New Mexico Tech
Earth and Environmental Science
801 Leroy Place • Socorro, NM 87801 USA

New Mexico Tech Department of Earth and Environmental Science

TECH TONICS

www.ees.nmt.edu

Alumni Newsletter **Jan 2004**

Mineral Science and Engineering Complex (MSEC), built in 1987 and home of the Department of Earth and Environmental Science

A Brief History of the Department

By Clay T. Smith, Professor Emeritus of Geology

The department of Earth and Environmental Science has had a checkered career as a department at New Mexico Tech. Fifty-five years ago it was slumbering peacefully as one of eight departments, the Department of Geology and Mineralogy, and only granted BS degrees in geological engineering.

When I first arrived In February 1947, I was taken to the second floor of Brown Hall to view the "layer-cake" geology on the east side of the river. It has taken most of the intervening time to develop a true picture of the complicated geological features that can be seen between Escondida and U.S. Highway 380. I joined a staff of two full professors (everyone was a full professor in

Inside

those days at the New Mexico School of Mines): George Vorbe and Ralph Wilpolt. I was acting head of the Engineering Department until the fall semester when Wilpolt left Geology.

In 1949 the geological engineering degree was replaced with a BS in geology, and undergraduate degrees in geophysics and physics were first offered in 1950 (administered by the Department of Physics). Since E. J. Workman, the President of the school, was a physicist, the last addition was certainly understandable.

"Layer-cake" geology of mountains east of the Rio Grande in Socorro

By 1950 George Vorbe returned to employment in the petroleum industry and John Elliot Allen became head of the Geology Department. I had known Allen before and during World War II when we both were looking for strategic minerals (chromite) in the western states. Enrollments were decreasing because of the Korean conflict, but since every degree had to take mineralogy the teaching load did not change for Geology, and a third staff member was added in the person of Stewart M. Jones. Stew was an interesting personality who always carefully located the position of the field vehicle on the map; then when it was time to return from the field, he would plot the bearing from his

location to the vehicle and walk that bearing back to the vehicle regardless of the topography.

The addition of a third staff member allowed us to introduce an MS degree in geology, a similar degree in geophysics (still as part of the Physics Department), and to begin the Graduate Program which is now such a major part of the college. When John Allen transferred his employment to the NM Bureau of Mines and Mineral Resources, I became acting head of the department, and Waldemere Bejnar and Curt Teichert joined the staff.

With the end of the Korean Conflict, enrollments had fallen to a very low figure (in the spring of 1952 the school enrolled a total of 147 students in all majors). In the middle 1950s the department was so small that Charles Pitrat and I taught all of the courses. Pitrat left in 1957 for Kansas.

The unfortunate airplane crash in the Sandias which took the life of Robert Balk in 1955 made Christina Balk available for appointment to the Geology Department staff. Since Christina was world renowned as a Cambrian trilobite expert, her joining the staff made us immediately world famous. The most interesting part about Christina was that in addition to being a world-famous paleontologist, she could also teach any course offered in the department including optical mineralogy if necessary. The addition of Christina and a gradual expansion of the NM Bureau of Mines and Mineral Resources allowed us to increase our graduate offerings to a PhD in earth science.

Anton J. Budding was added to the staff in 1956 and the rest of the school also began to grow. Mahdi Hantush joined the Research and Development Division in the early 60s making possible an MS degree in ground water hydrology. In the middle 60s Charles Chapin was added to the department staff and the graduate program was well developed with MS and PhD degrees in geochemistry, geology, geophysics, and ground water hydrology.

In 1968, the Geology Department merged with the other geosciences to become the Department of Geoscience. By 1970 when Charles Chapin was chairman, the staff had increased almost geometrically. Balk, Hantush, Holmes, Jacob, Kuellmer, Sanford, Smith, Budding, Gross, and Hathaway were listed as professors of

various ranks with 12 adjunct faculty derived from the NM Bureau of Mines and Mineral Resources and the Research and Development Division of the College.

In 1980 Chapin moved to the NM Bureau of Mines and Mineral Resources, and the Geoscience faculty roster was Bodine (chair), Budding, Condie, Gelhar, Gross, Kuellmer, Sanford, Smith, MacMillan, Huyakorn, and Schlue. In 1983 I left the department to become Director of Alumni Relations and Annual Giving and then retired January 1, 1987.

In 1987 John Schlue took over the chairmanship of the Geoscience Department, and the staff included Budding, Condie, Gross, Kuellmer, Lattman, Sanford, Wilson, Campbell, Chen, Johnson, Kyle, MacMillan, Norman, Phillips, Stephens, Bowman, and Knapp with 14 adjunct faculty. Balk and I were listed as emeriti. In 1996 the Geoscience Department changed its name to Earth and Environmental Science with Fred Phillips serving as chair.

As we open the new century many of the old faces are still serving. The EES staff now includes 22 faculty: Aster, Bilek, Boston, Bowman, Campbell (chair), Condie, Goodwin, Harrison, Hendrickx, Johnson, Kyle, McIntosh, McPherson, Mozley, Norman, Phillips, Schlue, Spinelli, Tobin, Vivoni, Wilson, and Zhou; 34 adjunct faculty; and 6 emeriti: Balk, Budding, Gross, Lattman *(President Emeritus),* Sanford, and myself. BS degrees are offered in earth science (with options in environmental geology, geochemistry, geology, and geophysics) and environmental science (with options in biology, chemistry, geology, hydrology, and instrumentation & measurement). MS degrees are available in geochemistry, geology, geophysics, and hydrology. PhD degrees are offered in earth and environmental science with dissertations in geochemistry, geology, geophysics, and hydrology.

For the Fall 2003 semester, 1,806 students were enrolled at New Mexico Tech—the highest enrollment in the school's history. The EES Department has 133 students including 53 undergraduates and 80 graduates. The Hydrology Graduate Program has been ranked 4th in the nation for the past 5 years by *US News and World Report*. In 2003 *Kiplinger's Personal Finance* magazine rated NMT the 18th best buy among the nation's universities, and *The Princeton Review* listed NMT as one of the nation's best institutions in undergraduate education in its *Best 351 Colleges* guide. *The Chronicle of Higher Education* ranked NMT **first in the nation** for receiving Congressionally approved earmarked research funds. Although small in size by national standards, NMT remains a giant in quality!

Clay T. Smith, 1917–2003

By Anton J. Budding, Professor Emeritus of Geology

Professor Emeritus of Geology Clay T. Smith passed away suddenly on November 10, 2003, of a cerebral hemorrhage, only two weeks before he was scheduled to give one of his famous geological tours of the Sevilleta area for Socorro's annual Festival of the Cranes. (Ed.)

Clay Smith in the sixties

For more than 50 years Clay has been associated with geology at New Mexico Tech. I joined the Department in 1956, and for one semester instruction in geology at NMT was limited to two persons, Clay and myself. Fortunately, the following January, Christina Balk joined us, but a three-person Department existed until 1966, when expansion started.

In the early days equipment was rudimentary. Our best polarizing microscope was found on a German railroad station at the close of WW II. It had been appropriated by a GI who later came to study geology at NMT, and donated the microscope to the Geology Department. Also, our field vehicles consisted of four two-wheel drive trucks and vans that had seen service in WW II.

Clay loved field geology, and for him the summer field course was one of the highlights of the academic year. He believed in driving to an outcrop as much as possible; a day in the field with Clay often included digging the vehicle out of a mud puddle or sand pile. Evenings in camp were devoted not only to review of the local geology, but often also to necessary repair activities, such as straightening of tie rods and reassembling of exhaust systems.

Clay Smith changing a tire in the early days of the New Mexico School of Mines (photo courtesy of the Smith Family)

Through the years, Clay acquired a broad knowledge of New Mexico geology. If he lacked the answer to a question, he could at least tell you where to find it. He was an Honorary Member of the New Mexico Geological Society and seldom missed an annual field conference or spring meeting. The NMGS Guidebooks contain many of his papers. His talks on geological subjects were broadcast by Public Television, and he contributed for many years to the Visiting Scientist program of the New Mexico Academy of Science. He was active in the New Mexico Science Fair since its inception and was its Director for a number of years.

Mrs. Sallie (Sarah Gwendolyn) Smith, Clay's bride of 68 years, was recently honored as an outstanding Woman of the West and selected as Volunteer of the Year by the Chamber of Commerce. Her interests include AAUW, PEO (a philanthropic organization), Women's Golf Club, Socorro Hospital Auxiliary, and Garden Club. Messages to Sallie, and to sons Stan and Dean and their families, can be addressed c/o EES if you wish to write or email.

See **www.ees.nmt.edu/smith/memorial.html** for pictures and links to other remembrances.

Andrew R. Campbell
Department Chairman
Professor of Geology

TECHtonics

Editor-in-Chief
Andrew R. Campbell

Assistant Editors
Susan Delap, Pat Mills

Design and Layout
Susan Delap

Distribution
Connie Apache
Mary Haenichen

B&W Logo Design
Robert Lowey, MS '84

TECHtonics
New Mexico Tech
Earth & Env. Science
801 Leroy Place
Socorro, NM 87801
(505) 835-5634
geos@nmt.edu
www.ees.nmt.edu

January 2004

Note from the Chair

After a hiatus of fourteen years, New Mexico Tech's Earth & Environmental Science Department (formerly Geology and Geoscience departments) is resurrecting the *TECHtonics* Alumni Newsletter. To get you up-to-speed on what's been happening over the years, Professor Emeritus Clay Smith has written **A Brief History of the Department** for this issue. Dr. Smith passed away suddenly in November 2003. This issue is dedicated to him.

Some of the new happenings around the department are the IRIS/PASSCAL seismological instrument center and Earthscope addition (see News), the expansion of the geophysics faculty (see Bilek), and the SAHRA program (see Phillips). The National Cave and Karst Research Institute (NCKRI) and the Experimental Program to Stimulate Competitive Research (EPSCoR) will be featured in future issues.

We look forward to reestablishing contact with as many alumni as possible. Let us and your fellow alumni know what you've been up to by completing the Alumni Update Form inside. Or you can go to our new alumni website (**www.ees.nmt.edu/alumni**) and provide your information online.

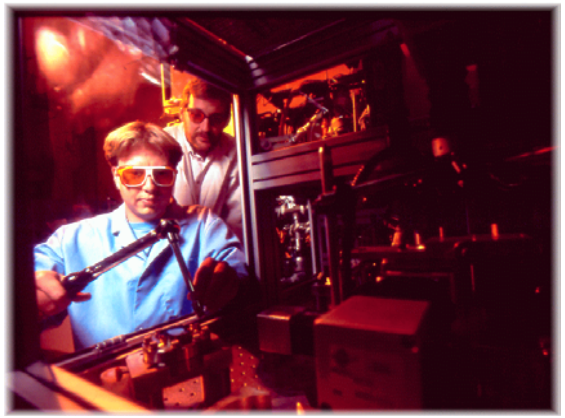
The department is growing and is involved with many exciting ventures. We look forward to sharing these with you in the newsletter.

News and Notes

Annual GSA and AGU Meetings

Six faculty and six students from the Department of Earth and Environmental Science gave presentations at the 2003 meeting of the Geological Society of America (GSA), held in Seattle on November 2–5, 2003. Sixteen faculty and seventeen students authored papers/posters presented at the 2003 meeting of the American Geophysical Union (AGU) in San Francisco. Their presentations described some of the latest research being done in geoscience at New Mexico Tech.

The New Mexico Geochronology Research Laboratory



Rich Esser (right) with student in NM Geochronology Research Laboratory. © Steve Woit

The NMGRL is one of the premier laboratories in the Department. It was commissioned in early 1993 as a joint effort with the New Mexico Bureau of Geology and Mineral Resources, Los Alamos National Laboratory, and the National Science Foundation. Co-directors Dr. William C. McIntosh and Dr. Matt Heizler and laboratory technicians Lisa Peters and Richard Esser operate the facility. The NMGRL employs the $^{40}Ar/^{39}Ar$ dating method which is a variation of the K/Ar technique. The utility of the $^{40}Ar/^{39}Ar$ method for geochronology and thermochronology crosses many subdisciplines of the geosciences and is therefore used by many students and faculty studying diverse problems.

Present research includes applications related to volcanology, structure-tectonics, economic geology, and environmental geology. Knowledge of the age of volcanic rocks allows reconstruction of complex volcanic histories and information about magmatic

systems. Geochronology of volcanic ash deposits are useful for determining ages of sedimentary units as ash layers represent geologically instantaneous events. The $^{40}Ar/^{39}Ar$ method is also useful for delineating rock thermal histories since minerals such as muscovite, biotite, hornblende, and K-feldspar all record variable times when a rock was at a given temperature. These thermal history analyses can be used to determine rates of uplift and erosion, timing of deformation and metamorphism, and ultimately give a depiction of the geological history of orogenic processes. $^{40}Ar/^{39}Ar$ analyses are uniquely suited for deciphering the age of multiple events in complex systems like those encountered in ore bodies. Determining timing relationships for mineral growth, alteration, and structures within economic ore deposits provides valuable information for understanding the overall ore genesis and facilitating models for exploration.

IRIS/PASSCAL at New Mexico Tech

IRIS/PASSCAL building on NMT campus.

The IRIS (Incorporated Research Institutions for Seismology)/ PASSCAL (Program for Array Seismic Studies of the Continental Lithosphere) Instrument Center at New Mexico Tech completed its fifth year of operation this year. IRIS/PASSCAL is the National Science Foundation's facility for supporting science done with portable seismic instruments. The staff (currently 14) at NMT is responsible for working with PIs from dozens of institutions across the US and abroad each year in the planning, deploying, and initial analysis of experiments on every continent. Recent deployments have been as diverse as the Andes, the Tibetan Plateau, the East Antarctic Ice Cap, and the Ethiopian Rift. PASSCAL ensures a heightened profile for the Earth and Environmental Science Department, and for NMT, as hundreds of

scientists and their students come to Socorro for planning, training, and assistance. The Instrument Center also provides hands-on student work opportunities, resources for teaching and outreach, and is a focal point for interactions with other disciplines at NMT, such as electrical engineering.

PASSCAL came to NMT as the result of a competitive proposal process, spearheaded by Professors Rick Aster and Harold Tobin, in close association with Research Vice President Van Romero and the NMT administration, in which NMT came out ahead of numerous competitors across the nation, including east and west coast powerhouse universities. Besides offering its considerable critical mass in geophysics and earth sciences, NMT also committed to the construction of an upper campus facility dedicated to PASSCAL operations. The center is funded by NSF through the IRIS consortium, an association of 100 US universities and foreign affiliates united in the advancement of seismological research.

IRIS and NMT associations continue to grow. Last year Rick Aster was named chair of the Education and Outreach Standing Committee, helping to oversee the operation of one of the four IRIS programs in the critical area of formal and informal education and outreach (the other IRIS programs are PASSCAL, the Global Seismic Network, and the Data Management System). Last year Congress approved funding for the EarthScope initiative, and NSF approved the operating proposal giving NMT the go ahead to manage key aspects of the "USArray," one of the four components of the EarthScope project. EarthScope is a decadal-scale investigation of the North American continent that includes a massive deployment of seismometers (USArray), GPS instrumentation, and a deep seismic observatory on the San Andreas fault. The NMT Regents recently authorized construction of a $2 million building for the USArray Array Operations Facility on campus next to the current PASSCAL building, which will house offices for the substantial expansion of the PASSCAL staff and facility. NMT has worked closely with IRIS to ensure the funding of EarthScope and to recapitalize the PASSCAL equipment to maintain the facility's state-of-the-art position in seismological research.

Faculty News

Richard C. Aster
Professor of Geophysics

In addition to my IRIS activities, I have been involved in several ongoing projects over the past year.

Phil Kyle, Bill McIntosh, and I were funded by NSF to develop and deploy next generation instrumentation for volcanic research and surveillance. We deployed the system in 2002 on the persistently active Mount Erebus. Besides giving us much better data about seismic signals, deformation, infrasound, gas, and other observables on Erebus for studying its source processes, this effort is spearheading the development of cost-effective, low power, multidisciplinary telemetered systems that are needed to monitor volcanoes worldwide.

I was refunded last year by NSF to continue the analysis of the remarkable RISTRA data set. RISTRA (Rio Grande Seismic Transect) was a 1000-km-long line of PASSCAL seismic recorders that were deployed along a great circular path from near Pecos, Texas, to near Lake Powell, Utah. During an 18-month deployment from 1999–2001, these recorders picked up signals from over 350 usable large earthquakes around the world. NMT PhD student Dave Wilson and I, along with colleagues from Diné College, Los Alamos National Laboratory, New Mexico State, and the University of Texas at Austin, are using these data to image the crust and upper mantle underneath the Rio Grande rift, Colorado Plateau, and Great Plains. Highlights include the detailed structure of the Moho and evidence that the thermal signature of the Rio Grande rift is fairly shallow, predominantly above 400 km depth.

In another highlight, Brian Borchers (NMT Mathematics) and I, along with Cliff Thurber (University of Wisconsin, Madison), under contract with Academic Press, recently authored a graduate level textbook, *Parameter Estimation and Inverse Problems,* for the geophysical and broader communities on solving ill-posed

problems in science. This effort grew out of our efforts teaching our Inverse Theory class at NMT. We have received many requests for preprints—which gives us confidence that there will be a good market out there when the book is published later this year!

Susan L. Bilek
Assistant Professor of Geophysics

I'm happy to introduce myself as the new geophysics faculty in EES. I've come most recently from a postdoc at the University of Michigan and am looking forward to a warm southwest winter this year! Since arriving in August, I've created a new geophysics computer lab for research. Many of my continuing research projects involve examining earthquake ruptures in shallow subduction zones, but I've been expanding that to include a few large deep (around 650 km) earthquakes as well as finite element modeling of subduction zone stresses in regions of heterogeneous plate subduction (such as seamount subduction). I've previously helped with a seismic network deployment in Costa Rica and I'm hoping to expand my research field component by proposing an offshore seismic network off the coast of Nicaragua.

Robert S. Bowman
Professor of Hydrology

The Hydrology Program continues to grow and prosper. We now have eight full-time Hydrology faculty.

Regarding my own research, I'm continuing to investigate the properties and applications of surfactant-modified zeolites (SMZ). Recently, we have investigated using SMZ to remove hydrocarbons from produced waters (the water that accompanies oil and gas production) and as a well filter pack to remove bacteria and viruses from drinking water. In summer 2002 we were awarded an NSF grant for the campus' first atomic forces microscope, which will allow us to investigate such solute/surface interactions at the molecular scale. A new initiative during the past year has been a program to investigate surface water/groundwater interactions in the Rio Grande basin in the vicinity of Socorro. As part of this project we are installing an extensive monitoring well and staff gauge network in transects across the river from San Acacia to Elephant Butte. Using geochemistry, hydraulic tests, tracer tests, and numerical modeling, we hope to better understand the controls on river losses and gains as it moves through this reach.

Andrew R. Campbell
Professor of Geology

If you started reading this newsletter from the front cover you have by now already discovered that I have recently started as Chair of the department. This is consuming a lot of my time but I still am involved with my research projects as well.

As always, the stable isotope lab receives the greatest amount of research time. After thirteen years of service, the Delta E mass spectrometer became obsolete (and very cranky). The big news is that we were funded to purchase a new mass spec and some very sophisticated sample preparation devices. For those of you who worked for me you may remember that I often told lab visitors that "I don't need automation; I have graduate students." Well, that isn't true with the new lab! Many types of analyses such as hydrogen and oxygen on waters, carbon and oxygen on carbonates, and sulfur on sulfides have all been automated. With the new equipment not only is analysis faster (and less student intensive), but we also have new capabilities such as hydrogen on hydrous minerals and fluid inclusions. I am busy experimenting with many new types of analyses.

My interests still lie in documenting the types of fluids in ore deposits. Currently I have students working on such studies at Questa, New Mexico, and Cripple Creek, Colorado.

Kent C. Condie
Professor of Geochemistry

In June 2002, we arrived in Sydney, Australia for a 6 month sabbatical leave. I was quickly off to Adelaide for the Australian Geological Society (AGS) meetings and a week-long field trip. Except for cold and windy weather, the field trip was great. We looked at Delmarian rocks along Australia's southern coast and spent two days on Kangaroo Island. There were lots of interesting papers at the AGS meetings where a Neoproterozoic supercontinent section and an Archean section ran simultaneously. My paper addressed the history of Rodinia and various geologic events that may be tied to the formation and breakup of the supercontinent some one billion years ago.

I had a great experience at Macquarie University. Decades have passed since I actually have run samples myself, but a main reason for spending my sabbatical at the National Key Centre for the Geochemical Evolution and Metallogeny of Continents (GEMOC) was to use their new cutting-edge research equipment including a laser probe ICPMS unit with which one can analyze small (30 micron) spots on minerals for many trace elements, as well as radiogenic isotopic ratios, with high degrees of precision. At GEMOC, I focused on two major research projects: 1) a study of the distribution of rare earth and high field strength elements (esp. Nb and Ta) in mantle and lower crustal xenoliths, and 2) a search for evidence of juvenile continental crust in the two age gaps on the continents: 1.6–0.14 Ga and 2.4–2.2 Ga. Perhaps the most important finding in the mantle xenolith study is that both rare earths and high field strength elements are housed primarily in secondary (metasomatic?) phases in cracks and around grain

boundaries. Less than 50% of these elements occur in primary mantle minerals (olivine, pyroxenes, spinel, garnet). This is important because these elements are typically used to model the magmatic history of mantle xenoliths, assuming equilibrium between magma and residual minerals. Our findings, however, indicate that these elements were introduced later, probably in fluid phases.

Our work with zircons was also really exciting. Using a laser probe ICPMS, one can analyze for Pb, U, and Th isotopes and thus date single spots on the zircons. And then using the multicollector laser probe ICPMS, it is possible to determine Hf isotopic ratios in another spot near the spot used to date the mineral. From the combination of U/Pb isotopic age and Hf isotope results, it is possible to estimate the amount of juvenile component (coming directly from the mantle) in the source rocks of the zircons. Although our results are incomplete due to a malfunction of the multicollector unit, they indicate for at least one population of detrital zircons from NW Canada that the zircons with ages of 2.2–2.4 Ga are not from juvenile sources, but represent either older reworked crustal sources or mixed juvenile and older crust.

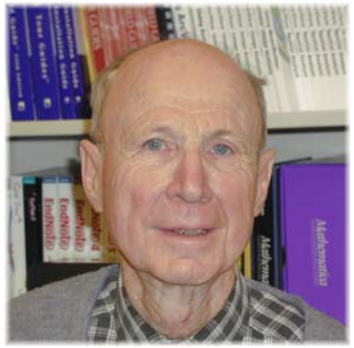
While in Australia I traveled to Beijing, China, to attend the Geological Society of America Penrose conference on Archean high and low grade rocks, including a field trip into the Hengshan and Wutai areas to observe high grade and low grade terranes of the North China Archean craton. Both rocks and weather were exceptional, as were Buddhist temples we saw in the Wutai valley. However, typical of Chinese field trips, the unexpected caused continual delays. Returning from the Wutai area to Beijing, a long line of trucks was stopped where the road had washed out; these trucks had been stalled for two days! Fortunately, our buses could turn around so we headed back the long way only to be detoured yet again by a washed out bridge, so that it was 2 am when we finally arrived at Peking University. After meetings at the University, 10 foreign geologists and 15 Chinese geologists visited the site of the controversial Dongwanzi ophiolite, allegedly the oldest know ophiolite in the world (ophiolites are thought to represent ancient fragments of oceanic crust). This site was

described in an American *Science* magazine paper and also received attention in the Chinese media (we had reporters with us on the field trip). Due to typical travel problems—washed out roads, detours, road and bridge construction, etc.—we did not see all of the evidence to support an ophiolite origin. However, what we saw was convincing (sheared harzburgites, podiform chromite) and the isotopic dating indicates an age of 2.5 billion years.

One incident at a site where a bridge over a river was closed is noteworthy. The detour involved fording a river, which was possible if one went slowly (the bottom was hard). But our drivers, who typically knew nothing about 4-wheel drive vehicles, sped across. One of the van's spark plugs got wet and it stalled in the middle of the river. After much delay, the vehicle was extracted from the river, only to then burst into flames. Geologists rapidly abandoned the vehicle through any and all openings! Bill Collins, an Australian scientist, bravely went under the van and extinguished the fire, otherwise the entire van would have burned up. This event left 10 Chinese geologists with no ride; they bargained with a local person to rent a smaller van and we proceeded onwards. On our return, the mayor of Zuhua met the group, gave us use of 3 new cars, and supervised fording of the river. Although it might not seem unusual for the mayor of a small town to personally help, realize that Zuhua is a city of over half a million people!

I first visited China and Beijing in the early 80s. There were enormous changes in the last 20 years: Beijing resembles Hong Kong or Tokyo—skyscrapers popping up, freeways criss-cross the city, big shopping centers exist. I saw fewer bicycles and many more cars. It is said that 5,000 cars enter the car pool in China every day! Construction on freeways and buildings proceeds 24/7. Big hotels are everywhere available, and tourist buses now frequent all of the interesting places around Beijing. Virtually everyone has a cell phone and a TV. Commerce is booming. BUT rapid growth is essentially limited to the big cities. Visiting the countryside on our field trips, I saw no changes in the last 20 years. In fact, living conditions of rural peasants have been the same for hundreds of years—primitive housing, no plumbing, poor

transportation, old putt-putt trucks, donkey-pulled wagons, hand thrashing of grains, lots of manual labor. All the money is going into the cities, and apparently none into the farming and peasant populations.

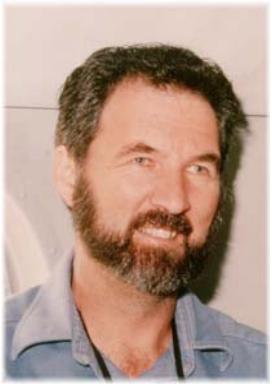


Gerardo W. Gross
Professor Emeritus of Geophysics

Water and ice in the atmosphere dissolve chemical compounds released by natural biological processes and by air pollution. Atmospheric currents transport ice particles and water droplets which eventually return to the ground. Deposited in polar icecaps and glaciers they become archives of climates past (100,000–200,000 years). Because solutes affect the dielectric properties of ice, electrical logging of ice cores helps in "reading" these records. Nitrates are important aerosol constituents produced both by biological processes (especially in the oceans) and anthropogenic causes (*e.g.,* release of agricultural fertilizers). Yet next to nothing is found in the literature on how nitrates affect electrical ice properties. In July 2002 I presented a paper on solubility and dielectric effects of nitrates in ice at an International Symposium on the Physics and Chemistry of Ice, held in St. John's, the provincial capital of Newfoundland (Canada).

The paper was published in the *Canadian Journal of Physics* in May 2003. In writing it I saw the need for a tutorial on the interpretation of dielectric measurements in ice, especially as they apply to the effects of atmospheric solutes. The tutorial was completed over the summer and printed in September 2003. Copies are available to interested parties on request. Please email grossgw@nmt.edu. An electronic version is also available at www.ees.nmt.edu/gross.

After visiting our daughter, son-in-law, and two grandchildren in Virginia in December 2003, Ruth and I will be traveling to Argentina to enjoy the austral summer with friends.



Philip R. Kyle
Professor of Geochemistry

It is December 2003 and here I am again sitting in a small hut at 3400 meters near the summit of the southernmost active volcano, Mt. Erebus in Antarctica. I am surrounded by trusted colleagues, friends, an invited guest, and three new graduate students. We are engulfed in swirling snow and the outside temperatures are around -25E to -30EC. A storm is raging and we are holed up watching videos, reading, playing cards, reviewing papers and proposals, and sending e-mail (while our wireless Ethernet link to McMurdo Station works). Erebus and Antarctica continue to dominate my research interests, and this year is my 32nd field season in Antarctica and 31st on Erebus. Technology is playing more and more of a role in our research efforts. NSF funded a major research instrumentation grant to Rick Aster and me to design, build, and install surveillance stations around the summit of Erebus. Last field season we installed five of these stations—each with broadband seismometers, a radio modem, and a dual frequency GPS. The stations also have a variety of other instruments including tiltmeters, microphones, infrared radiometers for monitoring the temperature of the magma in the persistent lava lake, and weather and power monitoring sensors. The data from all these are integrated into a single data stream that is transmitted by a spread spectrum 900 MHz radio modem to McMurdo and then onto the Internet for the world to see. We plan to install a fifth station this year and it will include sensors to continuously monitor the composition of the gas in the volcanic gas plume. The data from these stations will allow us a better understanding of the mechanisms of the small Strombolian eruptions and behavior of magmatic degassing from the lava lake.

This was my first full year back in the department after taking a year's sabbatical leave at University College London during February 2001. I am planning the coming year and hope to return to Kamchatka in the summer of 2004 after a 3-year hiatus. I

undertook field work on the volcanoes of Kamchatka for 8 summers from 1992 until 2000 and have missed the bears and wonderful colleagues and friends there.

Peter S. Mozley
Associate Professor of Geology

Last year I completed a four-year term as editor of the International Association of Sedimentologists journal *Sedimentology*. It was a great experience, but was extremely time consuming, so I'm very glad to have it come to an end. My research these days focuses on fluid flow and diagenesis, with particular concentration on carbonate concretions. Andy Campbell and I have a proposal pending to follow up on some of Jeff Klein's MS thesis work on laterally extensive cemented layers, which combines our interests in diagenesis, stable isotopes, and field work close to a first-rate brew pub.

Fred M. Phillips
Professor of Hydrology

Most of my efforts for the past several years have been directed toward two projects. The first project goes by the acronym **SAHRA**, which is short for the NSF-funded Science & Technology Center for the **S**ustainability of **A**rid **H**ydrology and **R**iparian **A**reas. The center is based at the University of Arizona and involves about 15 institutions around the U.S. and Mexico. SAHRA is focusing on the hydrology of two drainage basins: the San Pedro River in Arizona and the Rio Grande in Colorado, New Mexico, and Texas. The basic plan is to understand the processes governing hydrological partitioning (precipitation into runoff, evapotranspiration, and groundwater recharge) at the level of the individual plant, then scale up that understanding into high-resolution basin models that can be used

to address water resources problems in the basin. These include the effects of drought, vegetation change, population growth, and agricultural practices on water availability for municipalities, agriculture, and ecosystems in the basins. I am on the Executive Committee of SAHRA, which entails a lot of administrative time, but also enables participation in the design of a research effort far beyond the scope of any individual investigator project.

My own research under SAHRA initially focused on understanding the controls on vadose-zone hydrodynamics in the extensive basin-floor areas that make up the predominance of the basin areas being studied. Working with PhD students Michelle Walvoord and Mitchell Plummer, I found that the vast majority of the basin floor areas do not provide any groundwater recharge, but instead are areas of discharge in the form of water vapor. We discovered that the main controls on water fluxes are very strong soil-water suction at the base of the root zone, produced by desert vegetation and the geothermal gradient. The root suction has provided an essentially permanent water sink ever since desert vegetation was established ~10,000 years ago, and the geothermal gradient drives a vapor flux upward from the water table toward this sink. This process effectively insulates groundwater and the deep vadose zone from the atmosphere and has done so for thousands of years.

Another area of research under SAHRA has been tracing the sources of salinity of the Rio Grande. The TDS of the river rises from about 50 mg/L in the headwaters area to over 1,000 mg/L near El Paso. This rise has not been previously adequately explained. Working with MS student Suzanne Mills, I have employed geochemical tracing to quantify solute inputs. We have found that much of the salinity increase can be attributed to influx of deep sedimentary brines along faults at the low-elevation ends of the basins that make up the Rio Grande rift. Identification of these sources may contribute toward interception or mitigation of the salinity increases.

The second project alluded to at the beginning of this report is known as the **CRONUS-Earth Project**, standing for **C**osmic-**R**ay pr**O**duced **NU**clide **S**ystematics on **Earth Project**. The objective is to refine our quantification of the spatial and temporal distribution of cosmogenic nuclide production so that these nuclides can reliably be used for Quaternary geochronology and landscape modification studies anywhere on earth. This project is still in the proposal stage; if funded it will involve about 20 institutions and 50 investigators around the world.

Allan R. Sanford
Professor Emeritus of Geophysics

Since going into semi-retirement about six years ago I have been enjoying analyzing earthquake data collected with the help of many of you from 1960 through 2000. There is a backlog of potentially worthwhile research projects including studies of outstanding earthquake swarms and unusual geographic distributions of epicenters. An example of the latter is a band of seismic activity extending 400 km east-northeast from the Socorro area through the supposedly tectonically stable Great Plains; it follows the trace of a prominent topographic lineament. A swarm that John Schlue and I are currently investigating is centered 40 km northwest of Carlsbad. This sequence, which has had earthquakes up to magnitude 4.0, commenced in early 1997 and continues to the present with shocks of magnitude 3.4 and 3.2 on September 17, 2002.

Perhaps our greatest accomplishment the past few years was to generate and publish earthquake catalogs for New Mexico and bordering areas for the period 1869 through 1998 (Sanford, Lin, Tsai, and Jaksha, 2002, New Mexico Bureau of Geology and Mineral Resources, Circ. 210, 104 p.). The data contained within these catalogs are being used to estimate the earthquake hazard in New Mexico. Copies of this publication can be ordered online from the NM Bureau of Geology at geoinfo.nmt.edu. An electronic version is also available.

John W. Schlue
Associate Professor of Geophysics

In late 2000 I took over the operation of the WIPP seismic array from Allan Sanford. This array consists of seven short-period seismometers more or less surrounding the Waste Isolation Pilot Project near Carlsbad; the purpose of the array (whose cost of operation is paid for by a contract with the managers of the WIPP) is to locate all seismic events occurring within 300 km of WIPP. The data from the array make their way over the State of New Mexico's microwave system to NMT's seismic observatory, which is housed in the third-floor penthouse of Workman Center. There the data are recorded both digitally and on paper. Professor Sanford and I are currently collaborating on a study of an anomalous nest of earthquakes about 80 km west-northwest of the WIPP; we'll let you know what we find.

Results from the NSF-funded RISTRA experiment were published in 2002, a study of the background noise along the array was also published (*Bulletin of the Seismological Society of America*, volume 92, number 8; December 2002), and four posters were presented at the annual meeting of the American Geophysical Union in San Francisco in 2002. Two RISTRA posters were presented at AGU 2003, as well as a poster with MS student Todd White on a better characterization of the Socorro Magma Body using deep teleseismic events.

I have continued as an AYSO and high school soccer referee. Karen and I had a very nice vacation in Hawaii in Summer 2002; we visited three of the islands, ending up on Oahu, where I was a referee for the AYSO National Games. Tough duty, as they say, but somebody had to do it. Our local AYSO group here in Socorro held our annual Turkey Tuneup Tournament, which had 56 teams competing over two days on seven fields (two of which were at New Mexico Tech).

Glenn Spinelli
Visiting Assistant Professor of Hydrology

I am a recent addition to the hydrology faculty—and apparently I am the latest stage of a quiet plan to increase the number of faculty in the department who have passed through the University of California, Santa Cruz (there are now four of us). My research focuses on marine hydrogeology and sedimentology. Currently, I am determining the nature of the sediment entering the subduction zone along the Pacific margin of Costa Rica. I'm using the sediment composition data to model sediment dewatering and the relation between fluid pressures and seismicity in the subduction zone. I also study groundwater/surface water interactions and hydrothermal circulation in the ocean crust.

Enrique R. Vivoni
Assistant Professor of Hydrology

I recently joined the Earth and Environmental Science Department in the Fall of 2003 as an assistant professor of hydrology. How I ended up in New Mexico is still a considerable mystery to me. Having been raised in lush, tropical Puerto Rico and spending ten years of my life in cold, damp Boston, the high desert is a new experience. My wife Amapola and I are having a great time in our new surroundings, slowly exploring all that New Mexico has to offer and using our Spanish considerably.

I came to NMT after a few degrees at MIT—environmental engineering, fluid mechanics, and hydrology. My colleagues were already referring to me as an MIT Lifer since I had been on campus so long. My doctoral work was with Professors Rafael Bras and Dara Entekhabi in the Department of Civil and Environmental Engineering (in what was known as the Parsons Lab until a few months ago). Many of you may immediately recognize the MIT-

NMT connection with John Wilson and Lynn Gelhar (and a handful of students) having been at both institutions.

At NMT, I will be teaching and developing a research program in surface water hydrology, which will encompass rainfall-runoff processes within watersheds. My broad interests lie in the interdisciplinary aspects of surface water hydrology, in particular its relation to meteorology, geomorphology, and ecology. I hope to build on the capabilities in remote sensing, numerical modeling, and field experiments that already exist in the department. My goal is to expand the focus of our program to include watershed hydrology in semi-arid regions and to take advantage of the natural setting around Socorro for scientific study. I will be teaching three courses at NMT: Surface Water Hydrology, Hydrometeorology, and Geographic Information Systems with Geoscience Applications. In Fall 2003 I conducted a reading group seminar series on Ecohydrology of Semiarid Landscapes.

Coming to NMT was in fact not a mystery at all. I have been received by an excellent group of colleagues in hydrology, geology, and geophysics, by an enthusiastic and hardworking set of graduate and undergraduate students, and by a friendly and peaceful oasis in the desert. Amapola and I are very happy to be part of the NMT community and look forward to many productive years.

John L. Wilson
Professor of Hydrology

For the last two years I've been busy with a new venture for hydrologists: the creation of a research corporation to support science at universities and other institutions nation-wide and eventually overseas. With over eighty member universities, the Consortium of Universities for the Advancement of Hydrologic Science Inc. (CUAHSI) is one of the fastest growing consortiums ever sponsored by the National Science Foundation. As Chair of the Board of Directors I've participated in all CUAHSI developments

and have represented us to scientific societies, other consortia, potential members, and the federal government. We establish infra-structure to support hydrologic research, including a network of observatories, instrument centers, information systems centers, a think tank, and programs of education and outreach.

I also serve on the National Academy of Science's Committee on Hydrologic Science, where my major activity is to produce a report on the science that occurs at interfaces between groundwater and other components of the hydrologic system. The report grows out of a workshop that we held on this topic last year. This last year I joined two Advisory Committees of the National Science Foundation, one for the Geoscience Directorate which sponsors programs in Earth, Ocean, and Atmospheric Sciences, and the other for Environmental Science Research and Education, which is associated with NSF's Biocomplexity Program.

My own science is following several familiar paths, including upscaling with Vince Tidwell, backward-in-time and space modeling of transport with Roseanna Neupauer, and instrument design. Vince and Roseanna are both former students. With SAHRA, our new NSF sponsored Science and Technology Center (headquartered at the University of Arizona), I've been working with PhD student Huade Guan on the hydrology of mountain blocks with special attention to mountain front recharge, and with PhD student Bayani Cardenas on stream-aquifer interaction with special attention to the hyporheic zone. I've also been working with graduating PhD student John Sigda on a study of how fluids and chemicals move through vadose zones penetrated by faults.

Last year I retired as Department Chair, and to occupy my time, new Chair Andrew Campbell gave me a lava lamp. I'd stare at it for hours, if it only worked.

Betty runs Weems Gallery in Old Town, Albuquerque. If you make it to Old Town, drop by her Gallery to say hello. Our daughter Megan is in public policy graduate school at Princeton, while daughter Laurie designs educational toys for Leapfrog and lives in the Bay Area.

EES Faculty Retreat 2002: Future Visions

Top: Goodwin, Campbell, Gettemy (student). Bottom: Zhou, Schlue, Boston, Tobin, Mozley, Phillips, Bowman, Johnson, Kyle.

In order to talk and think about the future of this department, faculty wished to gather together away from their telephones, computers, and other distractions. We determined to have a Retreat at the Sevilleta National Wildlife Refuge north of Socorro, and did so on a beautiful day in mid-October of 2002.

Virtually all of EES faculty participated (among others, David Norman is absent from the photo, having left early to rescue his disabled sailboat trailer off I-25). We deemed the Retreat a success. It was a pleasant exercise in collegiate interaction as well as highly conducive to reaching consensus on big issues. We worked together on the agenda into mid-afternoon, pausing to enjoy lunch on the patio and take in the spectacular views.

We discussed areas of potential growth in earth science and reviewed issues related to research, curriculum, space, communications, adding faculty, and everything else. We emphasized a long view, looking 15 years into the future, and used both the 1999 EES Five-Year Plan (created during John Wilson's tenure as Chair) and NM Tech's Strategic Plan as guiding templates. We extrapolated into areas such as team-teaching, communications (TECHtonics!), web site and home page content, a dire lack of discretionary funds for student activities, and a major space crunch (the department has grown and is crowded). Many of these ideas were incorporated into our new departmental Five-Year Plan that was finalized late last Fall.

This Retreat strengthened EES by providing a venue for faculty concerns and desires, and we'll repeat the exercise periodically—because it was both fun and productive.

Alumni News

We've received many news items from alumni and have included a few in this issue. Many more are posted on our alumni website, so please be sure to visit and check them out.

If you would like to be included on the alumni website or in future issues of TECHtonics, please fill out the Alumni Update form in this issue or complete the online form on the alumni website: **www.ees.nmt.edu/alumni**.

George C. Evans (MS Geology '63) writes:
"I retired in 1995 and my wife, Bette, retired in 1998. I'm an active member of Kiwanis Club. We are involved in community service and travel. Recent travel includes North and South America, Russia, and Australia. We were in France on Sept 11, 2001."

Douglas Heath (MS Hydrology '83) writes:
"My wife Alison Simcox (MS Hydrology '83) and I have two wonderful boys aged 17 and 6. We both work at the EPA New England office in Boston, and we are intensively working to protect both surface and ground-water resources in New England. It is interesting work, despite the strong forces of development and lack of resources to adequately protect the environment. Hello to everyone in the Class of '83."

Robert M. Specter (MS Geology '84) writes:
"Here's a bit of trivia . . . I named the newsletter TECHtonics in 1982 or 1983. Grad student Steve Rosen took an interest in a departmental newsletter and ran a contest to name it (with a six-pack of beer of the winner's choice as prize—I chose Molson's Golden Ale). It's nice to see the TECHtonics name still in use!"

Matthew M. Flynn (MS Hydrology '94) writes:
"I have been plying my trade in environmental restoration efforts throughout Alaska since completion of school work in May of 1992. I've had the incredible fortune of traveling all across this great state of Alaska these past 10 years. I've worked on the North Slope in the winter with temperatures at -35F and wind chills greater than -120F. I've worked in the Aleutian Islands where the wind and rain never stop. I've worked at locations in the interior of Alaska where the temperatures constantly break 80F, and where the mosquitoes are so thick you can't help but breathe them in. I've worked and lived in such remote locations that the only way to the job site is by small airplane, the nearest village is 75 miles away, communications are only by satellite phone, and wildlife is so abundant you need a rifle to make it to the outhouse. I've come face to face with a 1,000-lb brown bear, been within visual distance of a polar bear, been surrounded by a mother wolf and her cubs, been chased by a very angry and very large bull moose, and have been in the middle of a herd of over 50,000 caribou. But the best part about this work is that I get to continue to restore places in Alaska back to their pristine and incredibly wondrous conditions."

Charlotte Rowe (BS Geology '81, PhD Geophysics Dec '00) writes:
"I recently became a permanent employee at Los Alamos, where I was a post-doc for the past year. My parents are doing well and are pleased that I will be staying in New Mexico (so am I)! I'm keeping busy not only with work, but also volunteering at the Santa Fe Animal Shelter, and I continue training and competing in freestyle figure (ice) skating."

Internet Links

Find out more about topics covered in this newsletter by going to the following web pages:

College on the Rio Grande, by Paige Christensen:
www.nmt.edu/mainpage/paige/homepage.html

Department of Earth and Environmental Science:
www.ees.nmt.edu

Earthscope:
www.earthscope.org

EES Alumni Site:
www.ees.nmt.edu/alumni

IRIS/PASSCAL Instrument Center:
www.passcal.nmt.edu

Mt. Erebus Volcano Observatory:
www.ees.nmt.edu/Geop/Erebus/erebus.html

New Mexico Geochronology Research Laboratory
www.ees.nmt.edu/Geol/labs/Argon_Lab/NMGRL_homepage.html

RISTRA:
www.ees.nmt.edu/Geop/Ristra/ristra.html

SAHRA
www.sahra.arizona.edu

Alumni Update Form

Any changes or news? Let us know below or online at

www.ees.nmt.edu/alumni

Name _____

Street _____

City_____State/Prov_____Country _____

Zip/Postal Code_____Phone _____

Email _____

Web page _____

Year Graduated _____

Degree/Major _____

Occupation _____

Company/Organization _____

NEWS _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

" Enclosed is a check for $_____ for the Department Alumni Fund. Make check payable to New Mexico Tech Earth & Environmental Science.

Mail form and check to:

New Mexico Tech
Dept of Earth & Environmental Science
801 Leroy Place
Socorro, NM 87801

EES/Bureau Team Travel to Antarctica

EES Professors Philip Kyle and Bill McIntosh, four new geology graduate students (Julie Calkins, Peter Kelly, Shauna Mikelich, and Dawn Sweeney), and geology alumnus Dr. Kurt Panter and others arrived at McMurdo Station, Antarctica, during November 2003. During their six-week jaunt they camped out at the Mt. Erebus Volcano Observatory 3400 m high near the summit of the southernmost active volcano. They repaired five geophysical observatories installed during the 2002/2003 austral summer field season, installed a sixth station on the crater rim, collected rock samples for dating and geochemical analysis, and sampled gases emitted from the persistent lake of molten anorthoclase phonolite magma inside the 250-m-deep summit crater. Kyle, students, and others plan to return to New Zealand for Christmas and to spend 10 days on a field trip visiting New Zealand volcanoes. Dr. Nelia Dunbar (geochemistry alumna) of the NM Bureau of Geology is also in Antarctica and will be joined by husband Bill McIntosh and others sampling ice and tephra at Mt. Moulton in West Antarctica.

Mt. Erebus volcano in Antarctica and the observation hut where scientists from New Mexico Tech stay to study the volcano