New Chair

Rob Van der Voo hands over the job of running the department to the new Chair, Dave Rea. Hard hats and sledge hammers are essential administrative equipment while the renovation of C. C. Little continues.

In this Issue:
Greetings from the Chair ......................... 2
It’s an Ill wind...Blowing Some Good .......... 3
Awards:
Bob Berner ............................................. 5
Larry Edwards ...................................... 6
Becky Lange ......................................... 6
Zach Sharp .......................................... 7
Damon Teagle ....................................... 7
Jim Wilson ............................................. 8
New Noble Gas Laboratory ....................... 8
Noble Gases, Hydrocarbon Reservoirs and Crustal Fluid Transport ......................... 9
Alumni News ............................................ 10
Simulating Plume Penetration
of the 670 km Discontinuity ................. 11
Faculty, Research Staff and Student News .... 12
Degrees Granted ....................................... 16
In Memoriam ............................................ 16
Greetings from the Chair

GREETINGS!

The greetings this Spring mark a particular occasion for me, because on July 1 there is to be a new Chair: it is Prof. David K. Rea who has been appointed to lead our Department into the next century (until July 1, 2000, to be precise). Dave has been a faculty member at the University since 1975 and has taught oceanography, marine geology and geophysics, tectonics, palaeoclimates, as well as the geology of the Great Lakes. He transferred to our Department in 1987 from Atmospheric, Oceanic and Space Sciences in the Engineering College. Dave has also served as Program Director at the National Science Foundation and as Interim Director of the Center for Great Lakes and Aquatic Sciences at the University. In her announcement to the departmental faculty of the appointment, Dean Edie Goldenberg cited: "he will need your support in this endeavor, and he has mine." The same is true for you, members of our alumni body: the new Chair will need your support!

Writing my last column in this place gives me the opportunity to reflect on the rapidly changing environment in which geoscience departments nationwide are functioning. The changes in the international area have been truly fundamental, with ripple effects that are advantageous as well as detrimental to geoscience research. New and relatively abundant opportunities for scientific collaboration with colleagues in Europe and the former Soviet Union have presented themselves in ways that no one could have predicted. Offsetting these positive effects are reduced funding opportunities for specific scientific research that used to be driven by a competitive environment during the cold-war era, and exacerbating these pressures to reduce research budgets are the national deficit, a strong desire for higher education has not remained as high as it used to be, and the notion that scientific research is a necessary ingredient in the activities of a modern society appears to be fading. Concerns for the environment remain high, but remediation is favored at the expense of the polluter, with the windows will be transparent and draft-free, the faculty will be happy and won’t worry (about funding), the staff will get huge raises, the deans can finally go on vacation, and the students will earn all A’s.

This Summer will be the zenith (some will say nadir) in the activities related to the renovation of the C. C. Little Building. As you know, everything will be done at once, all floors will be impacted, the nearest functioning bathroom will be in the Museum, the elevators will be demolished, no air will be conditioned, and all that so that after August 20 the roofs won’t leak, the pipes won’t burst, the radiators won’t clang, the courses in which these students will earn their A’s will soon include quite a few new offerings. They will form part of a new undergraduate degree program in Environmental Geology. The program has been approved by our College and will, pending approval by the State of Michigan’s Presidents’ Council, start in 1996. Characteristic of the program is a strong emphasis on geoscience fields, whereas in the Department, courses such as geochemistry, surficial processes and materials, and aqueous geochemistry will feature prominently.

So, as you see, we keep on being busy. Never a dull moment! But when you are back in Ann Arbor, please stop by, we will always have time for you. You can then admire our building, say hello to the new Chair and to old friends!

Sincerely,

Rob Van Der Voo
Chairman

Database Audit

The Department is undertaking a major revision of its Alumni Database, which among other things provides the mailing list for the Geoscience News. We try to update the addresses on a regular basis, but over the past few years some of the other information has become incomplete or outdated, to the point where we feel a major effort is warranted. Therefore, we request that everyone receiving the Geoscience News please complete and return the information form on page 17. Many thanks!
by Sally Pobojewski

Nobody has anything good to say about smog. It burns our eyes, hurts our lungs, kills plants, acidifies lakes and spoils the view. Environmental activists and government officials have spent millions of dollars and written reams of legislation in an attempt to get rid of the stuff.

According to Jim Walker, Arthur F. Thurnau Professor of Atmospheric, Oceanic and Space Sciences and of Geological Sciences (pictured above), the blanket of air pollution that hangs over much of the industrialized world has a benevolent side. He says it could be protecting us from the full impact of other serious environmental threats, such as global warming and depletion of the ozone layer.

**A Boon of Bad Air**

"Bad air does have its benefits," says Walker. "But by masking the effects of other environmental problems, it may be lulling us into an unmerited complacency. Environmental damage may already be worse than we think."

A specialist in global change issues, Walker’s laboratory is the Earth itself. He’s interested in how human activities—particularly the widespread burning of fossil fuels like oil, natural gas and coal—are changing the global ecosystem in fundamental ways that scientists do not fully understand.

One of the more publicized and controversial changes is global warming. When we humans burn fossil fuels to run cars or power plants and factories, tons of carbon dioxide and other greenhouse gases rise into the atmosphere and remain there for hundreds of years. Although not as visible as the smoggy haze of air pollution, greenhouse gases are just as dangerous. Like the plastic cover on a greenhouse, they trap heat near the Earth’s surface and prevent it from radiating into space. With no way to escape, the heat builds up and our planet gets warmer.

If the trend continues, scientists say average temperatures could climb by 3 to 8 degrees F in the next 50 to 100 years—a level of warming unmatched since the end of the last Ice Age 10,000 years ago.

**Why the Erratic Pattern?**

The pattern of global warming has puzzled scientists, however. Since the beginning of reliable meteorological records about 1850, the amount of carbon dioxide in the atmosphere has climbed at a steady rate, but records show the warming effect of CO₂ has been erratic rather than steady, with periods of nearly constant temperatures separated by periods of rapid increase.

Walker wondered why global temperatures have not increased in a more uniform pattern and began looking for possible explanations. When he compared meteorological data and economic statistics, he noticed that “average global temperatures have increased during periods of economic recession and remained unchanged during periods of rapid economic growth.”

“It occurred to me," he says, “that competition between warming greenhouse gases like carbon dioxide and cooling air pollutants like..."
From World War I (1914-18) until the end of World War II (1945), global temperatures increased rapidly. “This correlates with slower growth in the economy—especially with the factory closings during the Great Depression in the 1930s—and the corresponding drop in the amount of cooling pollutants spewed into the atmosphere.”

From the mid-1940s to the mid-1970s, there was little or no change in global average temperatures. “These were the years when nobody paid any attention to global warming, because the globe seemed to be cooling off—or at least not warming up,” Walker says. “This also was a time of post-war economic boom, with renewed rapid growth in fossil fuel consumption and a corresponding surge in air pollution.”

Then came the oil crisis of the mid-1970s, escalating oil prices, the worldwide recession of the 1980s, and a sharp drop in industrial productivity. “And what happened to global temperatures?” Walker asks. “They just rocketed up. Nearly all the hottest years on record were in the 1980s.”

If Walker is right about the relationship between global warming trends and the world’s economy, what does he foresee in the world’s future as it moves into a global economic recovery?

If the analysis is correct and the economy continues to pick up, then average global temperatures will not increase as fast as they have since the late 1970s,” Walker says.

**Classic Case of Catch 22**

According to Walker, it’s a classic Catch-22 situation. When economic times are good, we do serious long-term environmental damage by dumping tons of additional carbon dioxide and other greenhouse gases into the atmosphere. Since weather conditions seem normal, however, people stop worrying about global warming and have no incentive to make the lifestyle and economic sacrifices needed to reduce fossil fuel emissions.

When economic times are bad, factories shut down, reducing pollutant haze, and temperatures go through the roof. Confronted with heat waves, drought and massive hurricanes, people worry about the environment again, but faced with the social and economic impact of widespread recession, have no resources left to invest in environmental problems.

“We are in a race between environmental destruction and human attitudes on how to deal with it,” Walker says. “It’s not clear which side will win.”

Jim Walker has no idea how long the Earth can continue its delicate balance between greenhouse warming and pollutant cooling. He doesn’t know how much time scientists have left to anticipate the effects global warming will have on life on Earth, or how much time policy-makers have to develop a plan to deal with it. But he does know one thing. “The benefits of bad air are illusory and only temporary.”

The above article originally appeared in the magazine *Michigan Today* and is reproduced with kind permission. Sally Pobojewski is a science writer with *U-M News and Information Services.*

**Stability Till WWI**

“From about 1850 until World War I, global average temperatures didn’t change significantly,” Walker says. “This was during the Industrial Revolution when fossil fuel burning increased at a nearly constant 5 percent annual rate.”

**Geolumni Information Form**

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Please send us any news of your “doings” to be included in the next newsletters; simply write it on the reverse side of this sheet.
In Memoriam

Fred M. Bullard (BS ’21, PhD ’28) died July 1994.
James Lewis Calver (AB ’36, MS ’38, PhD ’42) died December 1994.
John W. Johnson, Jr. (BS ’45, MBA ’47) passed away during the summer of 1994.

Robert A. Berner
Wins the 1995 V. M. Goldschmidt Award

Bob Berner (BS ’57, MS ’58) has been awarded the Goldschmidt Medal of the Geochemical Society in recognition of his outstanding contributions to sedimentary geochemistry. Bob and his wife Betty (BS ’58) (then Elizabeth M. Kay) are alumni of our department. They published a textbook together, Global Water Cycle: Geochemistry and Environment with Prentice Hall. While at U-M, Bob was greatly influenced by Professor Lou Briggs. Bob and Betty now teach at Yale and the University of Connecticut respectively. John Morse (Texas A&M) was the criticatian at the recent Goldschmidt Conference at Penn State. Much of what follows is conditioned from his citation with kind permission.

Bob Berner’s outstanding accomplishments are reflected in the fact that he is among the most frequently cited members of the Earth sciences community in scientific literature, a past President of the Geochemical Society, and was made a member of the National Academy of Sciences at a relatively young age.

Bob Berner was born in Erie, Pennsylvania, close to 60 years ago. He grew up, among other places, in Michigan where his many humorous stories about the Pickle Boat and the Pharaoh were spawned. (By the way, for those of you have wondered that “HFTP” means in his papers, it is not high test pure, but hail the Pharaoh!). The stories about the Pickle Boat and the Pharaoh were spawned. (By the way, for those of you have wondered that “HFTP” means in his papers, it is not high test pure, but hail the Pharaoh!). The Pickle Boat and the Pharaoh were spawned. (By the way, for those of you have wondered that “HFTP” means in his papers, it is not high test pure, but hail the Pharaoh!). The Pickle Boat and the Pharaoh were spawned. (By the way, for those of you have wondered that “HFTP” means in his papers, it is not high test pure, but hail the Pharaoh!).

Bob Berner stands out as a shining example of how “small” curiosity-driven science can produce big results, a fact that seems to be increasingly lost by federal funding agencies and bureaucrats. He has not been an empire builder, but preferred to work with modest funds, relatively simple equipment, and small groups of individuals whom he has generally become closely associated with on a personal basis. Doing truly innovative work that results in major advances in a field inevitably leads to controversies as preceding hypotheses and theories are challenged. Throughout it all, however, Bob has always remained a true gentleman whose goal was not “winning or losing” but rather trying to find the best scientific explanations that could be revealed by existing data and theories.

Larry Edwards (MS ’86) is this year’s recipient of the prestigious George W. Taylor/Institute of Technology Alumni Society Award in Research of the University of Minnesota. The award is made annually to a young faculty member who has shown outstanding ability in research. The Taylor awards are endowed within the Mechanical Engineering Department. Each year in an institute-wide competition this research award is conferred to one of the 407 faculty members in the Institute of Technology.
Larry Edwards obtained an MS degree at U-M in 1986 working on the petrology of the major magmas in the Northwest Adirondacks with Eric Essene. His thesis was published in 1988 in the Journal of Petrology. He obtained his PhD in 1988 from Cal Tech working with Gerry Wasserburg and pioneered the precise determination of the timing of sealevel changes over the past 200,000 years using U-Th dating of carbonates. Larry grew up in Ann Arbor and attended MIT as an undergrad. His father is a U-M faculty member (now emeritus) in Chinese Studies. His mother, Vi Edwards, from China, was a potter of repute. Larry was hired as a radiogenic isotope geochemist at the University of Minnesota in 1988.

Rebecca A. Lange wins the F. W. Clarke Medal

Becky Lange (U-M faculty) is the 1995 recipient of the Clarke Medal of the Geochemical Society, awarded to a young geochemist for a single outstanding contribution to geochemistry. Much of recent work involves understanding the isotopes that have helped Becky become a successful scientist; first, you should get data of impeccable respect to volume. By recasting her results as partial molar volume curves, she determined that the rates of change of molar volumes can be used to calculate melt densities as a function of temperature and composition. Moreover, her data have greatly improved the reformulation of some speed data into a model for the compressibilities of silicate liquids, so that her data can be used to represent the densities of anhydrous melts at elevated pressure.

Her data have several applications. First, the magmas physists assume that the density contrast of less than 1% can lead to important convective phenomena in magma chambers. For the first time, we can model the density of natural liquids within this precision. Second, her data allow crystal-melt equilibrium calculations to be extended to high pressure through integration of V⁹T terms. This application is perhaps the most important and often the least appreciated; until recently, it has been notoriously difficult to achieve equilibrium with clinoxyroxene and to quench small-degree partial melts in high-pressure experiments. Her density data allow the METLS thermodynamic model, developed by Mark Ghiorso, to predict the products of small-degree mantle melting at high pressure. The predicted compositions have been recently corroborated by experiment at Caltech using diamond aggregates. Finally, the volume data are an important probe of silicate melt structure.

The other part of her PhD thesis involved mapping an isolated and mountainous area in western Mexico where an extraordinary suite of potassic, hydrous and oxidized magmas coexist with the more common products of arc volcanism, namely basaltic and andesitic andesites. Her geologic mapping showed that these small-volume, hydrous lavas are confined to extensional grabens, so that their ascent to the earth’s surface is entirely dependent on the fault pathways which may extend to the lower crust. She established that this suite of potassic magmas preserves evidence of surprisingly high magmatic water contents and oxygen fugacities, some approaching the H-M buffer. The extreme arc signature of these magmas indicates that they may be nearly direct fusion products of cold hydrated eclogite. She established that the history of the subduction to marine and atmospheric circulation, especially the shifting of the intertropical convergence zone. Dave Dobson is beginning a study of the variation of the distribution of the amount of H₂O in the earth over time. We can expect him to report on his progress at a future meeting. Libby Prueher passed her preliminary exams and is setting out on a thesis that will investigate potential links between explosive volcanism and climate change.

Leah Joseph has been the tasked of teaching with an adversarial style at UC Berkeley. She has been the instructor of research scientist at UC Berkeley. She is a meeting dedicated to the retiring Hank Magloughlin, to whom we extend our gratitude.

In the early Fall, the entire structure / tectonics cast went on its annual “deformed field” trip, where this picture was taken (in the Peace Office). The entire structure / tectonics cast went on its annual “deformed field” trip, where this picture was taken (in the Peace Office). The entire structure / tectonics cast went on its annual “deformed field” trip, where this picture was taken (in the Peace Office).

May 1995

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measurements yet of the concentrations of the volatile elements indium, thallium, and cesium in the Earth and shown that the Earth is less depleted in indium than it is expected to be, possibly explained by more oxidizing conditions in the later stages of accretion. Also these techniques have allowed the preliminary development of new methods for the isotopic measurements using laser ablation. The stroncium, lead and tungsten isotope data generated so far by MC-ICPMS with laser ablation are the most precise accurate in situ isotopic measurements of any kind yet made. Some of these results were presented at the recent Goldschmidt Conference of the Geochemical Society at Penn State. Also, at the same meeting, Carsten Israelson, a visiting student from Copenhagen, presented new U-Pb data for carbonate concretions that permit accurate calibration of the Lower Palaeozoic timescale and the determination of sediment compaction rates. This work nicely complements the work of graduate student Hailiang Dong whose new method of Ace-MS dating of diagenetic clays was published in Science earlier this year. A new postdoctoral fellow Mark Rehkampfer has recently joined the group from Mainz. Mark’s expertise is in mantle geochemistry, HPLC and chemical separation techniques and he is currently developing new methods of platinum group element analysis. Finally, two new graduate students Dan Barford and Xiaozhong Luo are just starting their research projects in noble gas geochemistry and U-Th disequilibrium studies, respectively.

Steve Kesler served as Thayer Lindsley Lecturer for the Society of Economic Geologists this year. Thayer Lindsley was a prominent mine finder, whose bequest supports a lecture series for schools and other groups interested in mineral deposits. Steve met Thayer Lindsley, then in his late 80s, while passing through New York in 1963 to begin thesis work in Haiti. The lecture tour included universities of Missouri and Utah in the U.S., Alberta (Canada), Geneva (Switzerland), Orleans (France), and Cardiff (U.K.), and the Universities of Missouri and Utah in the U.S., Alberta (Canada), Geneva (Switzerland), Orleans (France), and Cardiff (U.K.), and the Universities of Missouri and Utah in the U.S., Alberta (Canada), Geneva (Switzerland), Orleans (France), and Cardiff (U.K.).

On the teaching front, Steve worked with Phil Meyers and Jim O’Neil to start Environmental Geochemistry, and other research equipment. Jim O’Neil was teaching with the help of an NSF grant that he wrote. He is a Research Faculty member at the University of Lausanne where he has built an impressive stable isotope facility with laser sampling. Zach has now established himself as one of the preeminent stable isotope geochemists in the world. Congratulations, Zach!

Damon Teagle (U.M Postdoctoral Fellow) has been awarded a Sokol Postdoctoral Fellowship. This relatively new award is a very competitive U-M fellowship. Only one is awarded per year as a result of a competition with current postdocs from other science departments. Damon did his PhD at Cambridge University with Mike Bickle and Ron Oxburgh studying isotopic studies of fluid flow in the Troodos Ophiolite. He is currently working with Jeff Alt on alteration of the ocean floor. Damon was selected from the current postdocs in our department and competed with applicants selected from the current postdocs in each of the science departments, notably Physics, Chemistry and Biology.

Zach Sharp (MS ’84, PhD ’88) is this year’s recipient of the Mineralogical Society of America Award given to an outstanding young mineralogist/petrologist. Zach got a BS degree at the University of California in 1982 and worked for a year as geologist for the BART tunnels in the Bay Area. He got a MS degree in 1984 with Bill Kelly and Eric Essene. His PhD was on stable isotope and petrologic studies of granulites from the Wind River Range in Wyoming. He was a notable field camp TA and very active in the department. Zach took a postdoctoral fellowship at the Geophysical Lab in Washington, D.C., working with Doug Rumble, where he set up one of the first successful laser oxygen isotope systems with the help of an NSF grant that he wrote. He is a Research Faculty member at the University of Larseanhe where he has built an impressive stable isotope facility with laser sampling. Zach has now established himself as one of the preeminent stable isotope geochemists in the world. Congratulations, Zach!
In the midst of all the noise, dust and rubble of building renovation that has devastated C.C. Little over the past year, we have built a new laboratory for noble gas isotope geochemistry which is now fully occupied and engaged in an exciting new research program.

The Radiogenic Isotope Geochemistry Laboratory (RIGL) has expanded with the acquisition of two additional noble gas mass spectrometers in addition to the new multiple collector ICPMS.

The noble gas geochemistry laboratory (NoGGL) is housed in newly renovated separate space next to the RIGL (see photo) and now contains three mass spectrometers and a variety of extraction and gas cleanup systems including a laser microsampling facility. This is being developed to enable the study of natural rare gas isotopic compositions in a variety of samples ranging from fluid inclusions to plume-derived basalts. The financial support for this facility has come from the Department, the Shell Foundation, the College of LS&A, the Office of the Vice President for Research and the National Science Foundation.

Dr. Chris Ballentine is a new Assistant Research Scientist in the Department and his background in studying rare gas geochemistry of fluids from hydrocarbon reservoirs is ideal for much of the research that will be developed at U-M, as explained in the following article.

The current team of “NoGGLers” (l-r): Chris Ballentine, Chris Hall, Alex Halliday, Marcus Johnson, and Dan Barfod.

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The noble gas geochemistry laboratory expansion is discussed elsewhere in this issue. The development of MC-ICPMS is going even better than expected. Our new measurements of tungsten isotopic compositions in a variety of samples ranging from fluid inclusions to plume-derived basalts. The financial support for this facility has now been joined by the VG-3000 which will specialize in measuring helium. The lab should soon be an integrated noble gas laboratory. This work will be spearheaded by Chris Ballentine (see article in this issue). Control software for the laser system connected to the Plasma-54 mass spectrometer has been developed. This software can learn complex curves and then generate a smooth laser ablation track. We practised by performing “plastic surgery” on Abraham Lincoln’s nose (on a penny) and then moved on to trying out tracks on pieces of mollusk shells.

Moving the new inductively-coupled plasma magnetic sector multiple collector mass spectrometer into RIGL went smoothly thanks to cordial collaboration of members of the department. Plant Operations, Fisons Instruments, and the building contractor Ellis-Don.

Dan Fisher’s successful completion of the casting of the Brennan mastodon trackway, last fall, was followed this winter by installa-
tion of a portion of the cast in the Exhibit Museum. Additional support for display material remains to be developed, but it is gratifying to have a major portion of the project much nearer to completion. Much of Dan’s time this winter was devoted to the search to fill the open faculty position in invertebrate paleontology. In addition, he gave two symposium presentations at the annual meetings of the Society for American Archaeology, the GSA of Archaeology. These covered aspects of his mastodon and mammoth work, which also wound up on the cover of an issue of the Chronicle of Higher Education and in a film put together by a BBC crew for a science news program called “Tomorrow’s World.” Meanwhile former graduate student Brian Bodenbender was selected for a highly competitive University postdoctoral fellowship at Ohio State, and has been using his remaining time here to get papers submitted from his dissertation work and complete various collaborative projects with Dan. David Fox has found exquisitely preserved incremental features in tusks of Miocene gomphotheres, confirming the feasibility of extending a proboscidean-mediated record of climate change back into the Tertiary, and Talia Sher has been experimenting with new analytical techniques for resolving sexual dimorphism in proboscideans.

Chris Hall writes that the argon geochronology lab has gone into a quiescent phase because of the move into the expanded portion of the RIGL lab. After some clay analyses by Hailiang Dong and some Grenville province runs by Jay Busch in late 1994, the system was shut down in preparation for the move. Both argon mass spectrometers and their associated fusion systems have been set up in the new lab space. With only a few bits of unwanted excitement, the move has gone remarkably smoothly. The two argon machines have now been joined by the VG-3000 which will specialize in measuring helium. The lab should soon be an integrated noble gas measuring facility. Work is under way to expand the software capabilities of both the MAP-215 and VG-1200S machines. This will allow us to shift the bulk of the argon dating work to the VG-1200S which will free up the MAP215 for work on the heavier noble gases. This work will be spearheaded by Chris Ballentine (see article in this issue). Control software for the laser system connected to the Plasma-54 mass spectrometer has been developed. This software can learn complex curves and then generate a smooth laser ablation track. We practised by performing “plastic surgery” on Abraham Lincoln’s nose (on a penny) and then moved on to trying out tracks on pieces of mollusk shells.

Alex Halliday says things have never been better in the field of radiogenic isotope geochemistry at U-M. New technique developments and lab expansion have dominated much of the activity in the Radiogenic Isotope Geochemistry Lab over the past six months. The noble gas geochemistry lab expansion is discussed elsewhere in this issue. The development of MC-ICPMS is going even better than expected. Our new measurements of tungsten isotopic compositions in meteorites, a principal research effort of postdoctoral fellow Der-Chuen Lee, are providing powerful new constraints on the history of accretion and planetary core formation in the inner solar system. Graduate student Wen Yi has made the most accurate
Noble Gases, Hydrocarbon Reservoirs and Crustal Fluid Transport

by Chris Ballentine

Whether we are looking at a minute quantity of fluid trapped as an inclusion in a mineral or an entire hydrocarbon reservoir, we can use the distinct isotopic structure of the noble gases to identify and quantify the noble gas contributions from mantle, crust and atmosphere-derived sources (Figure 1). Noble gases from these sources are intimately associated with major fluid species, and can give us direct information about the origin of the fluid. For example, at mid-ocean ridges (and hotspots) CO₂ and He are degassed at a near constant ratio. Similar CO₂/He ratios observed in regions of continental extension provide strong evidence for a magmatic (mantle) CO₂ origin, information not available from carbon isotopic systematics alone. Similarly, methane (CH₄), gas which has been transported as a dissolved phase in groundwater, on degassing gives a characteristic Ar/CH₄ ratio, determined by the Ar concentration fixed in the groundwater at recharge and the temperature/orinity of the groundwater during degassing.

Where these relationships are not preserved due to, for example, loss or addition of major fluids to the system, the noble gases still provide a conservative tracer of the volumes of these differently sourced fluids which must have at some stage interacted with the system. For example, it has been shown that in the Punpunon Basin, Hungary, tens to hundreds of cubic kilometers of groundwater must have been involved in the transport of natural gas into one trapping structure alone. In a separate system the quantity of noble gases derived from crustal sources (through the natural decay of U and K in the crust) requires long term build up and storage of these radiogenic noble gases in the deep crust, with subsequent release probably resulting from the increased thermal gradient and metamorphic fluid expulsion during basin extension.

Although they act as a conservative tracer of these processes, the elemental abundance patterns of the differently sourced noble gases are sensitive to different physical fractionation processes. For example, elemental fractionation between different subsurface phases, caused by the different solubilities of the noble gases in each phase, is quite distinct from elemental fractionation caused by a mass fractionating differentiation process. The identification of these patterns enable constraints to be placed upon the subsurface processes operating on the noble gases, and by inference the related major species. By identifying a similar (or lack of) fractionation in differentially sourced noble gases one can also constrain the importance/magnitude and relative timing of a particular fractionating process.

Work underway in the new U-M noble gas laboratory addressing crustal fluids includes the characterization of mantle-derived noble gases in continental environments. Although it is well established that mantle-derived volatiles are associated with continental extension, it has only recently been noted that the He/Ne ratios of this component are more similar to those observed at hotspots rather than mid-ocean ridges. This type of study will play a part in our understanding of the role of plumes in continental rifting and, given the more volatile rich nature of plumes, may change our understanding of the nature and magnitude of magmatic volatile input into basin systems.

A relationship between nitrogen and helium concentrations has been observed in many natural gas reservoirs, most notably that in the Texas Panhandle. It would appear that both the nitrogen and helium originate from the deep crust. A detailed study of the crustal radiogenic noble gases and nitrogen isotope systematics in these systems will provide us with invaluable information regarding the mechanism of metamorphic-devided fluid release and transport from deep regions of the crust. More broadly, comparison with nitrogen-rich systems containing little helium will help constrain the relative importance and physical processes by which differently sourced nitrogen is introduced to sedimentary hydro-carbon-rich systems.

The role of differently sourced fluids in mineral formation processes is also a topic which may be addressed by noble gas studies. Samples in which fluids are trapped, however, often contain two or more generations of fluid inclusions. We are currently developing a laser ablation system that will enable us to determine the noble gas composition within individual inclusions or groups of inclusions of the same generation.

Chris Ballentine is an Assistant Research Scientist in the Department.

Figure 1. The distinct elemental and isotopic compositions of noble gases derived from crust, mantle, and atmosphere-derived sources enables their contribution to any fluid to be resolved and quantified.
1940’s

Nancy Thomsson Rabe (BS ’46) writes from Phoenix AZ that she is enjoying her retirement by golfing and doing lots of traveling.

Lawrence E. Mannion (MS ’48) is retired to the San Francisco Bay area, which he believes to be the best climate in the world. He is trying to write and carve stone, among many other things. He was chief geologist for Stauffer Chemical Co. until 1986 and retired just before Stauffer was sold and broken up. During his 32 years the first half was mineral oriented, and the second half was environmental, engineering, ground water, etc. He managed to locate the shallowest trona in Wyoming in 1959.

Waldemere Beijnar (MA ’48) writes from Socorro NM that in his retirement he has a rock shop. He cuts and polishes a lifetime’s collection of rocks and sells some at craft fairs. He also farms and plays tennis.

1950’s

John W. Keeler (MS ’51) lives in Scott LA. He is a member of a partnership (B&K) which is involved in the development and sale of land tracts in Cameron County, Texas.

William K. Easton (MS ’52) and his wife joined an ice hockey and cultural tour of St. Petersburg, Moscow, and Amsterdam in the winter. They say it was an unforgettable and unbelievable experience and recommend it highly.

Chesley C. Herndon, Jr. (MA ’52) tells us that the beauty of petroleum geology is that you are never forced to retire but can continue to pursue your lifetime occupation, hobby and passion until you go to meet “that Great Rockhound in the Sky.”

Curtis L. Lundy (BS ’54, MS ’58) retired on June 1 from Michigan Consolidated Gas Co. after 32 years. He is planning to travel through the summer and autumn, with weekly sailboat races on Lake St. Clair and the Port Huron to Mackinac race in July. Curtis says “Retirement is great—you get twice the amount of life at half the income!”

1970’s

Roger L. Gilbertson (PhD ’72) has moved back to Houston from Buenos Aires, Argentina, which they miss greatly. After five years it was certainly home. George C. McIntosh and Roger still stay in touch — there are Devonian crinoids in northern San Juan Province after all. He is looking forward to more travels in Latin America, especially the Altiplano of Bolivia. “Best wishes to all in 1995!”

Wendy Gordon Sheridan (MS ’79) worked for Exxon Co. USA 1979-1986. She then went to Riverside County CA Health Dept. 1989-91. Their daughter was born in May 1991. Her husband was transferred to Oklahoma at that time. There were no job opportunities for Wendy in Ardmore, but she was Secretary-Treasurer for the Ardmore Geological Society 1992-94. Her twin sons were born in October 1994, so she is staying entertained by juggling twins and a pre-schooler. She wants to get back into environmental work when they leave Ardmore, which hopefully won’t be too far off.

1990’s

Teresa S. Czarnik (BS ’84) and husband Tim went camping in and around Olympic National Park in northwestern Washington state and comment on the spectacular pillow basalts in the area. At Geophysical Fluid Dynamics Laboratory (GFDL) Teresa is researching sources which may provide dated temperature estimates during the last glacial maximum, which includes surfing the WWW.

James L. Felicik (MS ’84) and wife Nancy are proud to announce the birth of their second child, Lindsey Paige, on February 11, 1995. Things went great as they made it to the hospital 30 minutes before the birth. Lindsey joins her brother Jared who is 2% and already hooked on Bill Nye the science guy. Class of 2014?

Bryan E. Stpanek (MS ’84) writes from Anchorage that he and his wife are enjoying their first child, Rachel, who was born in April 1994. She is 20 pounds of redhead willpower.

Gale D. Martin (BS ’80, MS ’85) tells us that she has been living in Las Vegas for five years now. She escapes from the summer heat every year by traveling the states from coast-to-coast (Washington DC toEUR Sussex, University of Sussex and community college system of Nevada. Gale enjoys the wide variety of geology in the valley, especially since there’s no “green stuff” in the way. Don’t sit down without looking for cactus needles, though. She bought a new home in Henderson and already had an earthquake roll through from the River Mountains behind the house on January 1—welcome to the new year!

1995

An interesting problem in geodynamics is the source of hotspot volcanism. It has long been agreed that hotspot activity is caused by localized upwellings from the deep mantle. These “plumes” impinge on the lithosphere, creating present-day uplift and volcanism, with Hawaii as a prime example. The geologic history of the plume can be traced in the hotspot trail, the linear trace of islands and seamounts, caused by now extinct volcanism. Although this cartoon view is attractive, it poses many questions regarding its dynamical feasibility: How can the plume source survive for many tens of millions of years? If the lower mantle is convection, why is it that the plume source does not seem to shift its location in the mantle, whereas the oceanic lithosphere moves (from a geological point of view) at high speed? How does the plume interact with the thermodynamic and rheological properties associated with the discontinuities in the upper mantle transition zone? In order to investigate possible answers to these questions, Peter van Keken has developed dynamical plume models in a collaborative effort with Carl Gable (Los Alamos National Laboratory), David Yuen (University of Minnesota) and Arie van den Berg (University of Utrecht, The Netherlands). The main focus is the possible rheological changes that occur across the 670km discontinuity. Although the experimental and theoretical evidence for slow creep of mantle silicates under high temperature and pressure conditions is limited, it is likely that the viscosity in the lower mantle increases with depth. In addition, it is possible that the creep mechanism changes, from dominantly non-linear dislocation creep in the upper mantle, to linear diffusion in the lower mantle. Based on these assumptions Van Keken and co-workers have constructed a model in which a plume rises through a high viscosity lower mantle and penetrates the 670km discontinuity and the lower viscosity upper mantle. The evolution of this model is described by basic physical convection laws, from which equations can be derived that are in this case solved by numerical methods. The figure shows an example of a three-dimensional model of such a plume. The model represents the mantle of the Earth with a thickness of 3000km. The 670km discontinuity resides at approximately one quarter of the distance from the top of the model. A shaded surface that indicates a constant temperature of approximately 2000K can be seen. Below this, surface temperatures are higher. At the left hand boundary the ridge-like feature indicates an upwelling of hot mantle material that could be thought to represent a mid-ocean ridge. In the center of the model a more or less cylindrical plume wells up from the lower mantle. The high viscosity in the lower mantle gives the appearance of a rather “bulky” plume. The plume changes its character as soon as it enters the lower viscosity region above the discontinuity. The hot upwelling material achieves a higher viscosity here, which effectively thins the width of the plume. As it reaches the bottom of the strong lithospheric plate, the plume is advected by the plate motion. As the hot material moves downstream, it spreads in a typical parabolic shape. In several other models it has been observed that the plume penetrates the upper mantle in a time-dependent manner. The higher speed achieved in the upper mantle causes the hot material to separate from its source. The hot material then impinges on the lithosphere as a discrete diapir, which is later followed by other diapirs, shed off the 670km discontinuity, fed by the slow upwelling in the lower mantle.

This research has produced explanations for two important observations. The first concerns the stationary nature of hot spot trails with respect to lithospheric motion, which can now be explained by the high viscosity of the lower mantle. The second observation is the episodicity of hot spot volcanism, such as is seen under Hawaii and the Cameroon line in the Gulf of Guinea. This fits nicely with the numerically modelled diapirs.

Peter van Keken is a Visiting Assistant Professor in the Department.