton—MS 72—After seven years as Director of the Mined Land Reclamation Division in Colorado, Dave has become Director of the Hazardous Materials and Waste Management Division for the state. Lives in Golden.

William D. Siapno—MS 53—Consultant in marine sciences, Gloucester Point, VA. Speaker at the First USSR International Marine Minerals Conference, Vladivostok, September, 1988. Lives in Ordinary, VA.

Betty Skipp—PhD 85—Recently returned from Kiev, USSR, where the voting members of the International Mid-Carboniferous Boundary Working Group trenched and collected samples from a potential stratotype in the Donets Basin. Major part of her dissertation will be published in GSA Memoir 171. She also won first place in her age group at the Wilkes-Barre, PA, National Championship for the International Distance Triathalon. Betty works at the USGS in Denver.

Robert C. Steinbach—MS 56—Dean of Mathematics, Physical and Behavioral Sciences, Grossmont College, El Cajon, CA. Has written two textbooks, 24 audio-visual modules, and three educational software products in mathematics. Teaching at Grossmont since 1962. Climbed Mt. Kilimanjaro in 1971. Sailed to the Caribbean and back in 1974-1975.

David K. Swanson—MS 84—University of Minnesota, St. Paul. Living in Rochester, MN. Expects his PhD in Soil Science in 1988. His thesis is on the relationship between peatlands and environmental factors in Minnesota. His field work is in northern Minnesota, but he spent six months in the USSR learning their point of view on peat and wetlands.

Patrick Tainter—MS 72—Works as an independent in oil and gas, since February, 1986. Has several publications in a variety of geologic journals. Married, with a new (first) child. Lives in Denver.

Tom Vinkier—MS 78—Manager of Geosciences, Southern California, for Dames and Moore Consulting Engineers. Tom did his Master's work on the deep ground waters of the Canon City Embayment. Living in Santa Barbara, CA. Tom has hired several of our recent graduates in geochemistry and hydrogeology and would like to hire more.

Alan R. Wallace—BS 74, MS 77—Geologist with the USGS, Denver. Received his PhD in 1983 from Oregon State. Married, but no children yet. Has published on the subject of hard-rock uranium deposits in Colorado and volcanics and gold deposits in Nevada. Present work is on gold deposits in volcanics. Trying to remodel their 1904 house in central Denver.

Patrick Williamson—MS 87—Working as a hydrogeologist for Harding-Lawson Associates, Novato, California.

H. O. Woodbury—BA 41, MA 42—Married in November, 1968. Publications on continental slope in Gulf of Mexico, salt domes, etc. Worked for Chevron Oil, 1946-1985. Still active in geology, including Potential Gas Committee, Rocky Mountain Chairman, and Advisor on AAPG Treatise on Petroleum Geology. Lives in Denver.

William (Butch) H. Wulftange—BA 82—With FMC Gold Company, Reno, NV. Has been with FMC since graduation. He participated in the discovery of the Paradise Peak Au/Ag mine and was mine geologist, 1985-1986. Currently Project Geologist for precious metals exploration in Nevada. Reports that his company can't find enough good geology students to fill temporary summer positions.

Warren Yeend—MS 61—Geologist, for 25 years, with USGS in Menlo Park, CA. Received a PhD from Wisconsin in 1965. Married, with a daughter. He has 93 publications; the most recent is on the subject of placer gold in the Kotzebue Quadrangle, western Alaska. Lives in Los Altos, CA. ■

Painted Wall in the Black Canyon of the Gunnison (W. R. Hansen, USGS)

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