



An artist's conception of GeoWall, courtesy of the GeoWall website.

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The arroyo south of Lemitar overflowing the road between Lemitar and Escondida Lake in August 2006. Photo by Paul Harden.

July and August 2006 Floods in Socorro

You probably remember Socorro as brown and dusty. This monsoon season, however, was a different story. During late July and early August, Socorro and its environs received almost its annual average of 9 inches of rain—most of that in a 4-day period. The resulting flooding was quite devastating: houses flooded, fields filled with water and silt, crops destroyed, and roads severely washed out. The up side of all this rain was cooler temperatures, an abundance of wildflowers, and the greenest desert most of us can remember. *—Editor*

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Flooding at the Interstate 25 Escondida exit in August 2006. Photo by Paul Harden



The greening of M Mountain after the Socorro floods

Fifty Years of Hydrology at the College on the Río Grande

by Enrique R. Vivoni, Assistant Professor of Hydrology

While the exact date is a topic of debate, this much we know. Between 1954 and 1956, during the leadership of President E. J. Workman, New Mexico Tech (NMT) established a presence in the burgeoning field of hydrology. At this time, few, if any, hydrologic science programs existed in the United States with hydrology courses typically taught in geology or civil engineering. Fifty years later, hydrology is an established geoscience discipline with a growing number of university programs throughout the world. Over this period, New Mexico Tech has served an important role in the development of hydrology as a science and as an integrated course of study at the graduate level.

In celebration of the 50th anniversary of NMT's Hydrology Program, this article discusses a few of the historical highlights as well as our current teaching and research efforts. Much of the program history has been documented by John Wilson in *The Porous Media* newsletter (vol. 1, no. 1, 1991 and vol. 2, no. 1, 1993). As will be discussed in the following, the 50-year history of the program follows, in many ways, the development of hydrology as a geoscience that is well-integrated with the Earth Science community. By attracting top talent, the program has been resilient in light of changes in scientific focus, societal needs, and competition from other programs.



Mahdi Hantush

According to several accounts, E. J. Workman convinced Mahdi Hantush, an Iraqi hydrologist educated in the United States, to commence a teaching and research program in groundwater hydrology at New Mexico Tech. This new program was complementary to NMT's efforts in geology, geophysics, and atmospheric physics. The program started with modest funds from the Geophysical Research Center and a handful of courses taught in the Department of Ground-Water Hydrology. During the early years, the

focus was primarily on transient groundwater flow problems with both a theoretical and applied emphasis. G. Emlen Hall¹ recounts that the first funded hydrology project at New Mexico Tech was in support of groundwater resources of the Roswell area.²

During the period 1956–1970, the Hydrology Program grew with respect to the number of graduating students, faculty, and scientific productivity. For example, fifteen MS and four PhD degrees were granted in groundwater hydrology during this time.



C. E. Jacob

Following Hantush's frequent visits to the Middle East in the mid-1960s, leadership in the Hydrology Program was transferred to C. E. Jacob in 1965. As Hantush's advisor, Jacob was already a well established leader in groundwater hydrology. As a result of their efforts during this period, New Mexico Tech became nationally recognized as a place for the study of well hydraulics. Today, most groundwater textbooks include the seminal discoveries they and their numerous students made in Socorro.

A brief transition occurred following Jacob's passing in 1970, during which time Gerardo Gross spearheaded the Hydrology Program, now in the Department of Geoscience. After a few years, Lynn Gelhar, a groundwater hydrologist from MIT, arrived at NMT. Gelhar reinvigorated the program during the period 1973–1982, with cutting-edge research being conducted by a growing group of students and faculty. Along with Allan Gutjahr, Gelhar created a nationally-recognized program in stochastic groundwater hydrology. Following national trends, the program also expanded its focus into numerical methods, hydrogeochemistry, and vadose zone and surface hydrology. During this period, New Mexico Tech established an international reputation in quantitative hydrology that still distinguishes our research and teaching efforts.

The period of 1984–present has been marked by stability, growth, and scientific progress under the leadership of John Wil-

¹G. Emlen Hall (2002), *High and Dry: The Texas-New Mexico Struggle for the Pecos River*. University of New Mexico Press, Albuquerque, NM.

²M. Hantush (1956), *Preliminary Quantitative Study of the Roswell Groundwater Reservoir*, New Mexico, Socorro, NM.

son, Robert Bowman, and Fred Phillips. Long-term, sustained efforts in groundwater hydrology, hydrogeochemistry, and vadose zone processes have resulted in international recognition for students and faculty alike. For example, John Wilson (1996) and Fred Phillips (2001) received the O. E. Meinzer Award, following in the footsteps of Hantush and Gelhar. In addition, the program has expanded into other areas including cave and karst hydrology, remote sensing, and ecohydrology. Along side this has been an effort to create an integrated graduate program in hydrologic science with a wide appeal to both MS and PhD students. Today, graduates from the program are highly sought out for jobs in consulting, government agencies, and academia.

As we mark the 50th anniversary of the Hydrology Program, it is important to reflect upon this historical background. This success story in the College on the Río Grande is the product of significant efforts (i.e., blood, sweat, and tears) by many students, staff, administrators, and faculty. Yet the road ahead is as exciting and challenging as the path that has been traveled. For example, an effort is underway to redesign our graduate curriculum to educate the next generation of hydrologic scientists. We are also offering a new BS degree with a specialization in hydrology. Our teaching innovations are accompanied by a strong commitment toward cutting edge research. We continue to seek new discoveries that impact hydrologic science and move us toward a deeper understanding of the natural world.

Current Hydrology Program Faculty



Bowman

Hendrickx

Phillips

Vivoni

Wilson



Robert S. Bowman
Department Chairman
Professor of Hydrology

TECHtonics

Editor-in-Chief

Andrew R. Campbell

Assistant Editors

Susan Delap
Pat Mills

Design and Layout

Susan Delap

Printing/Distribution

Pat Mills

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

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Note from the Chair

2006 has been a time of change and intense activity for the EES Department. Geophysics professor Harold Tobin and hydrology professor Brian McPherson both left for positions at other universities. Harold is now at the University of Wisconsin, and Brian is at the University of Utah. While we will miss these two friends and colleagues, it is a measure of our department's success that our faculty are actively recruited by other universities. Their departure offers the opportunity to recruit new faculty who will complement our current mix of expertise. We will be interviewing candidates for both of these positions this fall.

After years of lobbying, we have convinced the administration to fund a new geophysics position in exploration seismology, with an emphasis on hydrocarbon exploration and recovery. This new individual will develop a petroleum geology curriculum and give our graduates the training they need to enter this hot field. The addition will increase the number of geophysics faculty to five, and the total departmental teaching faculty to 22.

Another major effort this year has been a complete redesign of the undergraduate curriculum. Highlights are a suite of interdisciplinary freshman and sophomore courses, with opportunities for specialization in geology, geochemistry, geophysics, or hydrology at the junior and senior level. This new curriculum will become effective with the Fall 2007 semester.

Faculty Spotlight



Mark Murray

*Research Associate Professor of
Geophysics*

Greetings! I arrived at NMT in Fall 2005 to join the Earth and Environmental Science department as a research professor of geophysics. My specialty is the study of Earth deformation using geodetic techniques, particularly the Global Positioning System (GPS). As a graduate student at the Massachusetts Institute of

Technology (MIT) in the mid-1980s, I helped to develop and apply some of the first high-precision surveying methods using GPS. I then lived 15 years in the San Francisco Bay area working on a variety of crustal deformation studies, first at the US Geological Survey (USGS) in Menlo Park, then at Stanford University, and most recently at the UC Berkeley Seismological Laboratory. When my wife, Lind Gee, became director of the USGS Albuquerque Seismological Laboratory, we packed up our bags and two cats and made our way to New Mexico, where we have already become addicted to green chile and are trying to adjust to the more vigorous four-season climate.

GPS revolutionized the study of crustal deformation. It is now possible for anyone with a good view of the sky and a relatively inexpensive set of GPS equipment to rapidly locate themselves on the Earth's surface to within a few millimeters. By tracking how such positions change over time, GPS can monitor plate tectonic motions, earthquake slip, volcanic unrest, and many other interesting geophysical phenomena. For my PhD thesis, I helped to conduct the first surveys in central and southern California to map out the distribution of deformation across the ~200-km-wide San Andreas fault system, which accommodates about 35 mm/yr of motion between the Pacific and North America plates.

When I moved to California, I continued these types of surveys

along the northern San Andreas fault, in the Pacific Northwest, and in the New Madrid seismic zone to show how elastic strain accumulates near faults between earthquakes and to better assess future earthquake hazards. I also used GPS to map out how the crust deformed during and after large earthquakes to provide information about how the fault slipped and how the crust responds over time. At Berkeley, I led an effort to install GPS observatories to continuously monitor crustal motions. These stations provide position time series that not only show long-term average motions, but also more enigmatic transient deformation signals, including “slow” earthquakes—poorly understood slip events on faults that are not detected by seismometers. The continuous stations can also provide valuable near real-time information about major earthquakes to improve maps of strong ground shaking for emergency response efforts.

The number of continuous GPS stations in the US is increasing dramatically due to the ongoing installation of the Plate Boundary Observatory (PBO), which is one component of the NSF-funded EarthScope project. PBO currently includes more than 600 stations (1200 stations when completed in 2008) distributed along faults and near volcanoes throughout Alaska and the actively deforming western US. At NMT, I have established one of two funded Analysis Centers responsible for processing all of the PBO GPS data, which I am currently carrying out on a computer cluster in the IRIS PASSCAL Instrument Center. Our daily analysis has already captured several significant tectonic events, such as the long-anticipated 2004 Parkfield, California, earthquake and the current unrest at Augustine volcano in Alaska.

At NMT, I plan to continue my studies on the San Andreas fault system and New Madrid seismic zone, including occasional forays into the field to collect more data, and, together with Profs. Phil Kyle and Rick Aster, I am studying the deformation of Erebus volcano in Antarctica. I am developing techniques for detecting and modeling transient deformation events using PBO data from both continuous GPS stations and borehole strainmeters, which are a thousand times more sensitive than GPS to deformation over time scales up to a few months.

I provide departmental expertise in the use of several newly acquired GPS receivers that can do real-time navigational positioning at the cm level, which are being used, for example, by Prof. Vivoni’s group to map out hydrological basin topography. I have also begun trying to measure present-day extensional rates across the Rio Grande rift using available continuous GPS data; however, with deformation rates about 30 times less than those in California, I’ll have to be a lot more patient here!

EES Alumni Receptions for Fall 2006

Geological Society of America

Monday, October 23, 2006, 7-9:30 pm

Philadelphia Marriott Downtown

Liberty Ballroom, Salon A

1201 Market Street

Philadelphia, PA

We are having an alumni reception at GSA on Monday night. As it has been for the last few years, it will be in conjunction with UNM, NMSU, and UTEP. It is listed in the GSA schedule of alumni receptions as the Rio Grande Universities reception.

American Geophysical Union

Week of December 10th, 2006

San Francisco, CA

We are planning to have an alumni reception at AGU, but the details are not available yet. Please check the EES website before the meeting to get an update.

News and Notes

Alumni Activities and Fund Raising

by Andrew R. Campbell, Professor of Geology



Andy Campbell

During my inaugural year as coordinator of alumni relations and fund raising, EES hosted receptions at both the GSA and AGU conferences. This was such fun that we plan to do it again. You can find details on page 9 of this newsletter. Receptions are a particularly pleasant venue for EES faculty to visit alumni and catch up with your news, and for each of you to socialize with colleagues and former NMT classmates. If you'll attend either GSA or AGU this fall, be certain to find us to say hello again.

Since our last publication, 23 generous folks donated \$2,700 to the EES Alumni Fund; donors' names are shown beginning on page 12. Alumni Fund monies will be allocated for student scholarships, field trips, departmental events, and other student-oriented activities. Because alumni monies may be used at the discretion of faculty, these donations directly benefit current students. EES fellowship opportunities were enhanced significantly when the donor, who originally endowed the Don Yardley Fellowship in Economic Geology, contributed an additional \$5,000. The Don Yardley Fellowship currently supports two graduate students whose research pertains to ore deposit exploration. The Alumni Fund and the Yardley Fellowship are two of many ways in which alumni provide extra support for EES educational efforts. In the past year, alumni have also directly funded registration of several EES students at an SEG meeting in Keystone, Colorado, on "Wealth Creation in the Mineral Industry." Other alumni provided needed support for a volcanological field expedition to the Cascades. Alumni are extremely instrumental in providing employment for EES graduates by keeping us informed about opportunities available in their

organizations. Thank you for your continued involvement with us.

Particularly for alumni of the 60s and 70s, the following two news items are of special interest. In winter of 2005, Professor Emerita of Geology Dr. Christina Lochman-Balk passed away at the venerable age of 98. Dr. Balk, who was a noted Cambrian geologist and paleontologist, came to teach in the Geology Program in 1957, when the department consisted of herself and Dr. Clay T. Smith (sufficient!!). A memorial article, written by Jane Love of the NM Bureau of Geology and Mineral Resources, appeared in the August 2006 issue of *New Mexico Geology* (vol. 28, no. 3, 2006). For an excerpt of this fascinating biographical piece, see page 15.

Mrs. Sallie Smith soon will be moving away to California to reside in proximity to the sons of herself and late husband Dr. Clay T. Smith. We will all miss Sallie terribly. She has continued to grace us with her presence at many departmental celebrations, adding her ineffable sparkle and verve. To learn more about Sallie and her life in Socorro, you can read the article that appeared in the latest issue of *Goldpan*. (See **Internet Links** on page 20.) In honor of Dr. and Mrs. Smith, EES intends to establish and seek endowments for a Clay T. and Sallie Smith student fellowship; I hope to send you a letter in December elaborating on these plans.



Sallie and Clay Smith

EES Alumni Fund Donors

We would like to thank the following people who have generously donated to the Alumni fund since our last publication.

Anonymous

Julio and Felicia Aguilar

Drs. Robert Andres and Christina Behr-Andres

Mr. Alan Andrunas

Drs. Paul Bauer and Peggy Johnson

Ruth Lohmann-Davis and J. Matthew Davis

Dr. Martha Eppes

Ms. April V. Gil

Ms. Diane Hattler

David Jordan

Mr. Michael LeBaron

Dr. Gregory Miller and Mrs. Theresa Apodaca

Mr. Jerry Oliver

Mr. Stavros S. Papadopoulos

Victor Polyak

Mr. William F. Purtymun

Mr. W. C. Reise

Ms. Regina Rone

Dr. Charlotte Rowe

William C. Sullivan

Lawrence and Lucy Herber Trste

Dr. Jiamin Wan

Mr. Mike (Marvin) Wolf

EES Alumna Receives Prestigious Award

Roseanna M. Neupauer (PhD Hydrology 2000) won the 2006 Walter L. Huber Civil Engineering Research Prize from the American Society of Civil Engineers (ASCE) for "significant contributions to the advancement of probabilistic modeling of environmental contaminants." The Huber Prize is awarded to members of ASCE for notable achievements in research related to civil engineering.

Her citation says that Dr. Neupauer's research "recognizes the backward probabilistic modeling of environmental contaminants as

an efficient method for identifying characteristics of contaminant sources. In this approach, contaminant transport is modeled as reversed time from each observation to the possible source location. Dr. Neupauer and her collaborators (NMT Professor John L. Wilson) developed the theoretical framework for this modeling approach for groundwater contamination problems. She has developed the theory for conservative and reactive chemicals in steady state or transient flow fields in homogenous or heterogeneous aquifers. The approach has been streamlined so that it can be run with any commonly used flow and transport codes with only minor modifications to inputs and outputs; therefore, it can readily be applied in practice. The method has been used for source characterization, capture zone delineation, vulnerability assessment, and groundwater age dating."

We also note that this is not the only area of Roseanna's research. She is currently in the latter stages of a National Science Foundation (NSF) Career Award for her project "Wavelet Analysis of Scale Effects on Subsurface Flow and Transport."

EES Faculty Awards

Robert S. Bowman, Professor of Hydrology

During Commencement 2006, Rob Bowman was awarded New Mexico Tech's Distinguished Research Award for 2006. Rob has been a member of our department's Hydrology Program since 1987, having earned his bachelor's degree at the University of California at Berkeley and his doctorate at New Mexico State University. During his time at New Mexico Tech, Rob has achieved an exceptional record of innovation in soil and water-related environmental research. He has almost 70 peer-reviewed publications, many of them in the most prominent and highly cited venues in his field.

One of his major early contributions was the development of a new class of water tracers, called FBAs, which are now used by soil physicists, chemists, and hydrologists worldwide.

Dr. Bowman has also pioneered important new applications of natural zeolites for removing chemical contaminants and toxic organisms from contaminated water. He made the surprising

observation that surfactant-modified zeolites immobilize viruses and bacteria, which could have a major impact on public health in developing areas of the world. Rob's work with zeolites led him to host Zeolite '06, an international scientific meeting on zeolites, in Socorro last July.

For the state of New Mexico, Rob is leading studies of stream-aquifer interaction for the Río Grande basin, with significant implications for the water balance of our region. In addition, Rob is the primary investigator of the water portion of New Mexico's new EPSCoR project, recently funded by the National Science Foundation.

Rob Bowman has had a lifelong commitment to encouraging young people to participate in science. New Mexico Tech's Master of Science Teaching Program, Science Olympiad, and Science Fair have all benefitted from his work. He is also very active with local hydrology and has worked with the Socorro Soil and Water Conservation District, the Middle Río Grande Water Supply Study, and the Socorro-Sierra Regional Water Plan. (*George Zamora contributed to this article.*)

Other Faculty Notes

John L. Wilson II, Professor of Hydrology

John Wilson recently was elected president of the Hydrology Section of the American Geophysical Union (AGU), the largest division of AGU with over 6,000 members. He is currently serving a term as president-elect for two years, which will be followed by another two-year term as president.



Penelope Boston, Research Associate Professor of Cave & Karst Science

Penny Boston spent January 1–14, 2006, at the Mars Desert Research Station (MDRS) in Utah. At left is the official uniform patch for Crew 41, or the Double-X crew—a group of five scientists and engineers who explore all facets of human exploration in a simulated Mars environment. Boston, the geologist and science lead for the group, investigated the short photoperiod growth of greenhouse plants and co-investigated the following

Science Mission Objectives: mineral-rich and evaporite geomicrobiological desert habitats, desert varnish studies, saline environments and possible halophile habitats, and observed seep communities of cyanobacteria, lichens, and possibly other bacteria. She also co-investigated Individual Mobile Agents Systems (iMAS).



Christina Lochman-Balk

Photo courtesy NMT Archives

In Memory of Christina Lochman-Balk

by Jane Love (an excerpt)

Christina Lochman-Balk was an eminent Cambrian geologist and paleontologist and respected teacher. She died March 8, 2006, in Santa Fe, New Mexico, at the age of 98.

At a time when very few young women were encouraged to continue their education past high school, Christina Lochman received both BA and MA degrees from Smith College, Northampton, Massachusetts. In 1933 she received her PhD degree in paleontology from Johns Hopkins University in Baltimore, Maryland.

She held teaching positions at Mount Holyoke women's college (1935–1947) in South Hadley, Massachusetts, and at the University of Chicago (1947). She and her husband, Robert Balk, moved to Socorro, New Mexico, in 1952 where he had accepted a position with the State Bureau of Mines and Mineral Resources, a division of the New Mexico Institute of Mining and Technology. Following his tragic death in February 1955 in an airplane crash, Christina joined the bureau as a stratigraphic geologist and worked in the Capitol Dome area of the Florida Mountains. In January 1957 she transferred to the college division and a teaching position in the geology department, which she held for many years. Clay T. Smith, her colleague at New Mexico Tech, said that because she was a world-renowned trilobite

expert, she immediately made the department world famous. “In addition to being a world-famous paleontologist, she could teach any courses offered in the department including optical mineralogy if necessary. The addition of Dr. Balk helped enable the department to increase the graduate offerings to a PhD in Earth Sciences.”

Christina was a pioneer in the male-dominated field of geology. Her research in Cambrian–Ordovician paleontology, shallow marine carbonates, and Paleozoic stratigraphy as well as her teaching career spanned more than 40 years. Colleagues and students admired Christina’s brilliant intellect, indomitable spirit, physical stamina, warm personality, and great sense of humor. (*See [Internet Links](#) on page 20 for a web link to this entire article.*)

Alumni News

James R. Doty (BS Geophysics '50—one of the first three awarded) jrdoty2@earthlink.net wrote in December 2005:

“I will be 80 in March. I spend most of my time playing golf, making sure I don’t go broke, and enjoying the company of my wife of 56 years (as of January 13, 2006).”

Raul A. Deju (PhD Geoscience-Hydrology '69) rdeju@deju.net wrote in May 2006:

“I am a PhD graduate in Geosciences-Hydrology from 1969 at Tech under C. E. Jacob. I am also a mathematics graduate in 1966 at Tech under Dr. Rafael Sanchez Diaz (BS). Here are some of my career tidbits:

- Taught at University of Pittsburgh, Wright State University, UC Davis, St. Mary’s College
- Chairman and CEO URS, Inc. (one of the top 10 engineering companies in America)
- Founder and President of ISG Resources which became Headwaters, Inc.—a NYSE-listed company with a \$1.5 billion market value and the largest provider of recycled cement in the world
- Currently Managing Partner, Sienna Ventures—a venture capital fund family. Sit on several boards of directors.
- Recipient of the top 25 Hispanics in Northern Calif., 2005

- Recipient of 2005 Philanthropy award in San Francisco
- Author of over 150 publications and three books.”

James Gordon Jensen (BS Geology '72)

jimjensen777@comcast.net wrote in November 2005:

“After leaving school (was a MS candidate in geology at NMT in 1974), I spent the first 17 years (1974–1990) in the oil and gas business in Texas, Oklahoma, New Mexico, and California and ran an independent petroleum exploration company in Sacramento. The independent business didn't generate enough profit (what a surprise), so I started over and spent the second part of my career (1991–2005) working for several environmental companies in Sacramento conducting soil and groundwater investigations and managing projects in California and Canada.

The third phase began in 1999 when I started conducting independent research on the study of planetary resources with the primary goal being to organize the exploration and development of resources on the inner terrestrial planets to support the anticipated colonization of these planets. The research, which included development of a stratigraphic correlation chart of Mercury, Venus, Earth, the Moon, and Mars, is being integrated into two texts. One will be a handbook for exploration and development of resources on the inner terrestrial planets. The other will be a text/interactive CD organized as a comparative atlas of topographic and terrain features on the inner planets that will complement the exploration handbook.

In addition, I work with the Volcanological Society of Sacramento as the editor of the VSSAC newsletter and their field trip coordinator organizing and co-leading trips along the West Coast and to Iceland (2003) and the Central Mexico Neovolcanic Belt (2005). Iceland was particularly cool, as there are volcanic features that are comparative to similar features on Mars.

Still having too much fun. On a personal note, my son Phil went back to college two years ago at the age of 34 and graduated this year with a degree in radiology. Dad is too proud of this guy.”

Dean Alford (BS Geology '85, MS Geology '87)**dalford@converseconsultants.com wrote in May 2006:**

"I recently relocated from Elko, Nevada, to Phoenix, Arizona, accepting a promotion to Managing Officer for Converse's Arizona operations. I am developing a new office, managing a variety of technical and administrative personnel, and providing technical input for a variety of clients and projects throughout the western US, primarily in geology, groundwater and environmental science. With my wife Nelsene of 17 years, we have four daughters and enjoy sports, hot air balloons, and the great outdoors."

Alan Andrunas (BS Geology '87) wrote in June 2006:

"Occupied as a Geologist with Owens Geotechnical, Inc. Alan is currently working as an inspector on various construction projects including deep foundations for high-rise casinos and condominiums as well as smaller commercial projects. For fun, most free time is spent rock climbing, hiking, and working out at the gym."

Ruth Lohmann-Davis (MS Hydrology '92) and spouse J.**Matthew Davis (MS Hydrology '90, PhD Hydrology '94) wrote in Feb 2006:**

"Matt is Chair of the Hydrogeology department at the University of New Hampshire. They are looking forward to a sabbatical leave visit to Socorro in the Fall of 2006, as both Matt and Ruth plan to pursue collaborations with Professors Mozley and Vivoni. There are three girls in the family: Kelly (10), Natalie (7) and Carola (4)."

Hal Newell (MS Geochemistry Dec '97) halnewell@mac.com wrote in March 2006:

"I am writing to update my home address and engineering firm (Geologist for PS&S, LLC). I am still in Manhattan since Socorro. We just moved into a new apartment in Harlem. Our greyhounds love the apartment's proximity to Morningside and Central Parks, but do not seem to care about the dramatic schist outcrops. At the new firm I will be evaluating and assisting the development of brownfield sites in New York City and Westchester County."

Regina G. Rone (BS Geology, BS Env. Science/Biology '99; MS Geology '01) chinle65@yahoo.com wrote in March 2006:

"I'm a northern light now living ~90 miles south of the Canadian border and taking care of 2.5 million acres of soils for the Idaho Panhandle National Forest. While frolicking through the land of glacial Lake Missoula floods, I desperately miss New Mexico. Thank God for NMGS every year!!!"

Paul T. Brandes (BS Geology '01) ecoligite@pasty.com wrote in July 2006:

"I finished my MS in Geology from Michigan Tech University in 2004. We (Nathalie and I) then moved to Las Vegas, Nevada, and began working as a geologic consultant for a private company. After spending one year in "Sin City," we moved to near Houston, Texas. I have now begun working for the Texas Commission on Environmental Quality as a Field Investigator." Spouse **Nathalie Nicole Derrick Brandes (BS Geology '99, MS Geology Dec '02, nathalie.n.brandes@nhmccd.edu)** is an Associate Professor of Geological Sciences at Montgomery College.

Laura Jean Wilcox (MS Hydrology '04) ljwilcox68@hotmail.com wrote in February 2006:

Employed by MWH Global, Inc., in Sacramento, California, since January of 2004, Laura Jean works on implementing more efficient ways for California to manage its limited surface and ground water resources. This has been accomplished by developing management plans for water consumption and the development and implementation of recharge projects throughout California, New Mexico, and Australia. A native of Maine, Laura Jean enjoys climbing, skiing, sailing, music, and travelling in her spare time.

And in March 2006 she wrote:

Transferring to MWH Global, Inc., Perth, Australia, office in April 2006. Will be working on hydrogeological investigations to study and monitor mine dewatering effects on several natural parks in Western Australia. Also helping Perth municipal water agencies develop future plans for water use and sustainability.

GeoWall—A New Visualization Tool for Earth Science

By Penelope Boston, Research Associate Professor of Cave and Karst Science, and GeoWall Technicians Lisa Majkowski and Katrina Koski

Geology is an intensely visual science. Complex phenomena such as the motion of plates, geomorphic transformations, and many others can be difficult for beginning students to grasp. Visualization in three dimensions is required for advanced students to understand the molecular structure of minerals, the flow of water through drainage basins, and the structure of the Earth revealed through seismic ray paths. Even for experienced scientists, the ability to visualize the results of their research is immensely valuable.

To help address these issues, EES has purchased a GeoWall 3-D projection system from the GeoWall Consortium. (*See picture on back cover.*) The Consortium is a group of universities and other institutions that have been developing images, animations, and open development software tools. Paul Morin from the Center for Earth-surface Dynamics at the University of Minnesota, where the GeoWall Consortium is headquartered, presented a seminar on the topic to EES several years ago. The faculty and students were impressed with the potential of such a system for New Mexico Tech. During the Spring 2006 semester, a committee investigated the various options for acquiring such a system with our precious departmental funds and made the commitment to prioritize visually based teaching using the GeoWall.

Today's undergraduate students are accustomed to three dimensional graphics and motion in video games, yet professors have been limited to explaining the three-dimensional structure of minerals using ball and stick models in the classroom. With the GeoWall, instructors will be able to book the GeoWall classroom during regular class periods. Students will don 3-D goggles and the GeoWall projector will illuminate a screen. The students will see the three dimensional structure of minerals. Instead of trying to explain the Fe-Mg substitution in phyllosilicates, the students can observe an Fe atom replacing a Mg atom in phlogopite, creating biotite. Not only do the students observe the change from Fe to

Mg, but also the effect it has on the entire structure of the sheet silicate, as the mineral is rotated. No longer do professors have to hold up a ball and stick model and say "Imagine that this yellow ball is blue and bigger. How would that change the length of these sticks?"

Current computing power allows the GeoWall to show not just static 3-D pictures, but 3-D animations, allowing visualization of a subducting plate, melting, and the formation of a subsequent island arc. Still frames can be shown for discussion, and the students can be quizzed as to what they think will happen. Students can incorporate GeoWall animations into their presentations, or take time to sit and review material presented during lecture, replaying phenomena as many times as they desire.

Of course, all technology requires a learning curve. Lisa Majkowski, an Earth Sciences Specialist, and Katrina Koski, a PhD student in Cave and Karst Studies, are the GeoWall technicians. A general library of broadly based geologic phenomena will be created with a focus on getting classes using GeoWall by Spring 2007. An open house for instructors will be held late Fall 2006, showcasing commonly applicable concepts illustrated on the GeoWall. Requests for specific animations will be taken and filled, increasing the library. As the faculty integrates the technology into their lectures during the spring semester, we will work with the graduate students and faculty to incorporate GeoWall visualizations into their research projects. Another open house will be held in late spring for the entire campus, so other departments are informed about the capabilities and availability of the GeoWall. At other institutions, astronomers and chemists have very successfully used GeoWalls in their courses.

We have purchased a single system and installed it in one of the teaching laboratories. If this system proves to be as useful as we believe, we will consider adding additional units and capabilities as our budget permits.