GEOSCIENCE NEWS

for the Alumni and Friends of the
Department of Geological Sciences
University of Michigan, Ann Arbor, Michigan

Spring 2004

Landforms of the Conterminous United States: A Digital Shaded Relief Portrayal, by Gail P. Thelin and **Richard J. Pike (PhD '68)**, *USGS, 1991. See article on page 3 for the history of this geo-cartographic classic.*

In This Issue:

Greetings from the Chair

Dear Geoscience Alumni,

Another academic year is winding down and I am facing the realities of next year's budget situation. As I compare our situation to that of other departments on this campus and around the country I am prompted to send out a heartfelt thanks to all of those who contributed to the department over the past few years (see pages 16-17). Thank you for your generosity and for adding so substantially to the experiences that we can offer our students. As I am sure you are all aware, the budget of the State of Michigan has been hit very hard by the economic downturn of the past few years, and state appropriations to higher education have not been spared from reductions. For the third year in a row, belt tightening will be passed down to the academic departments.

So what does this mean for the Department of Geological Sciences? First, be assured that at both the department and university levels academic quality and scholarship remain the top priorities. Geological Sciences has worked successfully to maintain the outstanding opportunities that we offer, and insulate our students and faculty from state budget reductions. We recognize that it has taken many years to build a world-class department, and that it would be far more difficult to rebuild programs than to maintain them. The key to our very fortunate situation is the incredible support that we have received over the years from our alumni. Unlike many other geology departments nationwide, we receive generous contributions from alums targeted at the activities that are most important to our students. During economic downturns, we become increasingly reliant on these gift funds, which help us maintain the quality and stability of our program.

One of the areas where gifts are most important is providing field experiences for our students. Field excursions and field camp provide tremendous learning opportunities for all of our students, as well as a chance to bond as a community of students and faculty. Because of your gifts, this part of our program has actually grown during the last two years. For example, this spring we have over sixty students participating in fieldtrips to the Colorado Plateau/Grand Canyon, the southern Appalachians, and the Spanish Pyrenees. We have also improved the Camp Davis facility and expanded our course offerings there. And here in Ann Arbor, with your gifts we have been able to continue our outstanding visiting lecture series with leading speakers from around the world. The numbers of research fellows and graduate students have also increased over the levels of recent years. There is a great deal of optimism in the department and we feel we are improving our already highly rated program. This year in particular, with alumni contributions being such an important part of our funding, we wish to acknowledge the support of our alumni, and thank all of you for helping us maintain and enhance a program that served you well in the past, and that will move forward to serve the next generation of students and future leaders in the geological sciences.

Best Wishes from the Chair,

Joel D Blum

Joel Blum

Weaving Tapestries of Time and Terrain

by Richard J. Pike (PhD '68)

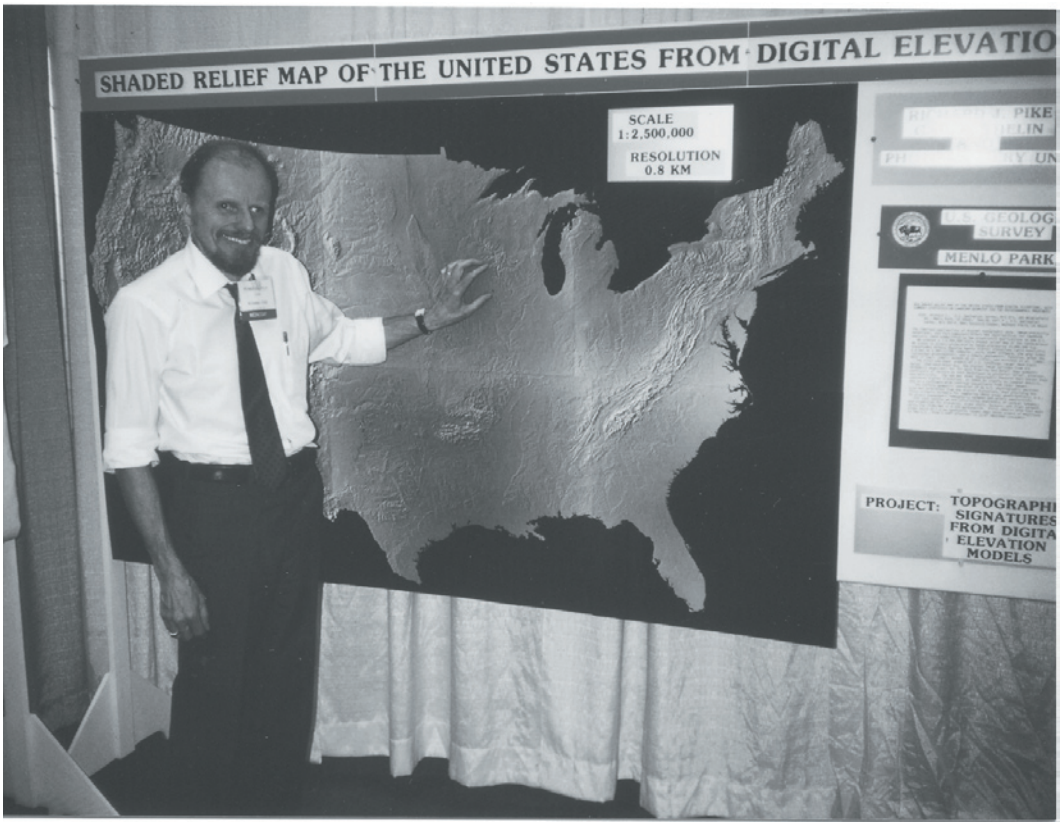
Joe Vigil, David Howell and **Dick Pike (PhD '68)**, *exhibiting Tapestry of Time and Terrain, the USGS map of the conterminous USA on which shaded relief is superimposed on the bedrock geology. The exhibit was part of the USGS 2000 Open House in Menlo Park, California.*

A new U.S. Geological Survey (USGS) digital map, the Tapestry of Time and Terrain, uniquely combines prior geologic and shaded-relief maps of the conterminous USA. Its recent cousin, the North America Tapestry of Time and Terrain, includes the entire continent. These colorful graphics have a 30-year pedigree that goes back to the first of two large-format maps that came out of the Geologic Division in the Survey's Menlo Park, California office. I have had the good fortune to be part of the team that created these "cartographic masterpieces," as they have been called by a prominent professor of geography.

The 1974 King-Beikman 1:2,500,000-scale geologic map of the lower 48 states was a planned replacement for the aging 1933 U.S. geologic map. The new effort took shape over many months through the early 1970s as Helen Beikman, in the office across the hall from me in Building 2, and Phil King painstakingly compiled the geology from scores of larger-scale maps and subsequently authored the four USGS Professional Papers that comprise the explanation.

By the mid-1980s, USGS Mapping Division colleagues and I had begun experiments in topographic analysis, exploiting newly available digital elevation models (DEMs) and digital image-processing software. Culminating this venture was the 1991 1:3,500,000-scale shaded-relief map of the contiguous 48 states, immediately dubbed an "instant classic" by graphics guru Edward Tufte. This map was born over a 1987 holiday dinner where my colleague Gail Thelin discussed terrain data with a fellow image-processing scientist in southern California. His company had a 12 million-point DEM of the 48 states (compiled from USGS topographic maps) left over from site studies for an anti-ballistic missile system, and he made this dataset available to us.

Based on a mid-1960s breakthrough by an Israeli cartographer, Gail computed shaded-relief for the western half of the US from the DEM. The big 1:2,500,000-scale sheet revealed the topography in stunning detail. Mightily encouraged, we rendered the eastern half. The enthusiasm of boots-and-hammer geologists for the pasted-together plots on the wall outside my office convinced me I simply had to see the entire lower 48 as a formal USGS product. The preliminary version was a hit at the 1988 Centennial GSA meeting and, after much experimentation and with help from cartographic experts in and outside USGS, "the big black map" emerged, an unfunded, bootlegged triumph of creative anarchy at 1: 3,5000,000 scale (http://tapestry.usgs.gov/two/relief.html). It rapidly sold out. Reprinted three times, it remains the all-time best-selling USGS map; thousands hang in venues ranging from elementary school classrooms to company boardrooms.



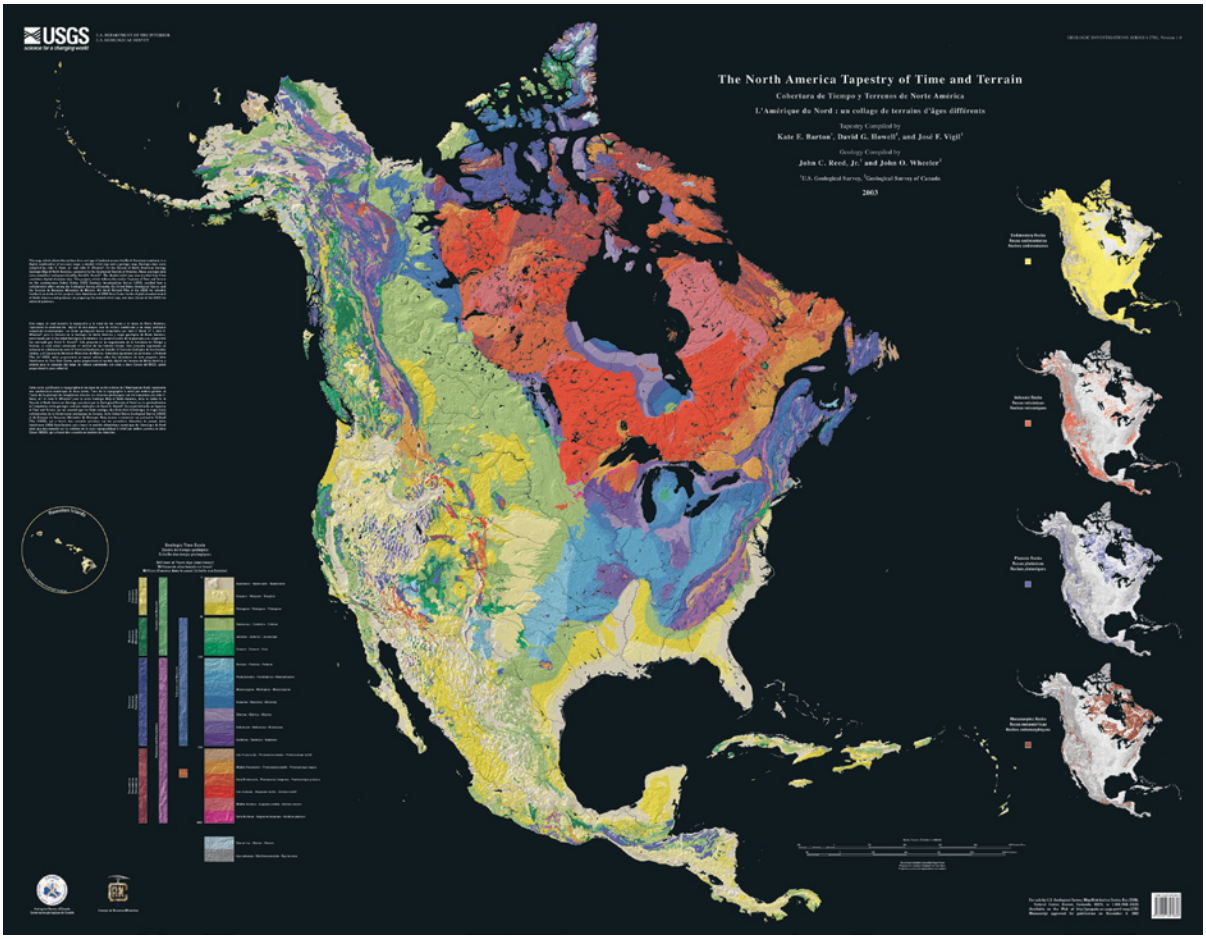
Dick Pike (PhD '68) *displaying the prototype shaded relief map of the conterminous USA at the GSA Centennial Meeting in Denver in 1988. Dick is pointing to La Crosse, Wisconsin, his wife Linda's hometown.*

Fast forward to 1995-97, when the Survey's new U.S. geologic map was recast as a digital dataset (http://minerals.usgs.gov/kb/), thus setting the stage for the next advance. As something of a lark, Joe Vigil, a multimedia/ motion graphics specialist for the USGS Western Publication Group at Menlo Park, combined digital representations of the two US maps, shaded-relief and geology, into a single image.

Urged on by my team, Joe subsequently re-ran his experiment in cartographic matrimony, but plotted the resulting file as a colored paper map. At a scale of 1:3.5M, that of the shaded-relief map, it was another spectacular map, but this time a riot of color. Melding the two, quite disparate, data sets–one vector, the other raster–taxed much of Joe's software expertise, and while Joe continually tweaked the image, David Howell and I experimented with getting the colors "just right." When at last I unrolled a near-final plot before my wife, Linda gasped, "Why, it's a tapestry!" To which I blurted reactively "… of time and terrain!"– and the new baby had a name. This time the map was supported by the Survey and printed lavishly (http://geopubs.wr.usgs.gov/i-map/i2720/). The Tapestry placed second in a Government-wide Communicators Award competition in 2000.

The paper map was a hot item at the Menlo Park 2000 open house, where Joe, David, and I signed over two hundred copies, but its broadest exposure would come from yet another advanced technology. Two of our temporary interns designed and assembled a Web site for the Tapestry (http://tapestry.usgs.gov/Default.html). The site features both source maps, a separate page for each of the 48 states and the four dozen locations for which I had written

geologic descriptions, a regional on-line jigsaw puzzle, and more. In 2000, the site won the USGS Eugene Shoemaker Communications Award and has since logged millions of visits. The Tapestry's most recent incarnation, a 550-piece jigsaw puzzle, was created along the lines of a similar puzzle of Yosemite National Park.



The North American Tapestry of Time and Terrain, by Kate E. Barton, David G. Howell, Jose F. Vigil, John C. Reid, Jr., and John O. Wheeler, USGS, 2003.

Spurred by the map's growing attention, David Howell, ever open to fresh opportunities and by 2002 supported by the Survey's National Atlas project, brokered a cooperative venture among the USGS, the Canadian Geological Survey, and the Mexican Consejo Recursos de Minerales. The resulting map, primarily the work of yet a third former USGS intern, Kate Barton, with guidance from David, me, and by then a seriously-ill Joe Vigil, is the 1:8,000,000-scale North America Tapestry of Time and Terrain released in 2003 (http://geopubs.wr.usgs.gov/i-map/i2781/). The 54" x 44" map particularly excels in portraying the Precambrian geology of the Canadian Shield–its subtly contrasting hues the outcome of many Barton-Pike deliberations.

While the colorful Tapestries indeed catch the eye, my aesthetic favorite will always be the gray-shaded relief map–its lustrous appearance unmatched by that of any other relief graphic. Each of the three maps, the first two including an explanatory pamphlet, is available for purchase from USGS's Earth Science Information Center (ESIC, 1-888-ASK-USGS, or www.usgs.gov).

Honors, Awards, Kudos

Presentation of the 2004 Geological Sciences Student Awards highlighted the annual John A. Dorr Memorial Dinner and Lecture. This year's winners… (dramatic opening of envelope):

Chris Palenik: John Dorr Graduate Academic Achievement Award

Holli Frey and **Zeb Page**: Outstanding Graduate Student Instructor Award

Lora Armstrong and **Emily O'Donnell**: Undergraduate Academic Excellence Award

Erin DiMaggio: Camp Davis Field Geologist Award

The Winners! (left to right) Emily O'Donnell, Zeb Page, Lora Armstrong, Chris Palenik, Erin DiMaggio, Holli Frey

Frannie Skomurski has been awarded an Oak Ridge Civilian Radioactive Waste Management Graduate Fellowship.

Michela Arnaboldi has won a Rackham Predoctoral Fellowship.

Abdulkader Afifi (PhD '90) has been selected as an AAPG distinguished lecturer for 2004.

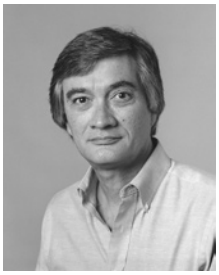
Ruth Blake (PhD '98) has been a Joint Oceanographic Institutes/United States Science Advisory Committee Distinguished Lecturer during the academic year 2003-04.

Ruth Blake

Kacey Lohmann

Kacey Lohmann (Faculty) will be an Ocean Drilling Program Distinguished Lecturer in 2004-05.

Rod Ewing (Faculty) has been named a 2004-05 Distinguished Lecturer by the Mineralogical Society of America.



Rod Ewing

Becky Lange (Faculty) received an LSA Excellence in Education award.

Carolina Lithgow-Bertelloni (Faculty) received a Crosby Research Award from the National Science Foundation ADVANCE program at the University of Michigan.

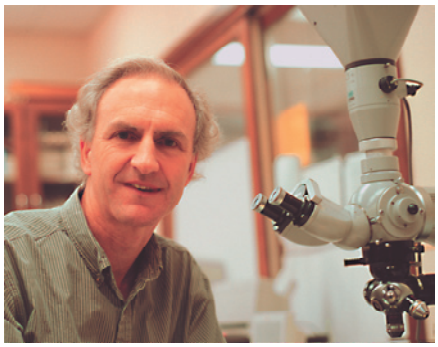
Jim O'Neil

Jim O'Neil (faculty, '88 – '98) has been named the 2004 winner of the Geochemical Society's V. M. Goldschmidt Medal, the highest honor bestowed by the society. The Goldschmidt Award honors major achievements in geochemistry or cosmochemistry, either through a single outstanding contribution, or a series of publications that have had great influence on the field. The 2004 award is in recognition of Jim's long and enduring contributions in applying isotopic and other geochemical clues to deciphering a wide range of enigmatic problems in earth processes and earth history. Jim will be remembered in the department as a warm and caring mentor of numerous undergraduate and graduate students. The Geochemical Society previously honored Jim by including him in the very first group of Geochemical Fellows in 1998. Previous winners of the Goldschmidt Medal include **Robert Garrels (BS '37, MS '39)** in 1973, and **Robert Berner (BS '57, MS '59)** in 1995.

Robert M. Owen, Professor of Oceanography and Associate Dean for Undergraduate Education in LSA, has been designated a Thurnau Professor in the College. The Thurnau Professorships recognize and reward University of Michigan faculty for outstanding contributions to undergraduate education. These awards, named after Arthur F. Thurnau, a U-M student in 1902-04, are supported by the Thurnau Charitable Trust established through his will. The University each year selects faculty members who are designated Thurnau Professors for a three-year term. Each receives a $20,000 grant to support their teaching activities.

Robert Owen (Photo by Bill Wood, U-M Photo Services)

In recognition of his undergraduate teaching, Bob has won the Amoco Foundation Outstanding Teaching Award and is a four-time winner of the LSA Excellence in Education Award. Many students name his geological field course in Jackson, Wyoming, as a highlight of their U-M careers.



John Valley

John Valley (**PhD '80**), Professor of Geology at the University of Wisconsin, received the 2003 N. L. Bowen Award from the American Geophysical Union. **Eric Essene** (the 1991 Bowen Award winner) and **Jim O'Neil** were the citationists at the awards ceremony in San Francisco this past December. Jim and Eric nominated John in recognition of his recent works on zircons from early Archean rocks of northwest Australia. Those studies provide documentation of previously missing Earth history, with evidence for an early ocean and a relatively cool history during the Hadean Eon. John has also published a major review on oxygen isotope variations of magmatic zircons preserved through geologic time, as a result of which he proclaims, "zircons are forever".

John's research interests are exceedingly broad, although most employ measurements of stable isotopes in materials involved in diverse earth and planetary processes. In the last five years he has authored or co-authored papers on the early Archean history of the Earth, Martian meteorites and their association with possible life forms, sedimentary basin flow regimes, geochemistry of ocean island and continental volcanic rocks, mammalian paleodiets, characterization of biogenic magnetite, authigenic and diagenetic minerals. His work continues to draw a great deal of attention both here and abroad.

Alumni News

Bob Dott (PhD '55), Professor emeritus at the University of Wisconsin in Madison, has just written and published the *Roadside Geology of Wisconsin*, as part of the growing state-by-state Roadside Geology series. [Editor's note: **Darwin Spearing (PhD '69)** has also contributed to this series, authoring *Roadside Geology of Wyoming*, and *Roadside Geology of Texas*].

Gordon Wood (MS '73) writes from Katy, Texas that "I am continuing as a consultant for ExxonMobil Production, Central Technologies Organization Upstream in West Africa. I'm presently a technical communications coordinator, with duties that include writing and editing reservoir characterization, reservoir simulation and engineering history match studies, and asset depletion plans." Gordon and wife Cathy have three children.

Steve Henry (BS '73, MS '78, PhD '81) writes from Houston with a fast synopsis of his family: "Older daughter Klarysa is a student at Wake Forest, younger daughter Natalia (almost 18) has been busy with Special Olympics ice skating and swimming competitions in Texas and Alabama, son Nikolas now has a driver's license (gulp) and plays on his high school baseball and football teams, wife **Krys (MS '78, PhD '80)** continues to supervise ConocoPhillips activities in Russia (mostly from Houston, but frequently in Russia)." Steve completed his long geological consultancy with the Government of Chad, but is assisting the Ministry of Petroleum in developing their technical skills. He is also working on a project in Angola with Sonangol, the state oil company. Steve also taught a graduate course in seismic interpretation at Texas A&M.

Mark Taylor (MS '82) writes, "I was recently elected vice president and COO of Fletcher Group, Inc., a group of environmental science and engineering companies based in Greenville, South Carolina. Our primary business is consulting services to industry, municipalities and government entities. My consulting practice covers groundwater, solid and hazardous waste management, wastewater treatment, and environmental management systems. We are also working with several clients, including BMW Manufacturing Corp., on their sustainability initiatives. Our other businesses include a contract waste treatment facility, site redevelopment projects, and product distribution."

"My volunteer activities include church (high school teacher, youth leader), the American Red Cross (currently chair of the South Carolina State Service Council), Upstate Forever (non-profit dedicated to sensible growth), and Rotary. Starla and I no longer have children at home. Eric graduated from Clemson last year, and Ashley is a freshman at Wake Forest. However, we've found that empty nest does not equate to empty calendar."

Ahmet Derman (MS '84) writes "Hello to everyone in the department! I have been working for the same company (Turkish Petroleum) since I came back to Turkey. I completed my PhD and am working toward academia. I am trying to get a position from one of the universities in Turkey. Currently I am working on submarine fan systems (especially in tectonically active basin margins), sequence stratigraphy on carbonates in the Mut Basin in southern Turkey (especially in the eastern Mediterranean Miocene Basin). One of my daughters got married, my son has become a geologist and is working for the same company, my little girl is in 10th grade. That is all for now. Hoping to visit you people one day in Ann Arbor."

Bryan Stepanek (MS '84) has been working with BP since leaving U-M in 1984. He is currently in Cairo, Egypt in a Gulf of Suez petroleum joint venture. Previously, he worked for BP in Durango (Colorado), Aberdeen (Scotland), Abu Dhabi (UAE), Anchorage, and San Francisco. Bryan has been married to Rebecca for fifteen years and they have three children in a British International School. In his spare time, Bryan is learning Russian. The whole family has been enjoying many travel opportunities (Russia, Turkey, Jordan, Malta, Sicily, Austria, Egypt) while being posted in Egypt.

Abdulkader Afifi (PhD '90) was selected as an AAPG distinguished lecturer for 2004. He will be touring the Middle East in April-May and North America during the fall. Afifi works for Saudi Aramco as Manager of the Exploration Technical Services Department.

Antonio Arribas, Jr. (PhD '92) was in Ann Arbor in April with his family for a tour of town (hopefully including the ice rink where he distinguished himself as goalie for the Department team) and lunch with Bill Kelly. Antonio lives in Reno, Nevada and is currently in charge of Latin American Exploration for Placer-Dome Gold.

Albert (Der-Chuen) Lee (PhD '94) writes happily from Taiwan that **"**Judy and I got married on New Year's Eve of 2003 in Los Angeles. However, since our families are so widespread, we then went to Vancouver for another banquet after the LA wedding. We just got back from Vancouver two days ago, and are preparing for the final details for another banquet here in Taipei. We're both exhausted, but the "show" must go on! We wish all the best for you in 2004."

Andy Mughannam (MS '94) writes "I have been teaching in California and Colorado since I left Michigan. For the past five years, I've been teaching science and literature (my new love) to 7th and 8th graders and loving it. I felt a change in the air last year, and so this year I began as an assistant principal at the same school. I'm not so sure about administration. It's quite the nutty experience. I miss the kids and feel I may be amongst them again soon. I don't do much geology anymore, but being in Arvada, Colorado, I lie on the rocks quite a lot and wonder. I'm still working on being a rock star though...."

Emily Bertolini (BS '99) works as a hydrogeologist at MWH Americas in Novi, Michigan. She writes that the company has an open position for a geoscientist, preferably with an MS, but they will consider a strong candidate with an undergraduate degree.

Libby Prueher (PhD '99) reports that she is working in the Geochronology Group at the USGS in Denver, Colorado.

John Hoaglund (Lecturer '98 -'99) is currently at Penn State as a research hydrologist. He has been funded by the U.S. Department of Agriculture to apply geophysical techniques to ground water investigations. John frequently crosses paths with **Andy Nyblade (PhD '91)**, a professor in the Department of Geosciences at PSU.

Katherine Griffin (MS '02) is now located in Golden, Colorado. She spent a semester teaching

geology to American high school sophomores at a study abroad program in Zermatt, Switzerland. She writes, "it was a wonderful program for both the faculty and students. I gave four one-hour geology lectures every day and led daily hikes, rock climbing and yes ... a five-hour geology lab every week! Weekends brought exciting trips including bike tours, mountain climbs, hut trips and travels through France and Italy." The program hires two geology teachers every year, and requires only an undergraduate degree in geology ... in addition to strong leadership skills, a desire to teach, and a love of the outdoors. Anyone interested should definitely look into it! More information can be found on the website at <www.swisssemester.org> or contact Kate at <kate_griffin@ekno.com>

Kate Kenedi (MS '03) is proud to announce the arrival of Peter Augustus Lewis Kenedi on January 7, 2004 in Durham, North Carolina. Both Kate and baby are doing well. In true motherly words, "the baby is perfect and beautiful!"

William Jones of Sterling Heights, Michigan took the big step of getting married on May 8, 2004.

Camp Davis Alumni Getaway August 11 - 15, 2004

The Department invites you to participate in the next *Camp Davis Alumni Getaway,* scheduled for August 11-15, 2004 (arrive the afternoon of 10th August and leave morning of 16th August). This event will be an opportunity for alumni and friends to visit the Camp Davis area, staying in the camp facility after the departure of the field camp students. The concept driving this adventure is a desire to share this spectacular resource with our alumni, faculty, and friends - to provide a venue where alumni can refresh their knowledge of the geologic features of western Wyoming, and continue to strengthen their ties within the U of M community.

For those of you who have not been to Camp Davis, it is located just south of Jackson Hole, allowing easy access to Yellowstone and Grand Teton National Parks. Camp Davis can serve as a base for your independent excursions around this region, or as a reunion where you can reacquaint yourself with old friends and the current U-M crew. Several sight-seeing and hiking activities have been organized to areas of the Teton and adjacent Gros Ventre Mountains, and local outfitters will provide float trips and wildlife excursions. U-M staff will be available to guide your activities and to provide stimulating evening lectures.

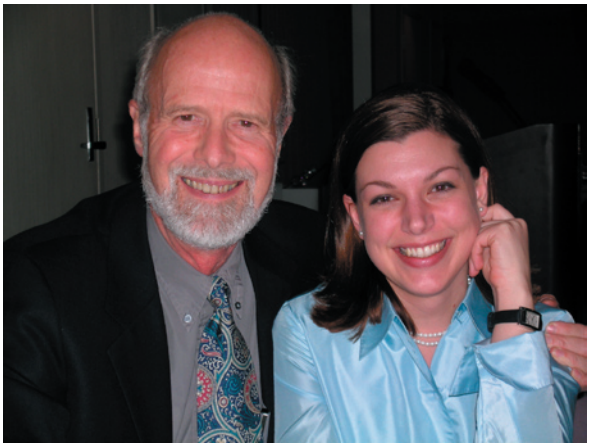
The accommodations at Camp are rustic and simple: a limited number of staff cabins are available and student cabins will be open for the adventurous. Additionally, areas for tents and RVs will be available in the camp. Our gourmet cooking crew will provide scrumptious breakfast and evening meals and assemble the makings for box lunches. We hope that you will join us this coming summer at *Camp Davis 2004* to share the beauty of this area and to rekindle your friendships around the evening campfires.

For additional information on dates, costs and activities, visit the Department's website at http://www.geo.lsa.umich.edu/ and follow the link to Alumni Getaway 2004.

Dorr Dinner, March 5, 2004

The 2004 J. A. Dorr Memorial Dinner was held on March 15, 2004 at the Campus Inn in Ann Arbor. The event was very well attended, and the evening was highlighted by the presentation of the following awards: the John Dorr Graduate Academic Achievement Award, the Outstanding Graduate Student Instructor Award, the Undergraduate Academic Excellence Award, and the Camp Davis Field Geologist Award. (see Honors on page 6)

Robin and Ruth Dorr



Phil Meyers and Courtney Saltz

Amelia Kesling and Mildred Koen

Clara Castro and Dave Rea

Josep Pares with new geologist

Lora Armstrong

Ed and Raye Poindexter

In Memoriam

Marion Escallon (BA '33) passed away in July 2003, in Elgin, Illinois.

Ray Burke Gripman (BA '43) passed away on April 2, 2003 in Issaquah, Washington.

Donald Clements (AB '49, MA '50, MS '52) passed away recently in Senatobia, Mississippi. Don had studied seismology with Professor James T. Wilson, and in 1952 wrote an MS thesis on the then-recent earthquake near Coldwater, Michigan. Don and J.T. Wilson continued to have professional interactions involving seismology for many years thereafter.

Lawrence A. Deimen (BS '51) passed away on June 23, 2003 in Blue Ridge, Georgia, after a long illness.

Mary Louise (Conant) Callas (BS '55) passed away on December 3, 2003. Geology was a natural for Mary Lou, since both of her parents were geologists! Mary Lou began her education at the University of Alabama in her hometown of Tuscaloosa, Alabama. She transferred to the University of Michigan after her sophomore year to complete her education. (The Geology Department at the U of A did not know how to accommodate a female in the long field trips that were part of the last two years curriculum!) After graduation she accepted a position at the U.S. Geological Survey in Washington DC as a geologist reviewing literature for mineral-deposit specialists, and she also served as a field assistant to a geologist in Connecticut. After a year in Washington she took a position at the new USGS office in Menlo Park, California, as a full time editor of reports by USGS authors for publication by USGS or outside journals. She also had the opportunity to serve as field assistant to geologists in Arizona and in Idaho.

In 1961 Mary Lou married George P. Callas and in 1962 took an extended leave of absence to raise a family of three children. In January of 1982, when the youngest child entered high school, Mary Lou resumed her work at the USGS until she retired in 1995. For her outstanding work at the USGS she received many commendations and was also honored as an author of some of the reports she edited.

Mary Lou was a loving mother and an equal partner! She loved to travel and fulfilled many of her travel dreams. She was an excellent skier, loved the mountains and the ocean. Her love of geology and devotion to this earth science is evident when you examine the hundreds of pictures she took during her travels and recreational trips to the mountains and ocean.

Wollastonite for an Acid-Ravaged Forest:

A Mineralogical Cure for Acid Reflux in a Forested Watershed

(Editors' note: This article describes a watershed-wide geochemical experiment to counter the effects of acid rain, conducted by Joel Blum, Chair of U-M's Department of Geological Sciences. The article, written by Nancy Ross-Flanigan, first appeared in the University News Service on March 8, 2004. It has been adapted from the original, with permission).

Heavy trucks and helicopters aren't the kind of equipment one usually associates with scientific experiments, but they played key roles in an ambitious project that's helping researchers assess the effects of acid rain on forests. Early results of the experiment, a joint project of the University of Michigan, Syracuse University and the Institute of Ecosystem Studies in Millbrook, NY, were presented at the fall meeting of the AGU and appear in the February/March issue of the journal Biogeochemistry.

Hubbard Brook Experimental Forest in the White Mountains of New Hampshire.

"We know that one of the effects of acid rain has been to reduce the amount of calcium that's available to plants in the forest, and a fundamental question is, how does that calcium loss affect the structure and function of forest and aquatic ecosystems?" said **U-M geochemist Joel Blum**. One way of finding out is to add back to the ecosystem the amount of calcium lost due to acid rain and watch what happens, and that's exactly what Blum and collaborators are doing with a 29-acre (11.8-hectare), wooded watershed at the Hubbard Brook Experimental Forest in northern New Hampshire, which scientists have been studying for more than 30 years. "If there's a single best place to do this experiment, it's at Hubbard Brook, where we think we understand the biogeochemical system better than anywhere else," said Blum.

Simple as the idea sounds, the actual experiment has presented a host of challenges, both scientific and logistical. First, the scientists had to figure out what form of calcium to use. "Most geological materials dissolve so slowly that in our lifetimes we wouldn't get enough calcium becoming available to plants to study it," said Blum. Lime (calcium carbonate) dissolves quickly, but researchers ruled it out because it changes soil pH — a measure of acidity — too much, making it difficult to separate the effects of added calcium from the effects of changing pH. Another mineral, plagioclase (a calcium-aluminum silicate), was rejected because its aluminum content would introduce another variable that might muddy up interpretation of experimental results. Finally, the research team settled on wollastonite, a brilliant white calcium silicate that's used in the ceramics industry to make dishes and decorative pottery whiter.

A mine in upstate New York supplied a customized batch of extremely pure, finely powdered wollastonite, but the researchers couldn't just go strewing it around the forest. "If we sprinkled it out of a helicopter, it would be taken by the wind and spread over a wide area, instead of being focused right on the watershed," said Blum. Not only could that dilute the effects of the experiment, it could cause problems because the experimental watershed is close to a pristine watershed that researchers have been studying for decades and use as a reference for assessing changes in other watersheds. "It's the sacred watershed of all watersheds, and we had to be very careful not to compromise it, because the chemical record for it is the longest continuous record in the world," Blum said.

Bags of pelletized wollastonite awaiting loading.

The solution was to have the wollastonite powder made into pellets using a water-soluble binder, but finding someone to do that was another hurdle. The researchers approached numerous companies that make pelleted products such as fertilizer and rabbit chow, but no one wanted to chance ruining their equipment by running the mineral through their mills. "Finally, we found a guy in a small town in the middle of Illinois who had a small, custom fertilizer factory," said Blum. "We had to pay to modify his little plant to be able to run this material through it." But first, the wollastonite — three tractor-trailer truckloads of it — had to be transported from New York to Illinois. Then the pellets had to be shipped back from Illinois to New Hampshire. "The logistics were unbelievable," said Blum. "I learned a lot about trains and trucks and helicopters."

Pelletized wollastonite being loaded into a hopper.

Finally, with the help of a helicopter pilot who specializes in precisely applying pesticides to cranberry bogs and blueberry fields using a global positioning system to insure accuracy, the scientists applied about 55 tons of wollastonite to the watershed. Now, they're carefully monitoring the effects by following the movement of calcium through the ecosystem, and that's where several other unique features of wollastonite come in handy. The mineral contains strontium, an element that behaves much like calcium in living systems, but has built-in properties that allow the wollastonite calcium to be distinguished from other calcium in the watershed. Both the calcium-to-strontium ratio in wollastonite and the ratio of the various isotopes of strontium in the wollastonite are very different from those of the minerals that release calcium into the watershed under natural conditions, and thus different from what was already in the watershed before the experiment began. As a result, researchers can use the calcium-to-strontium ratio and the strontium isotope ratio to trace the fate of the artificially applied calcium.

"We can follow tiny little amounts with high accuracy as they move through the system and cycle through different pathways, and we can test all sorts of hypotheses related to calcium — the path it takes through the system, the rates at which it moves through different soil layers and through groundwater, the rates at which it's taken up by different types of trees and how different trees vary in their ability to take up calcium," said Blum. "It opens up a million projects, and I have at least a half dozen students and collaborators from different areas of ecology and geology who are working with us on various aspects of the experiment."

The report published in the journal Biogeochemistry (lead author **Steve Peters, PhD '01**) documents how the tracer returned the stream water pH to pre-acid rain values, follows the processes by which the wollastonite dissolved and traces the storage of the applied calcium in the stream channel. Reports presented at the fall AGU by grad students **Amanda Ash** and **Carmen Nezat** document the uptake of calcium from the wollastonite by various species of trees, and the effect that trees have on the weathering of native minerals in the soils. Though most of the ecological results are still preliminary, they're very promising, said Blum. "We're already seeing biological responses — certain species of trees that were previously declining are coming back in large numbers, and we're seeing that different species of trees have differing abilities to access the calcium and take it up into their foliage."

Liftoff of chopper with loaded hopper, heading out for forest fertilization.

The point of the research is not necessarily to come up with fixes that will reverse the effects of acid rain—though foresters have inquired about the feasibility of dropping loads of wollastonite on other woodlands. "The idea is to improve our understanding of how the system works so that we can make better predictions about what the road to recovery will be like — how long it will take under various scenarios for pollution emissions, for example," said Blum. "Each piece of the puzzle enhances that understanding."

Ted Moore Retires!

Ted Moore will officially retire from his professorial post in the Department at the end of June, 2004. He joined the U-M faculty in 1989, where for 10 years he served as Director of the Center for Great Lakes and Aquatic Sciences, and for 15 years as Professor of Geology and Oceanography.

Ted started out in geology at the University of North Carolina where he earned his BS in 1960. Following a three-year stint in the U.S. Navy, he headed cross-country for graduate studies at Scripps, getting his feet wet in oceanography and leaving as a newly-minted PhD in 1968. The next stop in his distinguished career was an academic position at Oregon State. He joined a small group of oceanographers and climatologists across the country to conceive and initiate the CLIMAP Project, an ambitious undertaking to reconstruct global climatic patterns in the Pleistocene, and in so doing to lay the foundations of modern paleoceanography. Ted helped guide CLIMAP from a position on its Executive Committee, and then as its Director. CLIMAP evolved into CENOP (Cenozoic Oceanography Program) with Ted as one of its leading lights; later he served as its Director for four years.

In 1975 Ted moved to the Graduate School of Oceanography at the University of Rhode Island, and in 1981 to Exxon Production Research Company in Houston, where he initiated a program of stratigraphic research and resource evaluation. During his seven years at EPRCo he became an expert in seismic stratigraphy, and contributed to our understanding of sea-level history. He also taught seismic interpretation courses to geologists from various countries in which Exxon had exploration interests.

At Michigan Ted began a completely new undertaking, a project to decipher the details of the paleoclimatic record preserved in the Great Lakes, using his expertise in high-resolution seismic reflection profiling and paleoceanography. A decade of work by Ted, Dave Rea, their students here at Michigan, and colleagues in the Geological Survey of Canada, revealed that the Great Lakes are a remarkably complex natural system. That project demonstrated that there have been several episodes of lakes draining and refilling, at two or three different times in their history.

Throughout his career Ted has taught oceanography and climate change to myriad undergraduates, and mentored several generations of graduate students. A parallel endeavor has been his more than three-decade affiliation with the Ocean Drilling Program, an international scientific ocean research program sponsored by the National Science Foundation and the governments of more than 20 countries. Not only has he participated on several ODP research cruises, he has also been a member of many advisory committees to ODP. Most recently, he served as the Chair of the ODP Committee charged with mapping scientific ocean drilling for the next decade.

Ted hastens to let everyone know that retirement does not mean that, like an old soldier, he will just fade away. He intends to remain active in the Department, conducting research on radiolaria and guiding yet another generation of graduate students. Lucky students!

We gratefully acknowledge contributions from the following alums and friends of the Department over the past three years

Individual Contributors

Margaret and Lawrence Allard
John and Camille Amoruso
J.R. Baily
Giulio Baldrighi
Susan Barkeley
Frank M. Barnes
Gordon and Judith Barnes
Jack Barnes
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Howard F. Bartlett
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William Beauclair
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New Earth Systems Science Undergraduate Program

by David Rea

In the late fall of 2001, the department filed its most recent Long-Term Plan with the College of LSA. That plan called for increased focus on Earth surface processes, and the geologic record of those processes; a focus that encompasses teaching, research and faculty development. The educational part of this effort called for the creation of a new undergraduate concentration, in Earth Systems Science.

Earth Systems Science (several systems, one science) is a term coined initially, I think, by NASA in the mid to late 1980s. It refers to the fact that the several natural systems that control climate and life cannot be fully understood when approached one by one, but only by considering them all together. Such systems include the oceans, atmosphere, biosphere, cryosphere, and lithosphere. A good ESS program requires a full integration of all these aspects, and as such is broader in scope than some of our existing undergraduate concentrations.

The department already offers four concentrations to about 40 majors in Geological Sciences, Environmental Geosciences, Oceanography, and Earth Science. In offering these multiple concentrations, we hope to attract undergraduate majors and offer them the flexibility to study those aspects of the Geosciences that interest them. About half of the universities with undergraduate geology programs have a similar range of options for study.

After hiring four new faculty members that can fit under the Earth Systems umbrella, the department this past year began to focus on the development of an undergraduate program. Some of the impetus for this came from outside the department. The new chair in the Atmospheric, Oceanic and Space Science (AOSS) Department of the College of Engineering (CoE) and the Dean of Engineering both became interested in the engineering side of such an undergraduate program. In the fall of 2003, Geological Sciences Chair, Joel Blum, appointed an ad-hoc committee to formulate an undergraduate program in Earth Systems Science, and asked Henry Pollack, Chris Poulsen, and Dave Rea to take on this effort. The AOSS department appointed a similar 3-person committee.

The two committees met jointly every other week during the fall semester. Initially there was a strong interest in creating a truly joint undergraduate effort, but we found that it was not possible for a student to complete all the requirements of both LSA and CoE without at least six years of study. As an aside we also learned why there are no truly joint programs between the two colleges. When this understanding dawned over the two departmental committees, we concentrated on creating two undergraduate programs, one in AOSS and one in Geological Sciences. The programs have three core courses in common, on the topic of Earth Systems Evolution (formation and evolution of both the solid and fluid Earth), Earth Systems Dynamics (dynamics of atmospheres, oceans and climate), and a course on Modeling of Earth Systems. The programs are considered parallel programs, rather than joint programs.

As of this writing, the college curriculum committees of both LSA and CoE have approved the programs. The last hurdle is to get approval from the Presidents Council, where the presidents, or their representatives, of all the four-year universities in the state gather to approve new programs. The intent of such an approval process is to avoid duplication and is usually, but not always, a rubber stamp. Our hope is that this approval will be granted at the summer meeting of the Presidents Council and that we can begin to sign up concentrators beginning this fall. We have already had inquiries from interested students.

Paleocene-Eocene Epoch Boundary: Closure on a Century of Disagreement

by Philip D. Gingerich

Those of us who study earth history of the early Cenozoic have been divided for more than a century. In the early days, paleobotanists and vertebrate paleontologists recognized a Paleocene epoch separate from the preceding Late Cretaceous and following Eocene, and marine paleontologists generally did not. In more recent times, the Paleocene-Eocene boundary on land was more or less a million years older than the boundary in the sea. This was expressed in the empty million-year box so conspicuous on the 1995 Paleocene-Eocene time scale of William Berggren and others. I thought I would be teaching students forever to be careful because the Paleocene-Eocene boundaries of continental and marine geologists are different.

This all changed in 1991 and 1992 when James Kennett and Lowell Stott found evidence of a sharp spike in oxygen isotopes coincident with a similar spike in carbon isotopes at ODP site 690 in the South Atlantic. The associated warming was soon dubbed the Late Paleocene Thermal Maximum or LPTM. At the same time, U-M graduate student **Paul Koch (PhD '89)** was surveying carbon and oxygen isotopes in the continental Paleocene-Eocene record on Polecat Bench in northwestern Wyoming. Paul found a carbon isotope spike here too, but this one was right in the brief interval at the continental Paleocene-Eocene boundary where some mammals are mysteriously dwarfed and other modern mammals like horses characteristic of the Eocene first appear. I had just documented the unusual mammal changes here, **James Zachos (Post-doc, '91-'92)** helped make the connection to Kennett and Stott's discovery, and the marine and continental Paleocene-Eocene boundaries began, slowly, to snap together.

Professor **Philip Gingerich** *pointing to the centimeter-scale condensed interval marking the beginning of the Paleocene-Eocene carbon isotope event where the epoch boundary is defined at Dababiya in Egypt. Photo credit: Iyad Zalmout, 2004.*

The slow snap is chronicled in the progress of the IUGS International Commission on Stratigraphy's Paleogene working group 308 chaired by Marie-Pierre Aubry. This group was dominated by marine stratigraphers at first, who struggled to agree on a correlatable biotic event appropriate to signal a new epoch boundary. The working group was, in a sense, saved from itself as the carbon isotope excursion (CIE) of Kennett and Stott and of Koch et al. was found more widely and became recognized as a global event. I was added to the working group in 1999 and we agreed to place the Paleocene-Eocene boundary at the base of the CIE at a meeting in Paris in 2000. We met in Luxor in Egypt in 2002 to consider a marine stratotype section at Dababiya where Christian Dupuis had documented the CIE. Our proposal was ratified by the ICS in 2003, and Marie-Pierre Aubry and Khalid Ouda drove the 'golden spike' at Dababiya in February 2004 (see photo). I no longer have to teach that there are separate Paleocene-Eocene boundaries in marine and continental rocks. More importantly, this boundary and the accompanying chemical and biotic events on land and in the sea have become an important case study of a natural global greenhouse climate event and its consequences.

Faculty News

Dan Fisher is thankfully nearing the end of his wild-eyed undertaking to mold two complete mastodon skeletons in two years. His second small army of UROP (Undergraduate Research Opportunity Program) students and volunteers just went on furlough, with the end of the academic year, leaving little enough still to do that a reduced summer crew should be able to finish the second skeleton shortly. These ventures were initiated when it became clear that both of these remarkable skeletons faced uncertain futures, and would perhaps be unavailable for further analysis unless emergency measures were put in gear. With the successful completion of these molding projects, and production of research casts by a new cohort of UROP students next year, the Museum of Paleontology's reference collections will have virtually unparalleled resources in mastodon osteology. When not engaged in this pursuit, or any of his other more mundane obligations, Dan has been thrilled to begin work on a wonderful collection of mammoth tusk samples imported from northeastern Siberia with the help of Russian collaborators Alexei Tikhonov and Sergey Vartanyan. It has taken about three years to collect this material and arrange for its export, but it was worth the wait to learn more about the lives of some of the last-surviving woolly mammoths. **David Fox (PhD '99)** is also participating in the analysis of these specimens, from a stable isotope perspective. Meanwhile, current graduate students **Sarah Jarvis** and **Adam Rountrey** are getting a little woolly themselves, with Sarah looking at strontium isotope ratios as potential tracers of migratory behavior of woolly mammoths, and Adam refining age estimates of woolly mammoths by deciphering evidence of nursing and weaning in the tusks of juveniles. If it smells like a dentist's office as you come down the hall, we're cutting tusks … it's the smell of mammoths and mastodons giving up the secrets of what brought about late Pleistocene extinctions.

Steve Kesler got into the field quite a bit last year, including a trip through the Iberian pyrite belt, a conference on Variscan and later mineralization in Sardina with Maria Boni from the University of Naples, a tour of ore deposits and granites of Cornwall with Chris Halls from Imperial College, a review of the Huronian Supergroup with guidance from Mike Hailstone of the Ontario Geological Survey, and a trip to several Nevada gold mines with PhD candidate **Martin Reich** (including a meeting with **John Muntean (MS '89)** in Eureka). Back in Ann Arbor, Steve is one of five editors for the 100th Anniversary Volume for the Society of Economic Geologists, and is entering the final phase of compiling the volume on *Evolution of the Early Atmosphere, Hydrosphere, and Biosphere: Constraints from Ore Deposits* that resulted from last year's Penrose Conference at GSA.

Phil Meyers' group hosted **Dr. Abdelfettah Sifeddine** for six months starting in December. Abdel, an organic geochemist involved with studying climate histories preserved in the sediments of lakes in Brazil, is a truly international scientist! He is originally from Morocco, but he has worked in the Paléotropique Program of the French Institut de Recherche pour le Développement for the past ten years, where he has spent most of his time in Rio de Janeiro. His next assignment promises to be Peru. While in Michigan, he has been working with Phil to interpret and publish the results of several years' worth of lake sediment analyses. The first stream of papers have produced the first post-glacial to Holocene paleoclimate reconstruction of tropical South America and have yielded a detailed description of the processes that contribute to the delivery and accumulation of organic matter in lake sediments. Abdel is also a gourmet cook and a lover of fine wines. He has produced a succession of culinary treats for Judy and Phil and for others lucky enough to join them for dinner.

PhD candidate **Michela Arnaboldi** has been awarded one of the very competitive Rackham Predoctoral Fellowships for 2004-2005. These awards are based on an excellent academic record, exceptional research accomplishments, and a strong future promise. Michela is assembling a very impressive multi-geochemical parameter study of the paleoceanographic and paleoclimatic conditions recorded by Mediterranean sapropels. She is focusing on two sapropel layers deposited in the latest Pliocene at six locations that constitute an east-west transect of the Mediterranean Basin. She is also likely to link the depositional conditions that led to the sapropels with the Cretaceous black shales she sampled during her participation in Ocean Drilling Program Leg 210 last summer.

Yuehan Lu is a new member of the group. She arrived in Ann Arbor last fall after completing a BS and MS at Zhejiang University. Yuehan is interested in Holocene paleoclimate reconstructions using organic matter proxies from lake sediments. We anticipate that her PhD dissertation research will center on some promising lake cores from the Great Lakes region.

Ben van der Pluijm is happy to see the second edition of his book *Earth Structure* appear just in time for the start of Winter Term teaching. The edition contains fully revised text and art, and is expanded from the first edition. Several colleagues contributed new and updated essays on tectonic settings around the world, emphasizing a global approach to structure. The book is published by W. W. Norton, and can be viewed at: http://www.wwnorton.com/college/titles/geology/strgeo/welcome.htm

Ben at Harold Creek, near Harihari, as it cuts (actually rages) through the Alpine Fault zone in the overgrown hillside. The zone is a rich source of fault rock samples including pseudotachylyte.

The structure group said goodbye to old faces and hello to new ones. **Eric Tohver** completed his PhD on Brazilian "Grenville" and subsequently moved to Sao Paulo on an NSF postdoctoral fellowship. He received the department's Graduate Academic Achievement Award for his excellent work. **Noralynn Hassold, Philip Ong,** and **John Solum** continue their work on Antarctic paleoceanography, the Pennsylvania salient and fault gouge studies, respectively. **Jim Hnat** and **Sam Haines** joined our group last fall, working on oroclines and fault rocks, respectively. Beside these research projects and continued development of field-based computing with **Peter Knoop** (see http://geopad.org), Ben started a NEHRP (National Earthquake Hazards Reduction Program) project on friction melts along New Zealand's Alpine Fault with visiting faculty **Laurence Warr** (University of Strasbourg) and seismologist **Larry Ruff**. An enjoyable sampling trip with Laurence and local colleagues in New Zealand took place last February (see photos). The summer brings the start of the San Andreas Fault drilling project (Earthscope's SAFOD), samples of which will be analyzed at Michigan. The drilling site is not geologically glamorous, but the project will provide a unique natural laboratory for the study of mineral transformations in fault mechanics.

A sample of friction melt (dark gray) in fractured and chloritized schist (light gray).

Rob Van der Voo is busy this year as President of the Geological Society of America having started in this function last November. His year will be culminating with his presidential address

at the Annual Meeting in Denver in November. As already reported before, Rob's appointment as Director of the Honors Program in the College of L.S.& A. ended last Summer, and he is now full time back in the Department. His teaching in the just-completed Winter Term once again was the main introductory geology course with laboratories and discussion sections (117-119), whereas last Fall he taught his usual graduate tectonics course that several alumni will remember as either GS 606 or 515. Rob's graduate student **Daming Wang** is now in his fifth year of work on the magnetic properties of ocean-floor basalts, supervised by Rob and Don Peacor. **Maodu Yan** (working with Rob, David Rea, and Josep Parés) continues his magnetostratigraphic studies of the Neogene deposits of northeastern Tibet. Two new students joined the paleomagnetic group: **Sasha Abrajevitch** will be working on the Paleozoic paleomagnetism of Kazakhstan. This is a collaborative project with **Dr. Misha Bazhenov** (**Visiting Scientist, 2002**) of the Geological Institute of the Russian Academy of Sciences. The project has received renewed funding from the National Science Foundation for the coming three years. The coming summers will see fieldwork to collect Paleozoic volcanics and red beds in attempts to firm up our preliminary conclusions that the highly curved belts of Kazakhstan constitute an orocline. Another new student, **Jim Hnat**, is interested in vertical-axis rotations as well, and will be investigating structures in the Upper Peninsula of Michigan. Philip Ong is also looking at vertical-axis rotations, but in the Pennsylvania Valley and Ridge Province in a structural-geology project supervised by Ben van der Pluijm; he is using calcite-twinning analysis rather than paleomagnetism. **Phil McCausland**, a Turner post-doc, is continuing his project to investigate North America's paleolatitudes in the latest Proterozoic, a time for which scientists have postulated a most unusual climatic condition called the Snowball Earth. Because glacial relicts are thought to have formed in low latitudes during the "snowball" conditions, data on the paleolocations of the various continents are needed to test this model.

Lynn Walter's Experimental and Analytical Geochemistry Lab (EAGL) principally known for studying hydrogeochemistry, had several unexpected opportunities to study water chemistry last year: the first floor EAGL was flooded from above, not once but three times. But all was not lost in the dark little corner on the first floor of C.C. Little. EAGL, a mecca of training numerous students, had been getting by on outdated equipment, but thanks to the National Science Foundation, EAGL is moving into the 21st century with state-of-the-art instruments, including a brand new JY Horiba Ultima II ICP-OES, a new Dionex Chromatography system with photodiode array detector, a new Milestone microwave Digestion system, two new UIC carbon Coulometers with acidification modules, and a new Shimadzu spectrophotometer. Thanks to the College of LSA, the badly overcrowded EAGL space has had a serious facelift to accommodate the new instruments and to update the lab design for current project needs.

The ICP-OES arrived in late November 2003; it is capable of measuring metal ions close to the detection limits of an ICP-MS. The ICP-OES will also be capable of measuring rare-earth elements and halides. The ion chromatograph is up and working and is capable of measuring anions and organic acids, as well as separating and identifying organics using the new photo diode array detector. A new addition to the lab is a microwave digestion system capable of extracting refractory materials from sediments and soils.

Despite the setbacks of the recent floods, and the disorganization that accompanies extensive laboratory renovations, EAGL was full of energetic people the last year, with the lab manager **Corey Lambert**, six graduate students: **Nina Carranco, Lixin Jin, Jen McIntosh, Naila**

Moreira, Kati Szramek, and **Erika Williams**. The lab also has a team of undergraduate student research assistants majoring in areas ranging from geology to chemistry to atmospheric sciences (**Emily LaVoie, Elizabeth Siegle, Jean Tang, Aaron Regberg, Erin DiMaggio, Heather Whitting, Lauren Wilkinson**.). Research projects include the study of chemical transport of major and minor elements in watersheds of Michigan, the formation of dolomite in Brazil, a collaborative study of hydrogeochemistry of watersheds in Slovenia, and the response of silicate weathering to different agricultural and land use practices at the W. K. Kellogg Biological Station in Hickory Corners.

Degrees Granted

BS

Michael Allis
Cecilia Anderson
Jessica Bleha
Erin DiMaggio
Courtney Fritz
David Haglund
Travis Hayden
Marlon Jean
Julia Milne
Muhammad Muhamad Yew
Mohdyusnizam Mohamedyusoff
Mohdhairri Mohammad
Brendan O'Donnell
Emily O'Donnell
Samantha Sands
Caene Turner
Jill VanTongeren
Andrew Zimmer

MS

Brandon McElroy: *Quantitative Relations of Continental Physiography and Climate*

PhD

Andrea Dutton: *Extracting Paleoenvironmental Records from Molluscan Carbonate*

Erik Ekdahl: *The Sediment Record of Crawford Lake, Ontario and Derby Lake, Michigan: Anthropogenic Modification of Diatom Communities and Paleoclimate Reconstructions*

Forest Gahn: *Parasitism and Predation on Paleozoic Crinoids*

Ross Secord: *Late Paleocene Biostratigraphy, Isotope Stratigraphy, and Mammalian Systematics of the Northern Bighorn Basin, Wyoming*

Department Lecture Series, Winter 2004

The Department hosts a weekly series of visitors who present a lecture or seminar to the faculty and students, and interact with them for a few days in informal ways. The exchange is truly bi-directional: the Department becomes better acquainted with the visitor's teaching and research activities, and the visitors learn of the scientific activity in the Department. The lecture series for this Winter term included the following presentations:

January 9, 2004	**Dr. Linda Abriola** Tufts University	*Remediation of sites contaminated by organic solvent. What can we hope to achieve and is it worth the investment?*
January 16, 2004	**Dr. Doug Burbank** University of California at Santa Barbara	*Building collisional orogens: interactions of climate, erosion, and tectonics*
January 23, 2004	**Dr. Philippe Tortell** University of British Columbia	*Real-time measurement of oceanic trace gas concentrations using membrane inlet mass spectrometry*
January 30, 2004	**Dr. David Hilton** University of California at San Diego	*Volatile mass balance and recycling at subduction zones*
February 3, 2004	**Dr. Paul Sereno** University of Chicago	***Case Lecture:*** *Dinosaurs and drifting continents*
February 6, 2004	**Dr. Craig Lundstrom** University of Illinois at Urbana-Champaign	*The rates and processes of crustal level magma differentiation at Volcan Arenal, Costa Rica*
February 13, 2004	**Dr. Miaki Ishii** Scripps	*Inner core anisotropy and the inner-most inner core*
February 20, 2004	**Dr. Rob DeConto** University of Massachusetts	*Paleogene cooling and the early glacial history of Antarctica*
March 5, 2004	**Dr. Peter Sadler** University of California at Riverside	***Dorr Lecture:*** *Stratigraphic correlation as a traveling salesman problem*
March 12, 2004	**Dr. Christina de la Rocha** University of Cambridge	*Tracing the silica cycle using silicon isotopes*
March 19, 2004	**Dr. Ken Farley** Caltech	*A possible new technique for detailed rock cooling histories from He* in apatite
March 26, 2004	**Dr. Mark Zoback** Stanford University	*Friction, pore pressure and strength of the crust*
April 2, 2004	**Dr. Michael Hochella** Virginia Tech	*There's plenty of room at the bottom:having fun with nanogeoscience and the mineral-microbe world*
April 9, 2004	**Dr. Michael Foote** University of Chicago	*Origination and extinction in the history of life*
April 16, 2004	**Dr. Charles Langmuir** Harvard University	*A new composition of the upper mantle and its implications for the origin of mantle heterogeneity*