Virginia Tech

Department of Geological Sciences

"A University Exemplary Department"

Newsletter

Virginia Polytechnic Institute and State University *FALL 2002*

Message from the Acting Chairman

The brisk days of fall find the faculty, students, and staff of the Department of Geological Sciences invigorated and busy. I am especially busy because in addition to my normal duties, I am filling in as Department Chair for Cahit Çoruh who is on sabbatical in Turkey completing a research project on crustal structure and earthquake risk.

The state's budget problems continue to swirl around the Department but fortunately they have not seriously affected our plans to grow in size and stature. Our research activities and funding are vigorous and expanding. This fall twenty outstanding new students joined our already strong graduate program. Our undergraduate program remains quite rigorous and is one of the largest in the U.S. Decreasing geosciences enrollments nationwide along with an increasing rate of retirements have combined to make the employment outlook for our graduates very promising. This year we are enjoying seminars by several National Academy of Sciences members and similar high-profile geoscientists who have been invited to campus as part of our Geosciences Distinguished Lecturer Series. These lecturers bring exciting new ideas to the Department and take away an updated view of our growing prominence in the geosciences.

Although the Department has been generally immune to the financial distress of the state and university, some changes are inevitable. After 33 years of service, Jim Craig took advantage of retirement incentives this past June, and he and Lois moved to North Carolina where Jim is currently an Adjunct Professor at the UNC Institute of Marine Sciences. He continues to be an active member of the recovery team for the *Queen Anne's Revenge* (flagship of the pirate Blackbeard).

The university is undergoing broad reorganization and refocusing. By this time next fall, the Department will be a part of the newly formed College of Sciences. These changes continue to provide us with opportunities to grow in size and excellence.

Don Rimstidt

Faculty Research: Biogeochemical and Hydrologic Controls on Arsenic Release and Transport

by Madeline Schreiber

Madeline Schreiber

Long recognized as a toxic element, arsenic has recently been linked to skin, bladder, and other cancers (NRC, 1999). In an effort to protect human health, the U.S. EPA has lowered the arsenic drinking water standard from 50 to 10 mg/L. The tightening of the standard has encouraged federal, state, and local agencies to closely examine water supplies for potential contamination with even trace amounts of arsenic. Although anthropogenic sources exist, most arsenic contamination of water sources is attributed to naturally-occurring sources, including oxidation of arsenic-bearing sulfides, reductive dissolution of arsenic-rich hydrous ferric oxides (HFOs), release of arsenic from geothermal waters, and evaporative concentration (Welch et al., 2000). Due to the complexities of these and associated processes, identifying mechanisms responsible for a particular case of arsenic release is often difficult. For example, there has been considerable controversy over the cause of arsenic contamination of groundwater in Bangladesh. Some researchers have proposed sulfide oxidation as the predominant mechanism for arsenic release (Bagla and Kaiser, 1996) while others contend that reduction of arsenic-rich HFOs is the cause of the high arsenic concentrations (McArthur et al., 2001).

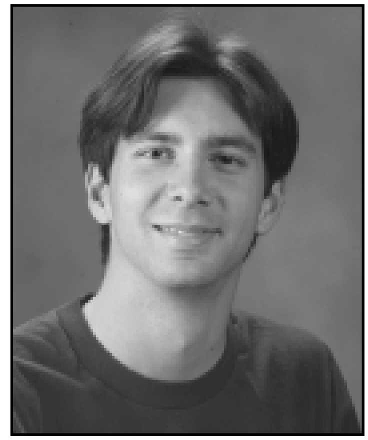
Please see Schreiber, page 16

Graduate Student Wins Prestigious Mineralogical Society of America Mineralogy-Petrology Grant for 2003

Andrew Madden, a Ph.D. student working with Mike Hochella, has won one of two $5000 research awards in Mineralogy and Petrology from the Mineralogical Society of America. This marks the second year in a row in which one of our graduate students has won one of these highly competitive and prestigious awards. In this year's competition the second awardee was from Stanford University and the two awardees were selected from among more than 50 highly qualified finalists. The MSA Mineralogy-Petrology Student Research Grant has been awarded since 1981 and previous awardees include such prominent scientists as Bill Carlson (a recent president of MSA), Tracy Tingle and Jill Banfield. The award selection is based on the qualifications of the applicant, the quality, innovativeness, and scientific significance of the research, and the likelihood of success of the project.

Mr. Madden obtained his B.S. degree from the Department of Geological Sciences at Michigan State University in 2000. He started graduate school at Virginia Tech in that same year, and soon thereafter won a National Science Foundation Graduate Student Fellowship which pays for all of his expenses and salary for three years. Only 35 other geoscience graduate students in the country won such awards that year.

Mr. Madden's research involves a new field called nanomineralogy, whereby the properties of minerals are studied as a function of their physical size. Specifically, he will be studying the oxidation rates of aqueous manganese ions in the presence of various sizes of minute crystals of iron oxides. Such a study has never been attempted before, and the results will have important fundamental implications in aqueous and environmental geochemistry.



Letters to the editor, suggested articles, and other comments are welcome at this address:
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Alumni Careers: Marshall A. Reiter Ph.D., Geophysics, 1970

Interviewed by John Costain

Marshall A. Reiter received his B.S. (Physics honors) from the University of Pittsburgh in 1965. He chose the University of Utah for graduate studies and when John Costain left the University of Utah to join the faculty at Tech, Marshall was one of the graduate students who accompanied him to Tech (others were David Worthington [November 2000 Newsletter] and Jim Ming [Spring 2001 Newsletter]). He showed an early interest in heat flow and his Ph.D. Dissertation was "Terrestrial Heat Flow and Thermal Conductivity in Southwestern Virginia," providing some of the earliest heat flow results that we have in this part of the country. Marshall was John's first Ph.D. student at Virginia Tech.

Costain recalls one memorable field day when Marshall and he lowered and hauled back out of a hole 3,000 feet of logging cable. Could we do that now, Marshall? This was apparently before the time when we could afford a truck-mounted hoist, or else we couldn't reach the remote location of the hole by truck.

Since 1970 Marshall has continued his heat flow research and coupled it with tectonics and substantial hydrothermal studies. His first academic appointment was at the New Mexico Institute of Mining and Technology where he taught exploration and solid earth geophysics as an Assistant Professor of Geophysics. Preferring full-time research to teaching, in1975 he joined the staff of the New Mexico Bureau of Mines and Mineral Resources as a Geophysicist, soon rising to the position of Senior Geophysicist, and where he is currently Principal Senior Geophysicist.

His research has been funded by the National Science Foundation, the U.S. Department of Energy, the New Mexico Energy Resources Research Board, and many others. Marshall lists his principle research interests as geothermal studies, hydro-geothermics, crustal geodynamics, and earthquake mechanisms. He has, in a most remarkable way, been able to integrate these fields, each drawing upon the other, to make significant contributions. His excursions into fluid flow and advective heat transport have resulted in

Marshall and **Bonnie Reiter**

the discovery of how to determine the vertical and horizontal components of near-surface groundwater flow (the Darcy velocity) using precision temperature measurements and heat flow data. These results thus provide a surface boundary condition for numerical model studies of groundwater flow in basins.

The above is simply one example of how understanding the distribution of heat flow can contribute to a wide variety of geological and hydrological problems. Early workers in heat flow avoided making thermal conductivity determinations in and near the fractured zones penetrated by drill holes where the geothermal gradient might be disturbed by groundwater movement. Therefore, core for thermal conductivity determinations was not collected there. Marshall showed, however, that an important piece of information can be gleaned from these disturbed zones; i.e., the direction of Darcy flow. The method is a clever use of both precision temperature and thermal conductivity determinations.

Marshall's studies since leaving Tech have investigated deep fluid flow in sedimentary basins and how this can influence shallower heat flow determinations. A few related titles are "Hydrogeothermal studies across the Pecos River Valley, southeast New Mexico," "Geothermal studies in the San Juan Basin and Four Corners Area of the Colorado Plateau," and "Analysis of the Socorro Hydrogeothermal System, central New Mexico."

He has applied his background in terrestrial heat flow to several problems in tectonics and we mention just a few titles here to illustrate the impressive scope and depth of his research. Marshall's published contributions to tectonics include "Rotational buoyancy tectonics and models of half-graben formation," "Three-dimensional visualization of Precambrian elevation in southeastern New Mexico," "Buoyancy tectonic models of uplift and subsidence along high-angle faults in compressional and extensional environments," "Parameters controlling low-angle normal and thrust movement," "Possible influences of thermal stresses on Basin and Range faulting," and many others.

The San Andreas Fault has been in the news (and in this Newsletter) a great deal lately and has been an enigma and a challenge for decades as far as understanding the fault mechanism. Related to this, Marshall has analyzed the stress distribution in a simple fault asperity and suggests that under some circumstances asperity failure may initiate from tensile stresses.

Marshall has supervised seventeen graduate studies and two post-docs. He is a Fellow of the Geological Society of America and a Member of the American Geophysical Union.

Marshall and Bonnie Reiter live in Socorro, New Mexico, and have three adult children: Nathan, Matthew and Kimberley. Nathan is presently a computer information specialist with the state of New Mexico and interested in bio-informatics. Matthew is teaching music in Las Cruces and pursuing an M.Ed. Kim is finishing her second year at the University of New Mexico Medical School and is interested in internal medicine. Bonnie is preparing an illustrated book for elementary level school children.

Please see Reiter, page 12

Close Encounter in Park City, Utah

"John!" reverberated through the new and spacious post office in Park City where Rose and I had gone to pick up our mail. It was Charles "Chuck" Stanley (B.S. '81 and M.S. '83, Geology) and his wife, Joy, newly relocated to Park City, Utah. "You don't look a day older than you did the last time I saw you," said Charles. (It's great to hear from former students.) Small world!

I requested an update from Charles for our Newsletter and he kindly supplied the following.

Charles is currently working for Questar Corporation, which is head-quartered in Salt Lake City, Utah, and is a $2.9 billion diversified energy services holding company that is involved in the full spectrum of natural gas activities through two divisions: Market Resources (QMR) and Regulated Services (QRS). QMR engages in gas and oil exploration, development and production; gas gathering and processing; gas storage; wholesale gas and hydrocarbon liquids marketing; and risk management. QMR is active in the Rocky Mountain basins and in the Mid-continent. QRS, through two subsidiaries, conducts interstate gas transmission and storage activities and retail gas distribution services.

Charles Stanley is President and CEO of QMR. He is also Executive Vice President and a director of Questar Corporation *(see recent Questar announcement below)*. Congratulations, Charles.

Since graduating from Virginia Tech Charles says he has been lucky enough to work in a variety of positions at different companies that have taken him and his family all over the world. He is married to Joy Francescon (B.S., Finance, '82) and they have three boys: Brian (11); Nathan (9); and Jack (3), already showing "geological tendencies." .Joy and Chuck celebrated their 20th anniversary this September and currently live in Park City, Utah. They also have a farm in Virginia near Fredericksburg that they visit at least once a year.

To all you geology undergraduate majors, a message from Charles: "I am seriously considering starting an internship program at Questar for technical folks. I'm wondering if there are any Tech geology majors interested in a career in the oil and gas business? Ideally I'd like students in their third year of the undergraduate program that might be interested in a multi-year relationship? Possibly we could work with faculty to identify a project for a senior thesis or other credit? Like most smaller companies,we haven't actively recruited from universities for entry-level technical positions, preferring to hire somebody with five to ten years of experience and a graduate of one of the major's "universities." The majors aren't hiring like they used to; and like our peers, we are looking at a huge generation gap in our workforce that is going to force us into the entry-level marketplace.

Not that I think it's bad, but I worry about our ability to train folks the same way I was trained at BP - lots of class-room training coupled with different assignments in different roles that produces a well-rounded employee. I think we can get most of the way there with mentoring...but we need to hurry up before all of the mentors retire! Anyway, if you or any of the faculty know of any candidates, I'd love to hear about them."

Charles' e-mail address is: <charles_stanley@attbi.com > or <charless@questar.com>, or write to him at Questar Market Resources Group, P.O. Box 45601, Salt Lake City, UT 84145-0601

And once again, as is so common with our alumni, Charles wants to be sure to send his regards to Wally Lowry!

John Costain

Promotion of Charles Stanley '81

"SALT LAKE CITY - Questar Corp. today announced the appointment of Charles B. Stanley as Executive Vice President and Chief Operating Officer of its Questar Market Resources subsidiary, effective Feb. 1, 2002.

Stanley, 43, previously served as President and Chief Executive Officer of El Paso Oil & Gas Canada, Inc.

Questar Market Resources conducts non-regulated oil and gas exploration and production in 16 western states and Canada, as well as gas gathering and energy trading. The subsidiary has approximately $1.4 billion in assets and contributes two-thirds of Questar's net income.

R.D. Cash, Questar Chairman and Chief Executive Officer, says "Stanley is a strong addition to our management team. This appointment reflects our intent to continue to grow our unregulated businesses and build a strong management team for the future. Adding new skills and ideas is vital to our continued growth. Over the past five years, we have doubled our oil and gas-equivalent production and reserves while focusing on the Rockies, Mid-Continent and Canada."

Keith O. Rattie, Questar Corp. President and Chief Operating Officer, said "Chuck and I have worked together in the past. He's a seasoned E&P executive, a talented businessman and a leader." Rattie noted that Stanley has managed both domestic and international exploration and production operations as well as midstream and marketing activities. "Chuck brings skills we need to continue to profitably grow our E&P business and pursue new initiatives in the energy marketplace," he said.

Gary L. Nordloh, Questar Executive Vice President and Chief Executive Officer of the Market Resources subsidiary, said "Stanley adds to the strong organization we've developed in our Market Resources group of companies." Nordloh noted that Stanley has successfully led E&P businesses pursuing an "acquire and exploit" strategy similar to Questar's.

A graduate of Virginia Polytechnic Institute and State University, Stanley began his professional career in 1981 as a research and field geologist for the Virginia Geologic Survey.

From 1984 to 1989, he was involved with exploration and appraisal for British Petroleum Company.

Beginning in 1989, he served in a variety of capacities with Maxus Energy Corp., Dallas, Texas, culminating as Vice President of International Exploration and Development.

Stanley joined the Coastal Corp. of Houston, Texas, in 1995, serving four years as President, CEO and Director of Coastal Gas International Company. He managed multicultural and multi-national project development, construction and operating consortia. During his tenure with El Paso Corp., he negotiated a $300 million acquisition of Canadian exploration and production properties and oversaw a seven-fold increase in production in his first year.

Questar is a $2.9 billion diversified natural gas company headquartered in Salt Lake City. Through subsidiaries, it engages in energy development and production; gas gathering and processing; wholesale gas, electricity and liquids trading; retail energy services; interstate gas transmission and storage; retail gas distribution; and information systems and technologies."

Congratulations, Charles, from all of us in the Department at Virginia Tech!

From Geophysics to Space Medicine Recent News From: Dwight Holland M.S. '86, Geophysics

***I* have been elected as the Secretary/Treasurer of the International Space Medicine Branch of the Aerospace Medical Association by my peers for a two-year term.** The announcement happened just before the talk of the new NASA Associate Administrator whom promptly asked me for my Vita as the HQ office is being reorganized completely. Who knows?

My dissertation won the prestigious **Stanley Roscoe Dissertation Award of the Institute of Aviation from the University of Illinois** for the best dissertation in an area related to Aerospace Human Factors in 2000-2001. I thank my good committee members for all of their ideas and support (you, too, Dr. Fox!)— I publicly thanked Barfield, Kemmerling, M.S. Advisors, as well as Dryden, Wiewille, at the awards ceremony in Montreal.

Also, the **Johns Hopkins School of Public Health** has accepted me into a very small class of Master of Public Health Candidates that are going to be allowed to do the program by distance learning and on-campus activities. We have six years to complete the program. I thank my mentors at Virginia Tech for supporting me in gaining entry into this highly regarded program. Hopkins has asked that I lecture on Injury Prevention there in the next year on several occasions as a guest lecturer.

Dwight Holland visiting with Dr. Patricia Dove

The M.P.H. counts for a year of medical school (4th) at many schools— and will also satisfy a year of credit for Board Certification in Occupational, Aerospace, Environmental or Preventive Medicine. If I can complete medical school, the Space Medicine Fellowship Director(s) in Houston promised to shorten the certified Space Medicine Fellowship to one year (it is two years now) with this degree in hand**.** The first year is the same as the Johns Hopkins program.

I reported to Hopkins for an intensive summer session in mid June. This program can be done anywhere in the world— with occasional visits to Hopkins.

Dwight

Capt. (Dr.) Dwight Holland, USAF (reserve)
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Alumni Careers
William D. Siapno, '51

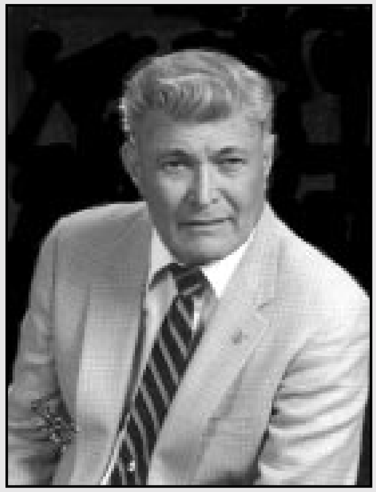
As told to Lynn Glover
September 2002

Tom Brokaw called them "The Greatest Generation." Raised during the depression, they fought the last Great War and went on to build a superpower. In 1946 Congress passed the GI Bill, which made possible college education for veterans returning from World War II. Many, probably most, were the first in their families to enter college. They were mature, dedicated individuals who set an intense pace that students just out of high school, as I (Lynn) was, found intimidating. Bill Siapno was a veteran classmate of mine at VPI and this is his story.

Bill's mother, Alice Lithia Russell Siapno, was a native of New Orleans. His father, Generoso H. Siapno, was born in the Philippine Islands. Bill was the middle child of five siblings. His was a large and loving family with totally devoted parents. "Not blessed with material abundance, I (Bill) was endowed with staunch principles of ethical living based on religious principles. All family members were taught responsibility necessary for a desirable life." He attended the Norfolk public school system, Epworth Methodist Church, and was active in hiking, biking, fishing, camping, boating and beach activities. He participated in tumbling, high bar, sandlot baseball, football and soccer. Like most high school boys he was busy afternoons and summers with jobs; carrying papers, working at Woolworth's 5 & 10, and carrying mail at Christmastime.

Bill volunteered for the Army Air Forces during his senior year in high school in order to graduate and still have a choice of services before induction. The Army sent him to aircraft mechanics schools in Amarillo, Texas (B-17 and B-29 bombers), Chanute Field (jet mechanics), and March Field, California (jet modifications). Then he was assigned to Project Crossroads (atomic tests in the Pacific) at Hamilton Field and Travis Air Force Base in California. In 1946 he was honorably discharged.

Under the GI Bill he enrolled at VPI in the autumn of 1947. Enrollment that year was larger than the college could



take, so some GIs and cadets were housed in barracks ten miles away at "Rad Tech," better known as the Radford Arsenal. Among the GIs in geology there were Bill Siapno and Bill Johnson along with the writer, sophomore cadet Lynn Glover, there may have been other geology students at Rad Tech but I don't remember. The next year it was possible to move back to campus and the long rides were over. Still it was a world of barracks, studies, classes, the mess hall and little else. Bill moved into a room that was adjacent to geology major Frank Lesure in the basement of Barracks 6, "Old Quadrangle" and they remained there until graduation.

Tech seemed to have a tough academic program with little time for anything else, even sports at a modest intramural level. The routine was endless and graduate school (M.S., University of Colorado, 1953) was a continuation of the same. A principal outcome was learning to take risks and carefully evaluate career possibilities in a rapidly changing world.

Bill was divorced from Elsie Martin Siapno in 1978. Although the marriage failed he encouraged his children to go on to high careers. His oldest son achieved two Ph.D.s, civil engineering and law. The second son is a construction superintendent. The daughter has a Ph.D. in liberal arts and teaches drama and dance at Fort Lewis College in Durango. All are step-children, but Bill says he could not be more closely bonded if they were blood relatives.

He still likes to ski, fish, hike and bike. Until recently he flew his own plane, unfortunately 9/11 made flying very expensive.

The following events of his career are in his own words.

"After completing my Master of Science degree at the University of Colorado in 1953, my first job was with the Atomic Energy Commission (AEC), Raw Materials Division, Grand Junction, Colorado. I accepted a Geologist GS-7 position but before reporting for work there arrived an offer of Airborne Geologist GS-9. I was delighted with the higher salary after endless financial struggles through the years in school.

At the first AEC briefing, I was informed that if the U.S. failed to win the Nuclear Race the world was doomed to be dominated by the U.S.S.R. It was made abundantly clear not just the U.S. but the rest of the civilized world was included. Further, I was shocked to learn the Airborne Section was referred to as the AEC Kamikaze Corp and further I was the only new hire joining the Airborne Section. Most were entering the Geology Section, some the Mining Section, and a few the Metallurgical Section. The USGS wryly noted that ore deposits were found in the ground not in the air. Undaunted by such derision, after years in academic dungeons, I was ready to fly. The job was exciting, fascinating, and dangerous. Airborne surveys were conducted extremely close to canyon walls and valley floors. Pilots were selected for their skill in flying in close quarters, many were experienced crop dusters.

Assignments took me throughout the Rocky Mountains, west to California and Oregon, east to Wisconsin, and north and south to the international borders. The Airborne Section developed quickly to survey broad regions and specialized in inaccessible areas of difficult terrain. Yes, flying could be dangerous. In early morning light while surveying near Aspen, Colorado we hit two high-voltage power lines in a dimly lit and narrow canyon. Fortunately the pilot glimpsed the lines just before impact and severed them with the propeller. Lines shorted amid a shower of fire as we crashed in an Aspen grove. Amazingly the plane did not catch fire. Through good fortune neither of us was seriously injured but the plane was a complete loss. The Power Company wrote, "If AEC promises to keep the planes out of their power lines, they will promise to keep their power lines out of our planes." We all agreed that was sound policy and with this exception, I enjoyed flying for the AEC despite its many challenges.

In 1955, I became the Assistant Chief of the Airborne Section and learned the management end of the business. I had earned my Private Pilot's license in the field and now studied intensely to acquire an FAA Commercial license needed to fly government planes. From Air Corp training I had earned Airframe and Powerplant Mechanic Licenses. The new appointment and qualifications as Pilot/Geologist brought me in contact with politicians, diplomats, and dignitaries both foreign and domestic. The world was eager to learn about advances in the U.S. Atomic Program. In 1957, I was assigned to the Atom Bomb Tests, Mercury, Nevada as Chief of AEC Airborne Crews. The assign-ament was to map fallout patterns and measure intensities of radiation following detonations. The need was to determine the fate of radioactive materials. A certain amount of nuclear material was consumed in the blast, some was blown beyond the explosion site, and lesser portions carried on air currents well beyond the test areas. The plane was equipped with instrmentation to measure the presence of radioactivity. The goal was to use this information in many ways. A prime purpose was to maximize weapon design to get the greatest destruction from the least amount of nuclear fuel. Also, the data was used to develop clean weapons that left minimum contamination. Radiation products combine readily with certain natural materials. Also, particles carried aloft may get concentrated in rainfall, which can cause particular problems. The U.S. was in the early stages of moving on to plutonium weapons.

The tests were prematurely terminated in the autumn of 1957 when an outcry of the international comm nity arose to halt atmospheric testing. Though not internationally agreed upon or unanimously well received, it was indeed the right decision. In years that followed we learned many locations well beyond the Nevada Test Site had been contaminated by fallout. High death rates in St. George, Utah among the very young and very old were attributed to fallout. As the tests concluded, I returned to Grand Junction to learn that the Airborne Section was to disband. On a chilly November evening with a heavy heart I turned in my plane for the last time. Yes, it belonged to the government but in my soul it was very much a part of me. In turning to leave, I bid farewell to a good and faithful friend to which I was devotedly attached. It had seen me safely through many harrowing experiences and always bought me home safely.

My next assignment was in Cameron and Flagstaff in Northern Arizona monitoring ore production. The Orphan Lode in the Grand Canyon fell within this province. Few people knew there was a uranium mine in the park just below the south rim of the Canyon. I immensely enjoyed working in this magnificent National Park. AEC succeeded beyond all expectations and discovered enough ore to meet national requirements at that time; more uranium could be purchased at lower cost overseas. As with many government operations, work rapidly dwindled to routine paper shuffling. The hand-writing was on the wall and by the end of 1959 it was time to say goodbye to friends and associates and find another job.

The Space Race had begun and I applied to agencies and industry seeking an interesting job. North American Aviation, prime contractor for the Apollo Program, came through with a position as Lunar Geologist. As in AEC, I had no previous experience but I soon found that few others did either - we were all equally ignorant hence equally qualified. There were no trained space scientists in the beginning; diligent study was the requirement. I went to work for Space & Information Systems Division in Downey, California as Research Engineer. Amazed and delighted I found I was to work for Dr. Jack Green, an old friend, VPI geologist, class of 1950. The space race was on. If Russia reached the moon first they would dominate the heavens and perhaps control the world. That was a challenge worthy of full attention and best effort. I was fortunate because Dr. Green was about to teach a special course in Lunar Geology at the University of Southern California and I hastened to enroll. This gave me an accelerated start in digesting what was known about the geology of the moon. Lunar Geology is a contradiction in terms in that geo refers to the earth, not the moon, and ology from Greek means study of. Regardless, the term stuck. Working overtime and going to night school absorbed available time. Constant study was the regimen of the day.

Much of the research was done by earth analogs of lunar terrain. Photographs of the lunar surface from aircraft, spacecraft, and telescopes provided study materials. Because much of the lunar surface is volcanic, similar terrain on earth was studied intensely. Across the western U.S. broad volcanic areas were studied, i.e., Craters of the Moon National Monument, Idaho, Meteor Crater, Arizona, the Valley of Ten Thousand Smokes and Katmi National Monument, Alaska. The need was to map potential landing sites on the moon, sites that also permitted takeoff and return to earth.

Please see Siapno, page 8

Siapno, continued from page 7

Another concern was the design of the landing gear for the lunar lander. The lunar surface had to provide support for both landing and take off. The program was ambitiously looking beyond just reaching the moon. The future outlook was to find lunar resources to develop and support a lunar base. Research was intense, interesting, and demanding. At this juncture the term "brain drain" was adopted. The Russians were worthy competitors. Fortunately the U.S. had the assistance of scientists and engineers around the world. Staff in many instances looked like a meeting of the United Nations (UN). Few scientists and engineers, no matter their origin, wanted to work for the Russians. I enjoyed the work, associations, and took night school courses in Russian. In return for the effort I was rewarded with a rapid series of promotions. There were many colloquia, symposia, and other technical meetings with scientists and engineers from around the globe. It was a fascinating opportunity for a geologist of modest qualifications.

In mid summer of 1969, the U.S. landed the first astronauts on the moon. The world stood with bated breath, witnessing in awe events on television. Again, the West had won a most important and demanding race in bringing peace to the world and subduing the Soviet threat. Though the West won this race the world now plunged into the Cold War. Russia was attempting to corner strategic resources, with emphasis on fuels and metals but also other materials essential to defense. In short order they gained significant control of African ores. This induced the West to look to the oceans for new sources. Already petroleum was being extracted in increasing amounts from beneath the seas. Now the challenge became manganese nodules as sources of manganese, copper, nickel, and cobalt. All of these metals were essential to the defense program. Reaching the moon greatly reduced the need for earth bound geological studies when such work was more effectively conducted on the moon with select samples.

Space capsules on return to earth landed in the sea. North American opened a new division, Ocean Systems Operations to develop this capability and to produce resources from the ocean. I joined this group at inceptions and became Chief Geologist of Ocean Systems Operations. The immediate challenge was the MoHole Program which sought to drill the earth's crust to the Mohorovicic discontinuity. It was short lived when funds were deleted but background research formed the basis of the successful Deep Sea Drilling Program. In the midst of these events, I had the good fortune to attend a meeting at Newport News Shipbuilding & Dry Dock Company, Newport News, Virginia. I quickly learned they were organizing a new company to explore and mine the world's oceans. They had converted a Great Lakes steamer to an oceanographic vessel renamed RV, Research Vessel, Prospector. To my surprise they liked my diversified geological experience and offered me the position of Chief Geologist, which I accepted at the end of 1958. I was delighted with the opportunity and the chance to return to my native Virginia. Deep sea Ventures was headquartered in Gloucester Point, Virginia just across the York River from Yorktown.

Early in 1969 RV Prospector made a port call in Washington, D.C. to announce the start of an international consortium to explore and mine manganese nodules. Dignitaries from government and industry were invited to lunch and the opportunity to inspect the vessel and its scientific equipment. It was a huge success and Deepsea was on its way. In January, Prospector began mapping the Blake Plateau in the Atlantic preparing for mining tests. A World War II cargo vessel was designed and converted to be Deepsea Miner, the world's first ocean mining ship. Tests were completed in 1970 and surveying was moved to the Pacific where higher-grade ores were known. During this time, several European consortia were organized. In short order, Japanese and German companies came to Deepsea to study nodule deposits and exploration techniques, and the Deepsea consortia was formed with U.S. Steel, Sun Oil, Simim of Italy, and Union Miniere of Belgium. Surveys were conducted out of San Diego, Hawaii, and Panama, that resulted in the filing of the world's first deep ocean mining claim in the late 1970s. This success brought me promotion to Director of Marine Science. The work was highly confidential; competition with other consortia was intense. International Nickel formed a group made up of German and Japanese industries. Kennecott consortium was composed of several international groups. Russia, Japan, France, China, and India also sponsored ocean mining programs.

The contest was on to see who would succeed in ocean mining. Early in the 1980s Deepsea successfully mined the Pacific Clarion-Clipperton zone. The company had converted a 625-foot ore carrier to Deepsea Miner II in order to operate in depths of 15,000+ feet. Lockheed in joint effort with their partners operated the Glomar Explorer to test their mining system. International Nickel with German and Japanese partners also successfully operated a mining vessel. These were very expensive programs operating within prevailing laws governing mid ocean areas. About this time, the United Nations declared that all unowned oceanic areas came under the jurisdition of the UN. This was not agreed upon and ocean mining nations objected. The UN had not invested a cent in ocean mining and those companies that had were not about to concede ownership to the UN. Disagreements raged in ensuing years but ultimately some nations accepted UN control. Rather than be subservient to the UN, Deepsea Ventures dropped out of the contest. This move was followed by other ocean miners who did the same. Soon the program that looked so promising to relieve metal shortages foundered in a legal morass. The simple explanation is members of the UN that had neither the money nor the talent to enter the contest decided they could profit by charging fees to those who did. In the end, no one prospered, entrepreneurs simply quit. Now some twenty plus years later ocean mining is yet to become a commercial reality. Deepsea disappeared from the scene in the late 1980s. The day will come when ocean mining will be necessary and ideas and techniques from this earlier age will be resurrected for review.

This was a discouraging turn of events. I was too young to retire so I became a consultant. In the autumn of 1986, I received an invitation to join the Soviet Academy of Sciences in their program to explore selected sites in the Pacific. Under Goborchev's initiative the Soviets seeking to join the world scientific community invited Woods Hole and Scripps to join but U.S. government restrictions precluded acceptance. Having just been released by Deepsea I was free to go. I joined Research Vessel Vinogradov in San Francisco in September to survey the Juan de Fuca Ridge and nodule deposits in proximity thereof. While engaged in this work an unmarked Navy plane overflew the vessel. We were in international waters so no one had jurisdiction. A survey had been conducted within 200 miles of the U.S. however, and hence inside the U.S. Exclusive Economic Zone, but there was no intent in taking any resources just samples. Life aboard Vinogradov came to a complete halt until the aircraft disappeared. However, in the distance a destroyer was visible through breaks in the outlying fog bank. No question, the Russian vessel was definitely under surveillance. Though we were only taking scientific samples, which was open to question, it was permitted under law. Very little was said by anyone on board. However, when we reached port at Prince Rupert, British Columbia I was interrogated by Canadian and U.S. Authorities. I responded to their many questions and explained it had been a most interesting cruise and when asked about the buzz job I told them it was carefully documented on board Vinogradov.

Immediately on returning home, I received phone calls from the CIA requesting interviews and that I prepare a report together with photographs covering details of the cruise. I agreed if they would pay the expenses incurred. They refused so I refused. Their heavy hand response was they expected me to be more patriotic. I explained tersely that I was indeed patriotic but self employed and needed income. Next a call came from Navy Intelligence requesting the same thing but they were willing to pay my costs so I agreed to cooperate. At a debriefing with the Navy, I did discuss all pertinent happenings and provided a report complete with photographs. Later, I reported to the Navy on other trips that I made to the Soviet Union. The Russians never requested or suggested that I not discuss or write about my experiences.

As an outgrowth of the cruise, I was invited in the autumn of 1987 to be a Visiting Lecturer, together with long time friend and associate, Dr. J. Robert Moore, Head of the Oceanographic Department, University of Texas, Austin, Texas. The lecture tour took us across the Soviet Union from Moscow to Leningrad, Khabarosk, Vladavostok and return. My Russian studies from my California days served me in good stead. Russians are most appreciative of foreigners who have gone to the trouble of studying their language. Robby Moore and I lectured and discussed scientific matters at many academic institutes and we were guests at numerous official affairs held in our honor, met a host of dignitaries, and visited many distinguished sites including the great Hermitage Museum in Leningrad, now again called St. Petersburg. It was a marvelous tour and I was delighted to accept invitations to return on four other occasions.

I also consulted for agencies and industries both in the U.S. and overseas, including Rauma Repola of Finland, the U.N. in Southeast Asia and in Jamaica. Also, I was an invited speaker for NATO in 1986 and in Germany and England. Further, I consulted for the Office of Technology of the U.S. Congress. I served as representative for NOAA in meetings in Washington and the Pacific and as principal investigator of nodule deposits in the Cook Islands for the U.S. Trade and Development Agency and consulted for NASA's SeaSat Program.

Today I live in Durango, Colorado near my daughter and her family. I am semi retired and still consult when opportunities arise. I still enjoy skiing, biking, and fishing and until recently flying. In looking back, I can only be pleased and grateful for the many opportunities that were mine. I am indebted to associates and friends who so willingly lent assistance. I have indeed been blessed with a most interesting career that took me around the globe and allowed me to visit so much of the world in the process. I was most fortunate to have many interesting associates with whom to share experiences. I am eternally grateful to VPI for the education that launched me on my way."

New Research in Information Technology and the Department of Geosciences

Dear Alumni:

The GEOscience Network (GEON) project is a research collaboration recently funded by the National Science Foundation between Geoscience and IT researchers with the goal of creating a modern information technology framework for the earth sciences. The geoscience research is coordinated by Virginia Tech Professor of Geology, A. Krishna Sinha. This multimillion dollar award to the geoscience research consortium also has a major partner in the U.S. Geological Survey (USGS), which will collaborate in building broader access through GEON for selected USGS national scale geological databases. "GEON will seamlessly integrate USGS data with those of the broader geoscience community," said Charles G. Groat, USGS Director. "This will significantly speed the pace of geological research."

Many interdisciplinary questions posed within GEON by the earth science team will "require a research partnership between geoscientists and information technologists" said Chaitan Baru, co-director of the San Diego Computer Center's Data and Knowledge Systems program. The geoinformatics cyberinfrastructure will provide interlinked information systems to enable the geosciences community to share not only data and information but also tools and programs that will let earth scientists collaborate more effectively than ever before. The development of the GEON cyberinfrastructure will be critical for integrating and interpreting data collected by projects such as the NSF Earthscope initiative.

If you desire further information, please send an e-mail to pitlab@vt.edu.

A. K. Sinha
Professor of Geology
Virginia Tech

GEON: A Research Project to Create Cyberinfrastructure for the Geosciences

The GEON (GEOscience Network) research project is being proposed in response to the pressing need in the geosciences to interlink and share multidisciplinary data sets to understand the complex *dynamics of Earth systems*. To rise to this challenge, we have formed a coalition of IT researchers, representing key technology areas relevant to GEON, and Earth Science researchers, representing a broad cross-section of Earth Science sub-disciplines. The need to manage the vast amounts of Earth science data was recognized through NSF-sponsored meetings, which gave birth to the *Geoinformatics* initiative. The creation of GEON will provide the critical initial infrastructure necessary to facilitate Geoinformatics and other research initiatives, in particular the *EarthScope* initiative.

Creating the GEON cyberinfrastructure to integrate, analyze, and model 4D data poses fundamental IT research challenges due to the extreme heterogeneity of geoscience data formats, storage and computing systems and, most importantly, the ubiquity of "*hidden semantics*" and differing conventions, terminologies, and ontological frameworks across disciplines. GEON IT research focuses on modeling, indexing, semantic mediation, and visualization of multi-scale 4D data, and creation of a prototype GEON Grid, to provide the geoscience community an "IT *head start*" in facing the research challenges posed by understanding the complex *dynamics of Earth systems*. An important contribution will be embarking on the definition of a *Unified Geosciences Language System* (UGLS), to enable semantic interoperability. The GEON Grid will leverage our experience in the National Partnership for Advanced Computational Infrastructure (NPACI) program, and the experience that will be gained in the recent NSF-funded *TeraGrid* Distributed Terascale Facility. We will create a *portal* to provide access to the GEON environment, which will include advanced query interfaces to distributed, semantically-integrated databases, Web-enabled access to shared tools, and seamless access to distributed computational, storage, and visualization resources and data archives.

Two testbed regions, the *mid-Atlantic* and the *Rocky Mountains*, have been identified to define the GEON geoscience challenges. These regions were selected due to the variety of geological issues embodied within them requiring interlinking of multiple disciplinary databases and also because they are areas of expertise for the GEON geoscience research team. The results of GEON research will significantly impact large multi-scale geoscience research programs such as Earthscope, as well as individuals and smaller groups of researchers, *thereby leading to an intellectual transformation of the entire science*. Recognizing this potential, the U.S.Geological Survey has joined as a major partner and has made creation of key GEON databases a priority effort over the next several years. Via Digital Library Earth Science Education (DLESE), GEON will become an important resource for sharing knowledge about the Earth for a variety of audiences, including K-12 students and teachers.

In summary, GEON is an IT-based Geoscience revolution that will play a critical role in a more holistic understanding of the dynamics of Earth systems. It will also create new scientific paradigms and renew the excitement in the community of the post-plate tectonics era.

VIRGINIA TECH'S CRYSTALLOGRAPHY LABORATORY

On Wednesday, Sept. 18, 2002 the Departments of Chemistry and Geological Sciences at Virginia Tech recognized both the co-location of their crystallographic facilities in the Virginia Tech Crystallography Laboratory as well as an agreement reached with Oxford Diffraction Ltd. The Crystallography Laboratory added a second diffractometer that will give researchers and students a unique opportunity to develop new experimental techniques to solve scientific problems.

Ross Angel (right) demonstrates the Xcalibur-2 diffractometer to Professor Brian Tissue of the Department of Chemistry.

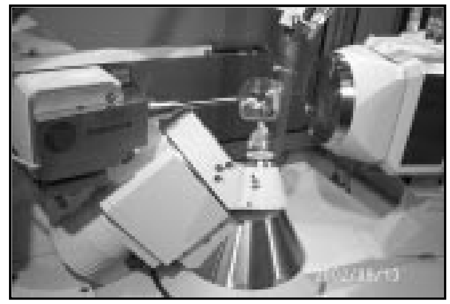
X-ray crystallography is a technique that has existed for nearly 100 years. The technique works by shining a beam of X-rays onto the crystal of the material. Due to its symmetry, the crystal will then scatter the X-rays in a characteristic pattern, and this can be recorded and interpreted to determine the structure and geometry of the molecules in the crystal. This is of great interest in chemistry, physics, biology and geology where a knowledge of molecular and atomic structure allows the properties of a material to be both understood and tailored. "Crystallography has always been interdisciplinary in nature; all crystallographers use the same techniques to address the relationship between structure and function in fields ranging from materials and electronic engineering, through chemistry and geology, to biology and medicine. The establishment of the Virginia Tech Crystallography Laboratory reflects this. We now have the ability to share instruments and expertise. We are exploring fundamental concepts in chemistry by applying techniques developed in the geosciences, and we will provide a focus and vehicle for interaction between faculty and research programs across the entire breadth of the university community," says Ross Angel, Research Professor in crystallography in the Department of Geological Sciences.

The addition of the Xcalibur-2 diffractometer from Oxford Diffraction to the Crystallography Laboratory was funded by a National Science Foundation (NSF) grant to Carla Slebodnick and Larry Taylor from the Chemistry Department. The Xcalibur-1 also located in the Crystallography Laboratory, was previously purchased from Oxford Diffraction in June 2001 by Nancy Ross and Ross Angel of the Department of Geological Sciences. Together, these two diffractometers allow experiments to be performed routinely to temperatures as low as 10 Kelvin and to pressures as high as 10 GPa (100,000 atmospheres) making the Crystallography Laboratory a unique facility that will serve not only Virginia Tech but other universities and colleges. "We see ourselves as a regional facility

The installation team from Oxford Diffraction and researchers from Virginia Tech with the Xcalibur-2 diffractometer.

for the scientific community" says Dr. Carla Slebodnick. "Eleven colleges and universities in Virginia, North Carolina and Tennessee will send their samples to us to be measured. Next summer we will host a workshop, sponsored by Oxford Diffraction, to bring students from these Universities to Blacksburg to train them in the use of the new equipment for their own research projects."

The Crystallography Laboratory will also house undergraduate and graduate courses in crystallography, improving the education of students by exposing them to a broader range of scientific applications and by giving them hands-on laboratory experience. This combined mission of research and training will be supported by the agreement with Oxford Diffraction, which identifies the Crystallography Laboratory as a "Gold Level Reference



A diamond-anvil cell mounted on the Xcalibur-2 diffractometer for high-pressure diffraction studies.

Site" for the company, the only one that will be established in the USA. Oxford Diffraction will provide the Virginia Tech Crystallography Laboratory with full service and support for the instruments, loan of equipment and direct sponsorship for staff and students. Faculty and students will also collaborate with the company in the development of new techniques and technologies.

Many of the research programs that will help advance Virginia Tech to one of the top 30 research institutions in the U.S. involve crystalline materials. The Crystallography Laboratory, located in Derring Hall, can now provide a central facility for the study of such materials while enabling full and improved support to be provided for developing research programs in materials, engineering, geological sciences, chemistry, biology, biochemistry, bioinformatics, and medicine.

For additional information, please visit http://www.crystal.vt.edu or contact Ross Angel (rangel@vt.edu) and Carla Slebodnick (slebod@vt.edu) at (540)231-7974.

Alumni Careers: John P. Grotzinger '85 Elected to the National Academy of Sciences

by Fred Read

John Grotzinger, a Class of 1985 Virginia Tech alumnus from the Department of Geological Sciences, was recently elected to the National Academy of Sciences. For his Ph.D. here at Tech, John studied in the Carbonate Research Laboratory under Fred Read and Ken Eriksson, and his field studies were under the guidance of Paul Hoffman (Geological Survey of Canada) who is now a professor at Harvard. John's Ph.D. described the sedimentary record and evolution of a 1.8 billion year old carbonate continental shelf that bordered an ancient landmass in present day arctic Canada. John's study illustrated how similar the shelf was to modern tropical shelves in overall character, but contained a major component of precipitated carbonate in contrast to modern shelves. Also, much of the shelf and slope was constructed by microbial assemblages capable of building a wave resistant rim comparable to modern coral reef assemblages.

John and the Carbonate Group at Tech developed some of the first computer models capable of simulating sedimentary deposition on such continental shelves. John's work showed that this ancient shelf showed a cyclicity similar to younger shelves of the last 600 million years where cyclicity records astronomical forcing of climate and sea level (termed Milankovitch orbital forcing and related to variations in the earth's axis and orbit). John did a post-doc at Lamont-Doherty with Gerard Bond on Cambrian (510 million years) sediments in the western United States developing techniques to extract the subsidence and sea level history from the sedimentary record. He then joined M.I.T. in 1988 where he became a full professor in 1995.

John has worked extensively in Namibia, South Africa, and the former Soviet Union, examining the Vendian sedimentary strata, which record the explosive evolution of metazoan groups within this narrow time interval spanning the latest Precambrian into the Cambrian. John and co-workers refined the dating of this event, by dating the boundary sediments, which resulted in the base of the Cambrian being put at roughly 540 million years, some 30 million years younger than most of the previously accepted dates. This suggested that the explosive evolution event was as little as 10 million years long. This work formed the topic for the cover page of Time Magazine.

John spent last year on sabbatical in Oman where he studied late Proterozoic platforms that are major petroleum reservoirs encased in salt. John is the world authority on Precambrian carbonate continental margins, and his work has led to a widespread reappraisal of the processes at work during development of these very ancient platforms. His work has provided a window into the atmospheric and oceanographic evolution of the Precambrian, and has helped explain why these early platforms had such a large cement component, and why certain evaporite minerals were rare until later. John and his coworker's (including Richard Bambach, emeritus professor from Tech and now at Harvard) have used the widespread precipitated carbonate cements at the Permian-Triassic boundary to help explain this extinction event, the largest to affect the Earth.

John has now headed off to Namibia to continue his studies of the Namibian carbonate platforms. Other awards include the Donath Award for Outstanding Young Geologists from the Geological Society of America and the NSF Presidential Young Investigator Award.

We are very proud of John's achievements. He is affectionately remembered by the Carbonate Group for his sense of humor, partying abilities and endless discussions. While at Tech, John kept secret the fact that he is the nephew of the world famous geologist, Preston Cloud. We are sure that Preston would be delighted at John's achievements.

Reiter, continued from page 3

Marshall's present research interests are: Using subsurface temperature data to study ground-water flow patterns in New Mexico, mostly in the Albuquerque Basin. "I've just assembled a system with a very fast time-response sensor so that we can also take continuous temperature logs in the vadose zone without deconvolving the data by the response characteristics of the probe. Hopefully we'll be able to look at vadose zone phenomenon with improved temperature data and relate to recent surface temperature warming. I'm also looking into the weakening of rocks in the upper crustal seismogenic zone due to temperature increase, and investigating the possibilities of the Socorro Magma Body being an in-situ partial melting of granitic rocks with water."

Greetings to Marshall at mreiter@nmt.edu and congratulations for a continuing successful career.

Free Student Memberships in the Society of Exploration Geophysics are Now Available

Through a generous grant from Halliburton, Inc., free student memberships in the Society of Exploration Geophysicists (SEG) are now available. To be eligible for Student Membership an applicant must be a full-time graduate or undergraduate student in good standing. Eligibility for Student Membership terminates at the close of the calendar year in which the student ceases to be a graduate or undergraduate student in good standing. Additional information and a downloadable application form can be found at the SEG web site http://www.seg.org/services/membership.

This year the Society of Exploration Geophysicists held its 72nd annual meeting in Salt Lake City, Utah. Our own Mike Bahorich (the one at the top in the photo with other SEG officers) has been elected President of this large and prestigious society for 2002-2003. Mike obtained his M.S. in Geophysics from Virginia Tech in 1981. He is also a member of our Department of Geological Sciences Advisory Board.

James Craig Retires

by Donald Rimstidt

Professor James R. Craig retired from the Department of Geological Sciences in June 2002 after 32 years at Virginia Tech. He joined the Department of Geological Sciences at Virginia Tech as an Assistant Professor in 1970. His extensive and valuable contributions to our department and to the university were recognized last year when he received the Outstanding Faculty Award from the State Council of Higher Education of Virginia (SCHEV). This honor was presented to him this past spring by the Governor of Virginia, Mark Warner. During his scientific career, Jim published more than 150 scientific papers and is the coauthor of two scholarly books relating to his research specialty, ore mineralogy and microscopy. In addition, he is the lead author of an important textbook on resources geology and he has taught more than 17,000 undergraduate students over his 35 years of university teaching. His teaching is widely regarded as that of the highest quality. For example, he taught 4400 students in 26 separate classes over the past five years with an average overall student evaluation of 3.7/4.0 and he received no evaluations below 3.4 in any of these courses. He has an exemplary record of service to Virginia Tech and to the Commonwealth of Virginia. He served as the Chair of the Department of Geological Sciences from 1990 to 1994 and as an appointed member of the Virginia Waste Management Board from 1986 through 1994 (he was the Chair of the Waste Management Board from 1988 through 1992).

Jim and his wife, Lois, have moved from Blacksburg and now live in Emerald Isle, North Carolina. Jim is currently an Adjunct Professor at the University of North Carolina Institute of Marine Sciences in Morehead City, North Carolina. He continues to be an active member of the recovery team for the Queen Anne's Revenge (flagship of the pirate Blackbeard).

Applied Geochemistry at Virginia Tech

By Don Rimstidt

The mineralogy-petrology-geochemistry program at Virginia Tech has been very successful over the past several decades and has long enjoyed a world-wide reputation. We have educated many graduate and undergraduate students who have gone on to successful careers in academia, industry, and government. We have also published a very large number of important papers and received significant grant support. I am proud to have been a part of this group of scholars for the past 22 years. The purpose of this article is to highlight some of the activities of my research group over this time.

I have always been interested in using geochemistry to solve applied problems. As a graduate student at Penn State, I was part of the Ore Deposits Research Section and performed research on the chemistry of geothermal fluids that might be used as an energy resource. These fluids are the modern equivalent of the hydrothermal fluids that deposited many types of mineral deposits. My interest in ore deposits continues to this day and I have participated in several ore deposit research projects, mostly with Jim Craig and his graduate students. Alas, ore deposit research is no longer fashionable in geochemistry, so student interest and funding has waned.

In order to be able to continue working with mineral deposits, I developed a fairly extensive research program to document the geochemistry of mine wastes and especially to understand the rates of the reactions that produce acid mine drainage. There are currently more than 60 billion tons of mine wastes from nonfuel mineral production in the U.S. and an undetermined amount of pyritic wastes from coal mining. Iron sulfide minerals in these wastes are unstable at the earth's surface and they oxidize to produce acidic, iron- and trace element-enriched sulfate solutions that have a deleterious impact on nearby receiving waters. Several of my graduate students have contributed to this research with results ranging from the oxidation rates of sulfide minerals to the thermodynamic stability of sulfate minerals. The ultimate goal of this project is to provide

a very complete set of kinetic and thermodynamic information that can be used to model the effects of various remediation plans on mine wastes.

Another area of applied geochemistry that has had continued high visibility is the disposal of high-level radioactive wastes. The U. S. is planning to dispose approximately 70,000 tons of high-level radioactive wastes in a mined repository beneath Yucca Mountain, Nevada. In order for this project to be successful, many, many details of the geology, geochemistry, and geophysics of the site must be understood. The site assessment and engineering design for this project is being carried out by the Department of Energy, but the State of Nevada is performing additional tests to insure the reliability of the repository design. We have carried out two different projects under contract with the State of Nevada. One project evaluated the mobility of silica in the thermal gradients that will develop around the waste canisters. The other is evaluating the corrodability of the alloy that will be used to construct the canisters. The objective of this research is to insure that the DOE engineering designs are adequate to contain the wastes for at least 10,000 years.

The corrosion of metals in the environment has been investigated by generations of engineers who want to preserve metal structures. Now the environment is full of corroding metal artifacts that are releasing dissolved metals that contaminate soils, waters, and biota. The fate and transport of these metals in the environment is an emerging problem in applied geochemistry. An excellent example are the lead shot and bullets that are expended into the U. S. environment at a rate of about 50,000 metric tons per year by recreational shooting and hunting. Much of this lead accumulates on shooting ranges where lead loading of the shallow soils can become very high. For example, we have documented lead loading of up to 5 kg/m^2 on a 10 year-old shotgun range near Blacksburg, Virginia. So what happens to all of this lead as it oxidizes and corrodes? We know that some of it is retained in lead oxide and carbonate minerals that form on the surface of the lead. However, some dissolves in water and migrates. The migration of this lead appears to be limited by adsorption onto iron and manganese minerals, organic matter, and clays in the soil. Our research will identify the transport pathways and fate of all of this lead.

One of the most fundamental geochemical processes at the earth's surface is chemical weathering. Chemical weathering dissolves rocks and minerals leading to the physical destruction of land forms. Chemical weathering transfers the components of these rocks and minerals to surface and groundwaters. We have carried out numerous research projects to understand the rates of chemical weathering of a wide range of minerals. The long term objective of these studies is to understand the reaction rates and mechanisms for the dissolution of silicate minerals in aqueous solutions. This will not only give us a better understanding of chemical weathering but also will lead to methods to synthesize complex silicate phases that might have technological applications. An immediate application of this work has been an improved understanding of the link between exposure to respirable mineral dusts and respiratory diseases. Our work has shown that respired chrysotile fibers should dissolve in lung fluids in less than one year; respired talc dust should dissolve in less than one decade; and respired quartz dust will not dissolve significantly over the span of a human lifetime. These mineral dissolution rate studies can be applied to many other technological problems ranging from solution mining to disposal of slags and ashes.

All of this research is tied to basic thermodynamic and kinetic theory and the graduate students who have participated in this research have shown that they can apply these theoretical methods to solve a wide range of experimental and field problems. I have had the pleasure of supervising more than 20 exceptionally bright and capable graduate students during my time here at Virginia Tech. They have taught me a lot and I am very proud of their contributions to the field of geochemistry.

Recent contributions of $1000 or more:

Mr. David Worthington(‘68) has made another generous contribution ($25,000) to the *John K. Costain Graduate Geophysics Endowed Scholarship Fund*

Dr. Lynn Glover (‘52) contributed $1,000 to the *Alumni Endowed Scholarship for Geological Sciences*

Dr. Matthew J. Mikulich contributed $3,000 to the *Matthew J. Mikulich Endowed Geophysics Scholarship*

Donald Vance Dalton (‘60) contributed $4,000 to the *Donald V. Dalton Endowed Fund for the Museum of Geological Sciences*

Donald Dalton (‘60) donated gifts to the Geological Sciences Museum valued at $1083.05

The Estate of Thomas Tabb Jeffries, Jr. (‘36) contributed $8,000 to start the *Thomas T. Jeffries III Sciences Endowed Scholarship Fund*
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Thomas T. Jeffries III (‘65) contributed $2,000 to develop an Endowed Scholarship in the honor of his father, Thomas T. Jeffries, Jr (‘36)

The ExxonMobil Foundation contributed $6,000 to match the contribution of Thomas T. Jeffries III for the *Thomas T. Jeffries Geological Sciences Endowed Scholarship Fund*

ChevronTexaco contributed $15,000 to support students via fellowships/scholarships and department use. The check was presented to the department by Mr. James C. Niemann (’82)

ExxonMobil contributed $4,000 for educational purposes within the department for the 2002 academic year

BP Exploration contributed $4,000 to support students and programs

BP Corporation North America, Inc. contributed $15,000 for educational purposes for the 2002-2003 school year

The ExxonMobil Foundation contributed $4,500 to match donations made by James Fisher (‘63), Thomas Jeffries (‘65), and William Presley (‘57)

Schreiber, continued from page 1

The biogeochemistry of arsenic is complex as it involves adsorption, biotransformation, oxidation-reduction, and precipitation-dissolution reactions. These processes affect the form (inorganic vs. organic), the speciation (arsenite, As(III) vs. arsenate As(V)), as well as the concentration of arsenic in natural waters. Understanding the form and speciation of arsenic is important because they both affect toxicity characteristics. As(III) is more toxic than As(V) to humans (Andreae, 1986), but As(V) is more toxic than As(III) to algae (Knauer et al., 1999). The relative distribution of As(III) and As(V) is often far from thermodynamic equilibrium, likely due to microbial activity, sorption processes, the presence of strong oxidants and reductants, and relatively slow kinetics of abiotic oxidation and reduction. Sorption reactions are particularly important in controlling arsenic mobility in the environment due to the high affinity of many minerals for arsenic. Studies have demonstrated that arsenic sorption to metal oxides, including HFOs, is strongly influenced by pH, the presence of competing anions, and the degree of aging of the mineral (Fuller et al., 1993; Manning and Goldberg, 1997; Pierce and Moore, 1982). In addition to metal oxides, arsenic binds to calcite (La Force et al., 2000), sulfides (Moore et al., 1988), and clays (Manning and Goldberg, 1996).

Organisms play a critical role in the biogeochemical cycle of arsenic (Cullen and Reimer, 1989). Microbial species, including bacteria, algae, and fungi, are capable of reducing As(V) to As(III) (Ahmann et al., 1994; Langner and Inskeep, 2000; Newman et al., 1998) and oxidizing As(III) to As(V) (Gihring et al., 2001). Microbially-mediated reductive dissolution of arsenic-bearing HFOs releases arsenic and Fe(II) to solution(Cummings et al., 1999; Zobrist et al., 2000). Microbial methylation of inorganic forms of arsenic is also widely documented (Andreae, 1986; Challenger, 1954; Cullen and Reimer, 1989).

Due to the complexity of biogeochemical and hydrologic controls on arsenic fate, multiple lines of evidence are needed to distinguish mechanisms that release arsenic to ground water in a particular setting. To fully identify processes of arsenic release and transport, information is necessary regarding (1) the geologic setting, to constrain petrologic, stratigraphic and/or structural controls on the occurrence of arsenic-bearing units; (2) aquifer mineralogy, to determine the sources of arsenic; (3) the hydrogeologic setting, to delineate ground water flowpaths; (4) water chemistry, to examine the relationship between arsenic and key chemical parameters; and (5) microbiology, to assess the role of microbial flora in the biogeochemical processes that control arsenic release. Accurate assessment of the mechanism of arsenic release will help to identify safe drinking water resources and to evaluate treatment methods for contaminated waters.

We are using a lines-of-evidence approach to examine arsenic fate and transport in three case studies: 1) oxidation of arsenic-bearing sulfides in a confined sandstone aquifer; 2) arsenic cycling at an abandoned arsenopyrite mine; and 3) fate and transport of organoarsenic compounds in agricultural watersheds. Although these case studies involve different forms of arsenic, geologic conditions, and hydrogeologic environments, the governing processes of arsenic geochemistry are the same. Thus, the lines-of evidence approach is useful to evaluate the dominant biogeochemical, and hydrologic controls in each setting.

Case study: Oxidation of Arsenic-Bearing Sulfides in a Confined Sandstone Aquifer

Funding: University of Wisconsin (UW) System, Wisconsin Department of Natural Resources Collaborators: M. Gotkowitz (Wisconsin Geological and Natural History Survey), J.A. Simo (UW-Madison)

Arsenic concentrations up to 12,000 mg/L have been measured in ground water from the St. Peter aquifer in the Fox River valley in eastern Wisconsin, USA (Fig. 1). In addition to a sulfide-bearing secondary cement horizon (SCH) (Fig. 2) present at the top of the aquifer, sulfide mineralization is also present throughout the aquifer. Within the SCH, arsenic occurs in pyrite and

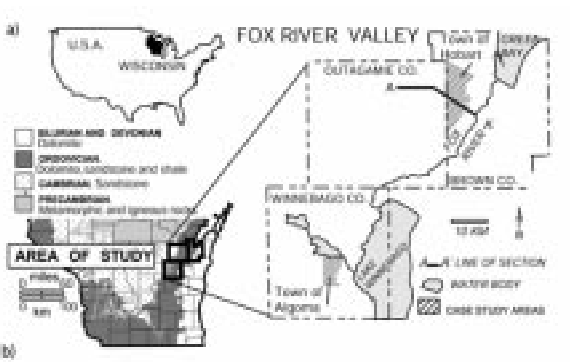

Fig 1: Location and bedrock geology of the Fox River valley, WI. From Schreiber et al., 2000.

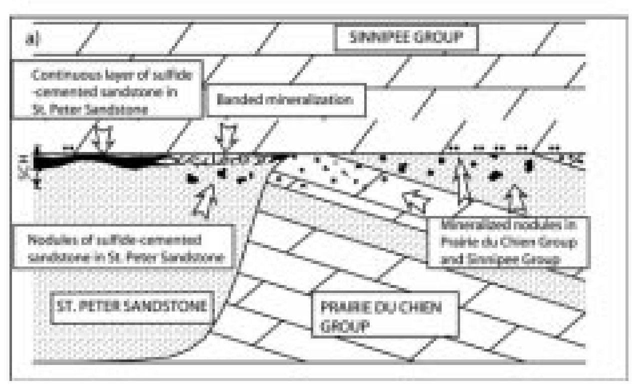

Fig 2: Generalized schematic of observed morphologies of the sulfide cement horizon (SCH) (Schreiber et al., 2000)

marcasite, and in iron hydroxides, but not as a separate arsenopyrite phase. Geologic, hydrogeologic, and geochemical data were used to characterize the arsenic source and the predominant geochemical processes controlling its release to ground water. Several lines of evidence suggest that oxidation of sulfides is the cause of high (>100 mg/l) concentrations of arsenic in ground water, including: 1) the presence of the arsenic-bearing sulfides in the aquifer; 2) water chemistry data that show a positive correlation between arsenic, iron, and sulfate and negative correlation between arsenic and pH; and 3) similar sulfur isotopic signatures in SCH sulfides and sulfate in ground water.

Results of previous research (Schreiber et al., in press; Schreiber et al., 2000) have strongly suggested that atmospheric oxygen, introduced to the SCH through well boreholes, provides an oxidant to the system. This hypothesis is supported by the occurrence of high arsenic concentrations where water levels within the well intersect the SCH. However, the data do not unequivocally show sulfide oxidation to be the cause of the moderate (10-100 mg/l) and low (<10 mg/l) arsenic concentrations measured in ground water in the study area. The variability in thickness of the SCH and the concentration of arsenic within the sulfides, as well as the local availability of oxygen to the SCH, likely contribute to the spatial variability of ground water arsenic concentrations.

Current research: A field experiment was conducted to examine the geochemical and hydrologic controls on arsenic release within a well borehole (Gotkowitz et al., In prep). Results indicate that residence time of water in the borehole is a strong control on arsenic concentration. This may be caused by microbial processes that are more active in the borehole than in the aquifer. Although the cause of arsenic release in the well cannot be attributed with certainty to a single process, results suggest that sources and mechanisms of arsenic release are related to borehole mineralogy and geochemical conditions.

Case Study: Transport, Transformation, and Retention of Arsenic in a Headwater Stream

Funding: National Science Foundation (8/1/02 - 7/31/05), Jeffress Memorial Trust (1/1/02 –12/31/02)
Collaborators: H.M. Valett (Dept. Biology, Virginia Tech)
Students: J. Chaffin, L. Chiehowsky, M. Fuller, K. Hankins, M. Harvey, J. Lare, F. Walker

Arsenic contamination of surface waters from sulfide mining activities has occurred in many areas worldwide (Armienta et al., 2001; Nicolli et al., 1989; Williams et al., 1996). One of the main challenges in remediating streams in mining-impacted regions is determining the relative contributions of surface runoff vs. groundwater in contributing arsenic to streams. The influence of groundwater discharge in controlling mass fluxes of arsenic to streams will be strongly influenced by biogeochemical and hydrologic processes in the aquifer as well as the hyporheic zone (the interface between ground and surface water).

We are currently using a combination of hydrologic studies of ground water-surface water exchange, geochemical investigations of the interaction between dissolved and solid components, and experimental studies of the influence of biological processes to elucidate the processes that govern arsenic cycling in stream-aquifer systems. Our field site for this research is the Brinton Arsenic mine in Floyd County, Virginia. At the site, arsenopyrite (FeAsS), hosted in quartz sericite schist, was mined from 1903 to 1919. Production of arsenic involved roasting of the ore, which volatilized arsenic to arsine gas (Dietrich, 1959). Tailings piles containing unprocessed ore, oxide-coated sand, and roasted ore, remain at the site. The Brinton stream, whose headwaters are located 75 m upgradient from the mine, flows within 10 m of the piles.

Results of monitoring of fourteen stream sites, two spring channels, and several monitoring wells indicate that dominant inorganic arsenic species at the site is As(V). As(III) concentrations up to 75% of total arsenic have been measured at some locations. Concentrations of total arsenic (Fig. 3), sulfate, calcium, nitrate, phosphate, and pH, vary spatially along the stream. Arsenic increases in the stream reach adjacent to the tailings piles; however, a large increase occurs downstream of two spring channels, both of which contain > 5000 mg/L arsenic (Fig. 3). While arsenic concentrations in the stream in the vicinity of the mine are clearly elevated, they are below detection 1 km downstream from the mine.

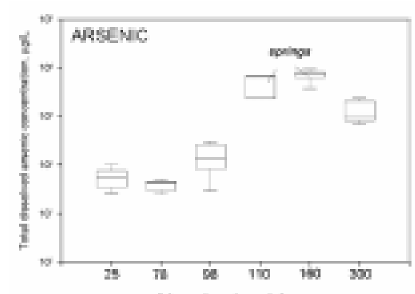

Fig 3: Box plots of arsenic concentrations in stream. Plots show 25th and 75th percentiles as end-lines. Mid-line of the box represents 50th percentile; capped bars indicate 10th and 90th percentiles. Mine tailings located ~98 to 110 m downstream.

Stream arsenic concentrations fluctuate seasonally, with concentrations up to two orders of magnitude higher in summer than in winter. Individual precipitation events appear to affect the water quality of the springs more than the stream. Sampling before and after a 7-cm rainfall over a one week period revealed small changes in stream

Please see Schreiber, page 18

Schreiber, continued from page 17

geochemistry. However, the springs showed evidence of significant dilution of arsenic and other solutes, indicating a rapid response of the springs to precipitation events.

Current research: Jake Chaffin (M.S., Biology) is examining the impacts of arsenic on stream biota and organic matter processing. Mary Harvey (B.S., Geological Sciences) and Forest Walker (Ph.D., Geological Sciences) are determining rates of arsenopyrite oxidation under varying pH and dissolved oxygen conditions. Other research tasks include using transient storage models to evaluate the hydrologic characteristics of the hyporheic zone and, through incorporation of reactive uptake terms, to address the role of the hyporheic zone in retarding or promoting arsenic transport to the stream.

Case study: Fate of Organoarsenic Poultry Feed Additives in an Agricultural Watershed

Funding: U.S. Department of Agriculture (8/15/02 – 8/14/05)
Collaborators: T. Hancock, J. Garbarino, and D. Chambers (U.S. Geological Survey), G. Mullins (Dept. Crop, Soil, and Environmental Sciences, Virginia Tech)
Students: B. Brown

The poultry industry is one of the largest and fastest growing livestock production systems in the world. In the U.S., poultry meat production increased by 24% from 1988 to 1993 (Sims and Wolf, 1994). Although economically successful, the poultry industry generates significant volumes of waste. The management of this waste has become a challenging environmental problem because poultry manure is rich in nutrients; high concentrations of nitrogen, phosphorous, and bacteria in poultry waste have impacted water quality in agricultural areas where the manure is applied. Recent monitoring of several creeks in Rockingham Co., which has the largest concentration of poultry operations in Virginia, indicated that 62% of samples exceeded water quality standards for fecal coliform (VADEQ, 2000).

In addition to high concentrations of nutrients and bacteria, poultry manure contains pharmaceuticals, such as antibiotics, steroids, and organoarsenicals. Roxarsone, an organoarsenic compound, is added to poultry feed at 22.7 to 45.5 g per ton, for the purpose of improving weight gain, feed efficiency, and pigmentation (USFDA, 2000). Previous studies have demonstrated that these organoarsenic compounds do not accumulate in poultry tissue or feathers (Aschbacher and Feil, 1991) but are rapidly excreted, resulting in elevated concentrations of arsenic (20 to 40 mg/kg) in poultry litter (Kunkle et al., 1981; Morrison, 1969). Despite the evidence that poultry waste contains significant concentrations of arsenic, there is a lack of information on the fate of organoarsenic compounds in the environment.

The primary objective of this research is to gain insight into factors that control the fate and transport of arsenic compounds in agricultural watersheds (Fig. 4). We are employing a multi-method approach of field and laboratory experiments to evaluate the cycling of organoarsenic compounds through soil water, ground water, hyporheic zone water, overland flow, and stream water (Fig. 4). Preliminary findings from our field site in the Muddy Creek watershed, Shenandoah Valley, Virginia, document that arsenic can be leached from soils where poultry litter has been applied.

Current research: Brenda Brown (M.S., Geological Sciences) is conducting laboratory experiments to test the significance of sorption in controlling partitioning of litter-derived arsenic compounds and to examine the potential for biotransformation of Roxarsone. Other research tasks include 1) detailed watershed monitoring to track the transport of arsenic through the watershed and 2) analysis of soils with varying litter application histories to evaluate possible correlations between litter-derived arsenic and key soil characteristics.

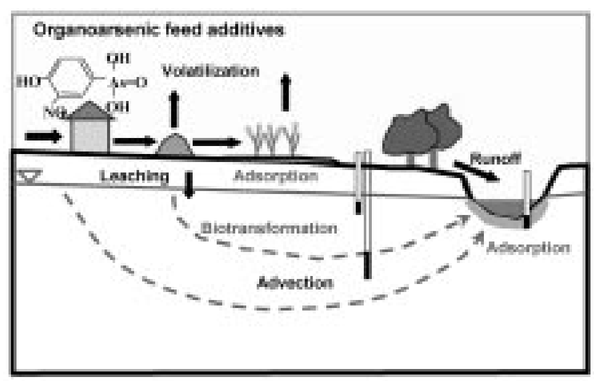

Fig 4: Arsenic cycling in poultry-dominated watersheds. Courtesy of T. Hancock

Summary

Because the processes that dictate arsenic behavior are often complex and interrelated, our approach is to use a combination of laboratory and field experimental techniques. The sources of arsenic in each of our case studies differ (arsenic-bearing sulfides under low-oxygen conditions; arsenopyrite exposed at the surface; arsenic-rich poultry litter applied on agricultural fields), but evaluation of the biogeochemical and hydrologic processes occurring at each site has yielded critical information on arsenic release and transport in surface and subsurface environments. Results of these interdisciplinary research projects will have implications for understanding arsenic fate and transport at the individual sites, and for our general understanding of the biogeochemical cycling of redox-sensitive trace elements in natural and human-impacted systems.

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ALUMNI NEWS

'73

Art Hayes (Ph.D. '73) Art's daughter, Jessica Hayes, graduated from the University of Illinois with a B.S. degree in Community Administration, with honors, and the Florio Award for

outstanding community and university service. She is currently employed by Health Care Alliance. Jess wishes to continue her education and is considering programs to become a nurse practitioner or chiropractor.

'75

John R. Lawson II (B.S. '75) has been appointed to the Virginia Tech Board of Visitors. John is President and CEO of the general contracting firm W. M. Jordan. He is actively involved with the Advisory Board of the Virginia Tech School of Building Construction, the Virginia Tech Stadium Expansion Committee, and is a member of the board of the Virginia Tech Foundation.

'77

William (Cliff) Bourland (M.S. '77) received a Master's Degree in Architecture and works primarily on commercial building and tenant finish out projects. Some of the projects are quite large and encompass 25 to 100 acres with multiple buildings and functions. These projects can last several years. He has designed and built large corporate campuses in Mexico and Venezuela. He even did a project in Algeria via the internet. He is presently involved with projects scattered up and down the West Coast of the U.S. and has started a rather large project in Louisiana. Cliff writes "Sometimes I think traveling is my vocation."

Cliff met a special woman while he was completing his graduate work and is now married. They do not have children but have two Border Collies, a poodle and two parrots. His wife works for an airline scheduling software company called SABRE Decision Technologies in Dallas, Texas.

Cliff writes, "Believe it or not, I think of being at VPI quite often, and sometimes, especially in the fall, really miss the Virginia hillsides." <cliffb@architeriors.com>

'83

Timothy P. Roche (B.S. '83) is the consul at the U.S. Embassy in Lima, Peru. He and his family transferred to Peru from Mongolia last year. The geology in Peru is interesting, and the surfing is great. While in Mongolia, they adopted a son, Thomas Jargal Roche, now 16 months old. Jargal is a Mongolian name, meaning 'happiness.' <RocheTP2@state.gov>

Michael Strickler (B.S. '83) recently left the Chevron/Texaco West Africa Exploration to work for Unocal in Sugar Land, Texas. He is currently working for Unocal's Deepwater Exploration drill site maturation team as a senior advising geologist. "A big hello to everyone in Blacksburg, and I hope some day soon I can come back up that way recruiting geoscientists!" <mike.strickler@unocal.com>

'84

Donald "Duane" Brooker (M.S. '84)
Lauren McKeever Brooker (M.S. '85) Duane left Texaco after 18 years and is now with Eastman Chemical Company in Kingsport, Tennessee. Lauren is currently unemployed after 14 years with Texaco and Shell. Their girls are now 7 and 10. "We think we'll like it here in northeast Tennessee!"

George Kokkoros (M.S. '84) works for Conoco, Inc. in Miri, Saawak, Malaysia. He is the lead seismic interpreter on the Sabah deepwater exploration project. He enjoys birdwatching, jungle trekking and sailing.

'87

David Salzberg (B.S. '87) is a senior software engineer working for SAIC in Arlington, Virginia. He is currently sleep deprived because he and his wife, Bonnie, are enjoying their newborn daughter, Abigail Salzberg.

'93

Connel Ware (B.S. '93) was promoted to department head of Dewberry & Davis's Environmental Division (Southern) in December 2001. Dewberry's is located in Danville, Virginia. <cware@dewberry.com>

Jane (Parks) Gardner (M.S. '93) and **Eric Jesse Gardner (M.S. '94)** were married in 1996. Eric has been working as a manager for Toll Brothers, a national home builder. Jane taught high school Earth Sciences for a few years and also worked as a science editor for Prentice Hall. Their son, Jesse Parks Gardner, was born August 29, 2001. Jane is currently staying at home with Jesse and freelance editing in her spare time. <janeric@attbi.com>

'96

Bonnie Ware (B.S. '96) is working as a staff geologist with S&ME in Greensboro, North Carolina. Bonnie and Connel (B.S. '93) have two children, Brock (5) and Sharon (1).

Udo Becker (Ph.D. '96) is now a professor in Technological Sciences at the University of Michigan.

'97

Aus Al-Tawil (Ph.D. '97) was selected Saudi Aramco's Geologist of the Year for the most geological contributions to the company for 2001. Aus writes "I feel that I have really been focused on the tasks at hand here. I never expected this type of recognition as it was enough that management was giving me all the support needed. I am not really much on this kind of propaganda; but, I have to say that this is a tribute to you, Fred, first and foremost, then to the Carbonates Lab, and to the department at Virginia Tech for all that I gained while I was in Blacksburg."

Fred Read writes, "Aus left here after completing his Ph.D. on the sequence stratigraphic development of the Mississippian reservoirs in Kentucky and West Virginia. He spent a couple of years as a post-doctoral fellow at Mobil in Dallas, working with Jim Markello (M.S. '79) and his group. He then went to Saudi Aramco where he has been since graduating. Aus left a lasting impression here in Blacksburg, both in terms of the science and his interpersonal skills. Thomas Wynn is building on Aus's and Taury Smith's (Ph.D. '96) Mississippian work to develop a 3-D stratigraphic model for the Mississippian rocks of West Virginia, and Virginia.

'98

Russ Abell (M.S. '98) is a geologist at Sanborn, Head & Associates, Inc. in Concord, New Hampshire. He has done a lot of field work, including two extended trips to Northampton, United Kingdom. His job includes logging soil/rock from drilling or excavations (trenches), collecting GW/soil samples, compiling data, analyzing slug test data, and contouring groundwater elevations and contaminant distribution. Russ and his wife, Mimi, purchased a house in Portsmouth, New Hampshire in June. Russ says all of his weekends for the foreseeable future will involve remodeling and fixing it up! <rabell@sanborn-head.com>

'99

Kelly Rose (M.S. '99) left Marathon Oil Company and the mid-continent region this spring for the hills and mountains of West Virginia. She is now employed by EG&G, working at the National Energy Technology Laboratory (NETL) in Morgantown. Kelly writes, "I bought a house on top of a picturesque hill, with lots of critters roaming out of the woods and into the backyard, and a good view of the valley and ridge off to the east. So, perhaps this will end my state hopping for a while …maybe…" <Kelly.Rose@eg.netl.doe.gov>

Elaine Nachtrieb Meil (B.S. '99) is pursuing her Masters degree in Urban and Regional Planning in Richmond, Virginia. <elainenacht@hotmail.com>

'01

Carmen (Davis) Lang (B.S. '01) received her MAED at Virginia Tech in 2002 and is currently employed by Henrico County Public Schools teaching Earth Science to 9th graders. <solluna25@aol.com>

'02

Jeane Jerz (Ph.D. '02) is now a faculty member at DePauw University in Indiana.

Obituary

Dr. Kris Soegaard
August 20, 2002

It is with great sadness that I inform you of the passing of Kris Soegaard, a former Ph.D. student (1984) of mine, and a person known for his love of life. I first met Kris when he was an undergraduate at the University of the Witwatersrand and encouraged him to consider pursuing graduate studies in the USA. We worked together in Australia in the early 1980's and then in New Mexico where Kris carried out field work for his Ph.D. After completing his Ph.D. at Virginia Tech in 1984, Kris taught at the University of Texas at Dallas for 12 years before taking up an appointment with Norsk Hydro Petroleum Company in 1997.

I do not have many details of his death but, apparently, Kris did not return from a hiking trip to a mountain hut he had visited on previous occasions. His wife, Hala, phoned the authorities and a rescue squad was sent to investigate. They found Kris's body, apparently fallen to his death.

Kris will be greatly missed by all who knew him both socially and professionally.

Ken Eriksson

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