



Group photo at Upper Geyser Basin. From left to right: Mariangela Sciotto, Rob Anthony, Nels Iverson, Aida Quezada Reyes, Aaron Curtis, David Krzesni (front), Jake Anderson (back), Scott Havens, Heather Rock, Rebecca Johnson and Jeff Johnson.

YELLOWSTONE!

by Jeff Johnson, Assistant Professor of Geophysics

This past summer the department Volcano Geophysical Field Methods class headed to Yellowstone National Park to study geysers, faults, and volcanic geology. In August of 2011, eight students and three professors crammed into an E&ES department van full of dataloggers, sensors, tripods, GPS, and camping gear and set off on the thousand-mile, two-day drive to the world's most famous supervolcano.

INSIDE

Geothermal logging	6
Alumni Relations/Fundraising	8
EES News	9
Student Spotlights	15

For eleven days the team resided in the park at Madison Campground, sleeping in tents, cooking with camp stoves, soaking in the nearby hot springs, and learning about the region's geology and geophysics.

Upon arrival in Yellowstone the first item of business was to begin the monitoring of several active geyser basins. Instructor Jeff Johnson (E&ES Geophysics) led the acoustic surveillance project, in which three arrays of infrasound-sensitive microphones were deployed at the Lower Geyser and Lone Star Geyser Basins. The arrays each consisted of four separated microphones, which allowed students to calculate signal origin direction. Multiple arrays could be used to cross-beam signal source directions and absolutely locate a geyser source. This proved particularly valuable at Lower Geyser Basin where no fewer than six geysers were detectable during the week-long observation period. The most exciting of the geysers here was the Great Fountain, a sporadic fountain-type geyser, which erupted only twice daily, but with magnificent bursts up to 30 m tall.



Rebecca Johnson deploying infrasonic microphones at Sawmill Geyser.

At Lone Star the major activity originated from its namesake geyser, a cone type geyser, which would jet a steam column for 30 mi-

minutes every 3 hours. Erupting in a style similar to Old Faithful, it proved ideal for field study owing to its remote setting, more than two miles from the trailhead. Even during the height of the August tourist season, when hundreds would gather for Old Faithful's eruptions, the geophysics class often had Lone Star to themselves.



Students collecting data at Lone Star Geysir.

While waiting for geyser signals to accumulate - the stations ran unattended for nearly a week - Professor Phil Kyle (E&ES Geochemistry) led students to the park's geologic highlights. The group visited ignimbrite deposits left from the three cataclysmic caldera forming eruptions,

explored phreatic eruption craters formed during the Holocene, and toured the travertine terraces of Mammoth Hot Springs as well as all of the principal geyser basins within the park. Halfway through the course, during a “rest day”, Phil Kyle and the entire class drove to neighboring Grand Teton National Park to explore spectacular results of Cenozoic mountain building and glacial geology.

Interwoven with the geology excursions and geyser gazing, Professor Mark Murray (E&ES Geophysics) organized a geodetic survey of the Hebgen Lake Fault scarp just to the West of Yellowstone. The 1959 magnitude 7.3 event was Montana’s largest historic earthquake and was responsible for 28 fatalities, many killed by a triggered landslide, as well as by a seiche in Hebgen Lake. Six-meters of throw along a normal fault were exposed and even now, 42 years later, the scarp is fresh looking and obvious. During two days of field activity Murray and colleagues from University of Texas at Dallas demonstrated LiDAR mapping techniques with the goal that the eroding scarp could be resurveyed during future field trips. The last few days of the course were spent analyzing geyser acoustic data in an ad-hoc West Yellowstone classroom. Students learned array processing techniques using portable computers, and student teams competed to discriminate individual geysers in the menagerie of recorded signals. Notably, fountain geysers were found to emanate much more intense and lower frequency sounds, whereas cone type geysers were characterized by lower amplitude and higher frequency jetting emissions. This finding and the general high quality of the collected data has since inspired Ph.D. student Aida Quezada Reyes to analyze the geyser acoustic signals for an upcoming research paper in collaboration with other class members.

Note: The Yellowstone class was the fourth iteration of Volcano Geophysical Field Methods class, which is directed at the advanced undergraduate and graduate level student and has attracted students from both NMT, across the U.S. and about a dozen different countries. Students who participated in the Yellowstone course were mostly from NMT, and included Jacob Anderson, Robert Anthony, Aaron Curtis, Nels Iversen, Rebecca Johnson, David Krzesni, Aida Quezada Reyes, and Mariangela Sciotto (INGV, Italy). Previous versions of the course have been held at Kilauea Volcano (Hawaii) and Tungurahua (Ecuador). In 2012 the course will again be held at the active volcanoes in Ecuador. The course is made possible with generous support from NMT’s VPAA.



Gary Axen

Department Chairman
Associate Professor
of Geology

Note from the Chair

Dear Friends of EES,

First, I'd like to thank, for all of us, Rick Aster, now Associate Chair and planning a well-deserved sabbatical for 2012-13 in Colorado. Rick led the Department and the IRIS-PASSCAL Instrument Center through the worst of the recession (we hope!) with vision and diligence. Rick also continues to guide me in my transition to the administrative side of NMT and to provide invaluable help with the many ongoing negotiations with Brown Hall. Thanks Rick!

Let me introduce myself: I am a field-oriented Structural Geologist in my seventh year at NMT, with interests in continental tectonics, fault mechanics, neotectonics and energy geoscience. New Mexico is a great place for all four, and a fantastic natural laboratory for teaching and research. I am honored to be Chair of EES.

We look forward to hiring a new Assistant Professor of Hydrology for fall, 2012, and are excited to be hosting Dr. Jamal Assad, Visiting Professor of Geophysics, who is teaching various industry-related courses this year. Sadly, Leigh Davidson of the front office has retired due to family illness. We all miss Leigh's unflagging enthusiasm, wish her the best and hope to see her from time to time.

EES remains an exciting and vigorous home to students, currently with near-record Undergraduate and Graduate numbers, a silver lining of the hard economic times. However, while enrollments are up, State funding is expected to remain flat, so we need your generous support now more than ever. Whether or not you donate, we hope to see you in Socorro (49ers was great this year, as always),

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at a meeting, or hear about your recent adventures and life changes. Please contact me or Andy Campbell with alumni news!

Geothermal Studies Expand

by Shari Kelley, Adjunct Professor of Geophysics and Mark Person, Professor of Hydrology

Funding from the U.S. Department of Energy and the New Mexico Energy, Minerals & Natural Resources Department has revitalized the geothermal program at the New Mexico Bureau of Geology and the Earth and Environmental Science Department. Six graduate students and two undergraduates are currently working on geothermal projects. **Robert “Zeke” Salaz** is mapping the northeastern part of the Pueblo of Jemez, looking for signs of past and present geothermal activity in the southwestern Jemez Mountains. Zeke has also installed a small seismic network on the Pueblo of Jemez to determine the background seismicity of the area prior to the drilling of a geothermal exploration well next spring. **Matthew Sophy** is helping develop New Mexico’s part of a National Geothermal Database that includes temperature-depth, thermal conductivity, porosity, heat flow, and water chemistry data. In addition, Matthew is evaluating the geothermal potential and hydrogeology of the Winston-Chloride area in central New Mexico. **Mussie Tewelde** is also working on the National Geothermal Database project, supplying bottom-hole temperature information. Mussie is researching the geothermal potential and hydrogeology of the Hillsboro-Lake Valley region in central New Mexico. **Jessie Hubbling** is modeling the hydrogeology several important geothermal areas in New Mexico, including the southwestern Jemez Mountains and the San Juan Basin. **Trevor Schlossnagle** is evaluating the geothermal potential of the Mimbres basin in southwestern New Mexico using water chemistry and refined geothermometers. **David Butler** is developing a web based GIS to allow interested parties to access all the geologic, geophysical, and geochemical data sets collected within NM to stimulate geothermal exploration by the private sector. Two undergraduates (**Kim Haar** and **Neil Curry**) are helping Schlossnagle and Butler in the collection of geochemical samples and statistical analysis of the geothermal data sets. **Mark Person** and **Shari Kelley** are advising this great group of students. They have teamed up this fall semester to teach a course focused on geothermal exploration.



From left to right: Mussie Twelde, Robert “Zeke” Salaz, Marshall Reiter (instructor), Dr. Shari Kelley, and Matt Sophy participating in a short course on geothermal temperature logging.

EES Alumni Fund Donors

We would like to thank the following people who have generously donated to the EES Alumni Fund during the 2011 fiscal year (July 1, 2009–December 15, 2011). Donors at press time include:

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EES Alumni Relations and Fundraising

by Andrew R. Campbell, Professor of Geology



During this past year, we achieved one of our fundraising goals; we reached the minimum (\$15,000) level to get the **Clay T. and Sally Smith Fund** established as an endowment! Income from this fund will help support student field projects and field travel. Making this fund an endowment is a big step in that it preserves the principle (from your generous donations) while creating an income stream for student awards. Of course at the minimum level won't be much, so we are still looking for substantial donations to grow this fund. If you have warm memories of Clay and Sally, please consider a contribution this year.

This coming year, our main goal is to get the **Rob Bowman Fund** up to level to be turned into an endowment as

well. If you were associated with Rob generous leadership and mentorship, and remember his substantial contributions to Tech and to your education, please help us to grow his fund into ongoing endowment.

Over the last several years income from the **Dave Norman Fund** has accumulated, so this year we were finally able to tap it to help three MS students studying ore deposits to attend a meeting in Colorado on Rare Earth Element Deposits. They came back with new knowledge and new professional contacts in the field of exploration and mining geology and in the critical area of rare earth element geology. Helping students get into the field, attend conferences and international field trips, and pay for research supplies are the sorts of activities that most benefit from our fundraising efforts and from your kind alumni donations.

As **Gary Axen** mentions in this issue of **TECHTONICS** in his comments from the Chair, budget cuts at the state level has diminished NMT faculty and other resources the last 4 years. As the economy turns around, the department will strive to rebuild our faculty numbers, but we will be competing with programs across campus. Having strong and involved department alumni support will help us push our case with the administration and otherwise strengthen the department. Your support is critical to our future successes.

Best wishes for a great 2012.

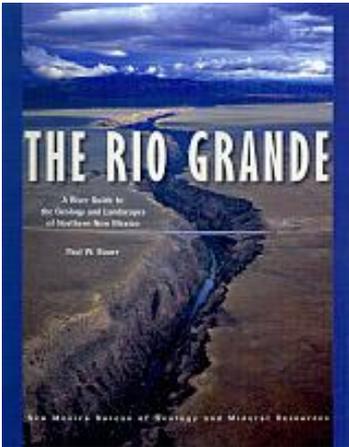
EES Department News



***Reining in the Rio Grande* Published.**

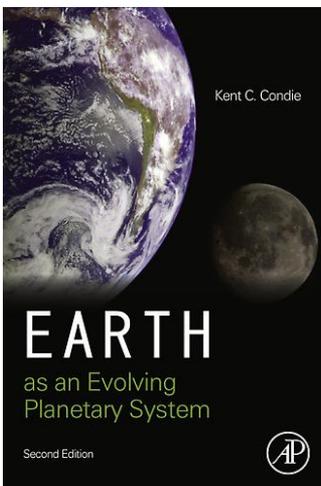
Hydrology Professor Fred Phillips, with co-authors G. Emlen Hall and Mary Black, recently published a comprehensive history of New Mexico's iconic river, *Reining in the Rio Grande: People, Land and Water*. The new book, published by the University of New Mexico Press, covers the entire spectrum of the history, geology, modern regulations and cultural impact of the Rio Grande. While the book is mostly a scientific and historical examination of the river, Phillips finds the river to be a central part of the New Mexican identi-

ty – and important personally as well. “Spiritually, when people think of New Mexico – or when you are away and come back home – you think of the cottonwoods, the Sandias, ‘M’ Mountain or the blue skies,” Phillips said. “The Rio Grande is deep within everyone’s self-conscious. The Rio Grande is emblematic of what New Mexico is. And it’s a precious resource.” For more information on Fred’s book, see the NMT press release at <http://www.nmt.edu/nmt-news/336-2011/4254-hydrology-prof-publishes-a-rio-grande-history>.



Bauer Receives National book award.

Adjunct Professor and New Mexico Bureau of Geology Associate Director Paul Bauer won a National Outdoor Book award for his guidebook to the Rio Grande in the “Outdoor Adventure Guidebook Category”. Anyone who has hiked or rafted in on the Rio Grande on Northern New Mexico will certainly enjoy this spectacular and detailed guide to New Mexico’s definitive river. The volume is published by the Bureau of Geology and Mineral Resources Resources.



Prolific author and globally renowned geochemist Professor **Kent Condie** produced a second edition of his landmark book *Earth as an Evolving Planetary System* (Elsevier Academic Press) in April 2011. A survey of all NMT publications since 1975 recently revealed that Kent has authored or coauthored 7 of the 50 most highly cited papers, University-wide!



Rick Aster (l) and seismological colleagues testifying before the House Natural Resources Committee on earthquake science and policy in March 2011.

Another Remarkable Year in Earthquake Science. In seismological news, the world was stunned and saddened by the astounding magnitude 9.0 Tohoku-Oki earthquake that hit Japan on March 11. This was the largest earthquake in Japanese history and generated an enormous tsunami that led to multiple meltdowns at the Fukushima nuclear complex. Geophysics Professor and Seismological Society (SSA) President (2009-2011) **Rick Aster** and Geophysics Professor, Incorporated Research Institutions for Seismology Board Member, and subduction zone seismicity expert professor **Sue Bilek** were in the news in the U.S. and Japan commenting on the geophysics of the earthquake. Aster was featured in an article in *Nature* regarding the statistical occurrence of super-large earthquakes. Aster and colleagues have noted in the media that the apparent clustering of giant earthquakes since the Sumatra 2004 event is not unprecedented (there was an even larger spate of such events in the 50s through the mid 1960s), and that there is not strong evidence for global linkages in such events or evidence that we are in a new era of great earthquakes. Aster and SSA colleagues convened the first major scientific meeting on the Japan earthquake this year at the Seismological Society's April 13-15 meeting in Memphis Tennessee, just a month after the event. Aster was also featured on

NPR's Weekend Edition in an interview with host Scott Simon on the unprecedented trial of Italian Seismologists for failing to sufficiently warn the population of L'Aquila, Italy before a devastating 2009 Earthquake.

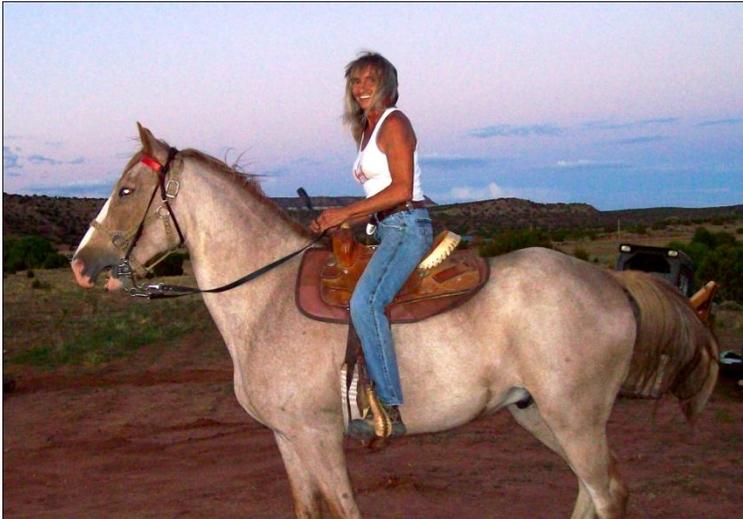
Field Camp News. 2011 Summer Field, Camp, led by Emeritus Professor **Dave Johnson**, included a module on the Rio Chama this year, led by new Adjunct Professor, Bureau Geologist, and river guide extraordinaire, **Mike Timmons**.



Mike Timmons and Bruce Harrison on the Rio Chama Field Camp trip. Looking good, guys!

Welcome to Elena Marshall.

In late breaking news at press time, EES is pleased to welcome Elena Marshall to the department office. Elena will be replacing Leigh Davidson in assisting Pat Valentine to keep things running smoothly in 2012 and beyond. A lifetime horse devotee, she is originally from Foxboro, MA, and graduated from Meredith Manor School of Horsemanship in 1975. She moved out west with her husband (who passed away in 2007) in 1982 where they worked as cowboys for several years and then traveled around the U.S. on horseback for 8 years before settling down in Socorro. She notes that she loves to ride horses, cooking, travel, and being a mom.



2011 Graduation News

This past year, EES students received 5 Bachelor's degrees, 8 Master's degrees, and 3 PhD degrees. Graduate students completing at the end of 2010 and in 2011 included Brian Cozzens, Rebecca Garcia, Melissa Kammerer, Shoba Maraj, William (Graham) Payne, Andre Ritchie, Matt Zimmer, Heather Casey, Jon MacCarthy, Marty Frisbee, and Jason Heath. Congratulations all!



May 2011 Commencement Ph.D. recipient Jonathan MacCarthy (now at Los Alamos National Laboratory) pictured with (l-r) Vice President Van Romero, President Daniel Lopez, and Vice President Peter Gerity.



Sophia Seigstedt and Diana Romero-Suarez at 2011 Graduation.

Student Spotlights

Julien Chaput, PhD Student in Geophysics

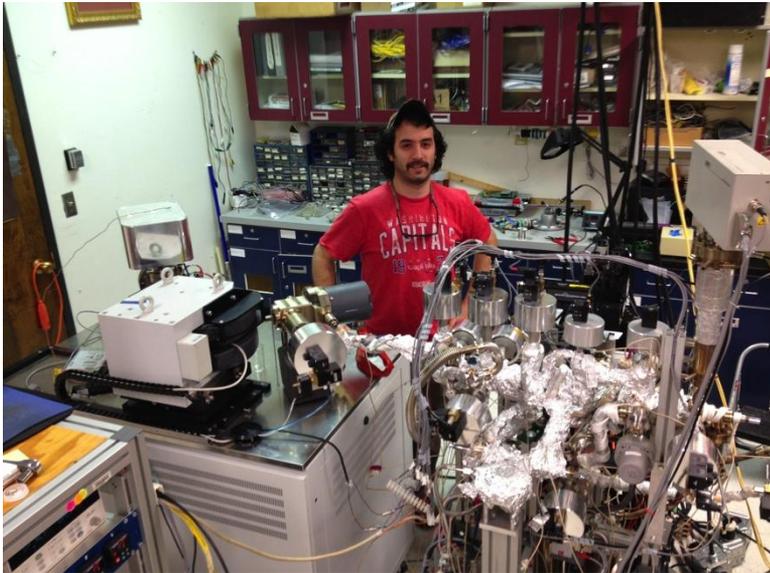


Julien Chaput sending holiday greetings from Erebus Volcano, Antarctica.

Julien Chaput, a fourth-year Ph.D. student in the Geophysics Program, won a Seismological Society of America Best Student Paper award this year at the Society's annual meeting in Memphis, Tennessee. He was honored for work in imaging the upper magmatic conduit system of Mount Erebus, Antarctica, using a unique data set collected by Mount Erebus Volcano Observatory Principal Investigator Philip Kyle, Chaput, and the 2007-2008 Erebus field team as part of the Tomo-Erebus project (last reported on in our 2009 issue of *TECTONICS*). The data were collected during a massive deployment of summit-region instrumentation that included more than 100 seismographs provided by the IRIS PASSCAL Instrument Center at NMT that briefly transformed the remote Antarctic peak into the most heavily instrumented volcano on Earth. Chaput's novel technique disentangles the cacophony of scattered waves produced by repeating abrupt eruptions from the volcano's central lava lake to identify internal structures that produce sharp and consistent seismic reflections. The new images show a complicated shallow conduit system that obliquely connects to the long-lived lava lake, and that centralizes into a shallow magma chamber around 1 km below

the summit that sustains the remarkable open magma-filled conduit of this volcano. Chaput expects to complete his Ph.D. in 2011, after which he intends to continue to pursue research opportunities for innovative seismic imaging on volcanoes and elsewhere.

Jake Ross, PhD Student in Geochemistry



Jake Ross looking at one of the new Argon mass spectrometers and the sample extractions line he helped design and build.

I started working at the New Mexico Geochronology Research Laboratory (NMGRL) at NMT in 2006 with professors Bill McIntosh and Matt Heizler. For my MS, I dated volcanic samples from the historic Antarctic sediment drill-core, ANDRILL, with the goal of working towards the construction of a high-resolution age-depth model. In 2009, I started my PhD research with a major focus on NSF-funded laboratory upgrade as well as continuing my work on dating Antarctic volcanic samples.

During the 2007-2008 austral field season, I traveled with a group of scientists from NMT, Albion, and Bowling Green, to spend five weeks at a remote field camp on the Ross Ice Shelf, Antarctica. Located 45 km to the south of the ANDRILL drill site, our target was Minna Bluff, a 70 km long volcanic peninsula. We were there to investigate the construction

evolution of Minna Bluff using the Ar-Ar technique, looking for past interactions with the Ross Ice Shelf and determine the possible effects of Minna Bluff on material deposited at the ANDRILL drill site.

In 2008, the NMGRL received funding for two state-of-the-art multi-collector noble gas mass spectrometers. The new instruments have been the centerpieces of a major laboratory software and hardware upgrade. The mass spectrometers have high sensitivity and low backgrounds, characteristics that allow us to analyze smaller and/or younger samples with greater precision and accuracy than previously possible. The new mass spectrometers were accompanied by three new laser systems: a CO₂ laser, an 810 nm diode laser, and UV laser. These additions to the lab have greatly enhanced NMGRL's analytical capabilities.

For most of my Ph.D. research, I have been working on integrating the new laboratory components. This task has been a large, multi-faceted, multi-disciplinary endeavor that has given me experience in fields ranging from computer programming and electrical engineering to theories on the propagation of energy by radiation. The main elements of my work have been the design and fabrication of an automated all-metal argon gas extraction line, development of a comprehensive laboratory software package called Pychron, extensive research and development on the diode and CO₂ lasers and integration of the mass spectrometer hardware software with our existing platform. My work on inter-process communication gave me the opportunity this spring to travel to the Thermo Scientific factory in Bremen, Germany to talk with their engineers and other noble gas mass spectrometer users.

My work has greatly increased NMGRL's ability to perform high quality automate Ar-Ar analyses. With the new analytical tools at NMGRL, we are hoping to answer some of the fundamental questions related to Ar-Ar geochronology and thermochronology, such as what are the causes of inter-laboratory dispersion in the age of dating standards and what are the intrinsic controls of noble gas diffusion in geologic samples.

Society of Economic Geologists Student Chapter

By Maureen Roth-Moore, MS Student

The Society of Economic Geologists (SEG) New Mexico Tech student chapter was originally established in 1992 and has been a very active Chapter since. Our mission is to promote interest and understanding of ore deposits and minerals exploration among the student community at New Mexico Tech.

We accomplish our mission by hosting and organizing academic and industry professional lecturers, workshops, round table discussions, and mine, and exploration site visits; we also organize field courses twice a year, including international courses. In the past year, we have had a number of industry professionals deliver round-table and technical discussions to our Student Chapter. **Eric Lipten**, Chief Mine and Development Geologist of Newmont Mining, has addressed our chapter the last four semesters, discussing topics, such as: development of the world-class Antamina mine in Peru, Newmont's "Stage Gate" prospect evaluation process, and the auditing of mine reserves and resource modeling. Karl Marlowe, Chief Exploration Geologist of Barrick, discussed site case studies involving gold properties in northern Nevada, offering students insight into how new thinking can generate new mineral resources.

Chris Hogan, a Mine Geologist from the Doe Run Company, discussed Viburnum Trend geology with emphasis on the regional structural setting and controls of carbonate-hosted Pb-Zn-Cu mineralization

We work hard to get our SEG Student Chapter students in the field as much as possible to expose the students to a variety of ore systems and exploration techniques. While in the field we examine and identify what defines the geology, structure, and geochemistry of different ore systems, and we perform mapping projects to improve our field observations. With the financial support of our advisors, student associations, and the Society of Economic Geologists, students from our chapter have been able to visit regional and international world-class ore systems. In the past year, we were able to visit the Pb-Zn mines of the Viburnum Trend (Missouri), the Tyrone porphyry copper system, the Tintic District, and Bingham Canyon Cu-Mo-Au porphyry systems in Utah, and copper-uranium deposits in southern Utah. In early 2012, we are organizing two field courses: one to visit the epithermal and porphyry systems of northern Chile and a series of visits to ore deposits of the southern

Colorado Plateau. We are also organizing a visit to the Questa molybdenum mine in northern New Mexico late next spring.

Our chapter consists of undergraduate and graduate students currently studying economic geology, mining engineering, or general geology. Students in our chapter come from a variety of backgrounds, providing different approaches and viewpoints in our overall mission as a club. In the last several years, the chapter has been coordinating with other SEG student chapters on field courses, which allows us to begin to build our professional network. The significant contributions of past alumni, coupled with the ambition of the current SEG student chapter membership, continue to contribute to the development of exploration and mining geologists, and to provide opportunities for undergraduate and graduate students to meet professionals and to gain work experience in their chosen field.

The SEG Student Chapter advisor (M.E. professor **W. X. Chavez**) is a Tech alumnus (Geology, '76, Mine Engineering, '77). And the chapter is supported by a network of Tech alums who contribute to the chapter through financial donations, work opportunities, and guest lectures.



Earth Science 202 students examining Ancestral Rio Grande deposits, October 2011.



EES is now on Facebook. Please note that the Department now has a lively Facebook presence (simply search for “Department of Earth and Environmental Science, New Mexico Tech”) where you can keep abreast of activities without waiting for the annual **TECHTONICS** newsletter. If you are a Facebook user, please consider friending our page!

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