GEOLOGY & GEOPHYSICS NEWS

Yale University | Department of Geology and Geophysics Spring 2010

Students in G&G 100, "Natural Disasters", investigating volcanic fumaroles, Valley of Desolation, Dominica, during Spring Break, March 2010. Faculty members David Bercovici (far right), Maureen Long (far left), and Frank Robinson (2nd from right), led the field trip.

Chairman's Letter

David Bercovici (david.bercovici@yale.edu)

Dear Friends and Alumni of Yale Geology & Geophysics,

I'm once again very happy to report on activities, changes and growth in our department.

As mentioned in the last newsletter, this academic year we saw two new faces on our faculty, **Mary-Louise Timmermans** and **Trude Storelvmo**. Dr. Timmermans is an arctic oceanographer and she began her position here as an Assistant Professor July 1, 2009. Dr. Storelvmo is an atmospheric physicist who started her position as an Assistant Professor January 1, 2010. This coming July, **William Boos** will be joining our faculty as an Assistant Professor. Dr. Boos's PhD is from MIT and he is currently finishing up a postdoctoral position at Harvard. His research involves the effect of global climate change on regional circulation such as the monsoonal cycles. The addition of these three new faculty members will make our atmosphere, ocean and climate dynamics group one of the largest groups in the department.

On the other end of the faculty spectrum, **Mark Pagani** was recently promoted to Professor with tenure, effective January 2010. Professor Pagani is a geochemist who focuses on paleoclimates and in particular on the record of carbon dioxide over the Cenozoic.

As many of you know well, this last November was the Yale Geology & Geophysics Alumni Reunion, which was in every sense a resounding success. Attendance by students past and present was phenomenal, with both graduate and undergraduate alumni joining us in good numbers. The two-day event entailed talks and panels on various topics of geoscience to which our many alumni have contributed, including Earth's deep interior, climate dynamics, energy resources, and the history of life, to name a few. Many thanks go to **Elisabeth Vrba** who chaired the reunion committee, as well as the Chair's Assistant **Becky Pocock**, and **Julia Downs** from the AYA, for organizing this event. After considerable feedback from our alumni, the department is in discussion for holding another reunion within the next 5 years.

Starting this spring and going through next fall, the department will be running three symposia on future directions in geoscience, in preparation for considering where we are going in the next 10 to 20 years. This May will be our first symposium on Frontiers in Paleontology and Geobiology. In the Fall we will have symposia on Frontiers in Crustal Geoscience and another on Earth-Atmosphere Exchange.

Finally, as I've noted in previous newsletters, our department has been leading the effort since 2007

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to build the new **Yale Climate and Energy Institute,** designed to integrate science and engineering with social sciences throughout Yale on critical problems of climate change, and a clean energy future.
The YCEI is currently in full swing with a spate of activities. The Director is Rajendra K. Pachauri, whom many of you know as the Chair of the IPCC which received the Nobel Peace Prize in 2007 along with Al Gore. I stepped down from being interim Deputy Director in January and Professor Gary Brudvig from Chemistry currently fills that role. Moreover, Dr. Juliana Wang (PhD F&ES 2009) is the full-time Assistant Director. The YCEI has a standing Steering Committee, which I currently chair, that oversees major initiatives and provides advice to the directors for ongoing decisions; the institute also has a large Executive Committee made up of 25 faculty from across Yale, which acts as a representative advisory committee, and is chaired by the Deputy Director. The YCEI has funded seed grants and workshops on activities ranging from innovative biofuels, development of cookstoves for Bangladesh, and the effect of climate change on salt-marsh ecology, urban development, vector borne diseases and stability of ancient and current societies. Its major initiatives include carbon storage in basalts and other mafic minerals in a partnership with the University of Hawaii and Schlumberger, development of an Energy Research Center on the Yale West Campus, and an adaptation/mitigation response team for developing countries. The YCEI also has an ongoing regular seminar series, and on April 23 will host the first YCEI Annual Conference, this year on Clean Energy Innovation, which follows the recent Yale Alumni in Energy Conference (March 5) that many of you attended. The G&G Department continues to play a crucial role in moving the YCEI forward and I (and future chairs) will continue to report on its development in this newsletter. However, ongoing activities can readily be found on the new YCEI website www.climate.yale.edu.

It is, in the end, a pleasure to report on the events and progress in our department. I hope this newsletter finds you well, and I wish you all the best for the coming year.

Yale Expands

The new 136-acre West Campus. The view looks easterly, with New Haven in the distance, and I-95 on the extreme left. The building in the foreground was Bayer's main administration center; the next two buildings back are new research labs, and all the other buildings house a mixture of facilities and storage. The West Campus already houses a lot of Peabody Museum's vertebrate fossil collection, and most of the rock collections from Geology and Geophysics. The ultimate use of all the space is still being planned.

FACULTY RESEARCH

Investigating the Dynamics of the Arctic Ocean

By Mary-Louise Timmermans (mary-louise.timmermans@yale.edu)

Mary-Louise Timmermans, who joined the department in July 2009, is studying the dynamics and variability of the Arctic Ocean to better understand how the ocean impacts Arctic sea ice and climate.

Recent observational evidence suggests changes to the Arctic climate system; records show increasing atmospheric and ocean temperatures, ocean freshening, rising sea levels, melting permafrost and declining sea-ice area.

Fresh water is stored in the Arctic Ocean in the form of water that is less salty than average, and sea ice. Under certain atmospheric circulation regimes, fresh water is released to the North Atlantic Ocean where it impacts the global ocean circulation and climate. Our recent analysis indicates an unprecedented increase of fresh water in the Arctic Ocean's Beaufort Sea (Fig. 1). We have further found that exchange of heat and fresh water between the Arctic Ocean and the North Atlantic depends upon both dynamical processes associated with the atmospheric circulation over the Arctic Ocean, and on seasonal sea-ice melt and growth. This leads to complex seasonal variability in fresh-water storage cycles. One of the main goals of our ongoing field research is to understand what mechanisms cause storage and release of large volumes of fresh water and ice in the Arctic Ocean on seasonal, interannual, and decadal time scales.

Ocean heat is a critical factor in the growth and melt cycle of sea ice. Unlike in the lower latitude oceans, the temperature of the Arctic Ocean increases with depth. A cold stratified layer (the halocline) near the surface effectively insulates the overlying sea ice from the heat in the underlying warmer and saltier Atlantic-derived water. It is well known that the heat contained in the Atlantic-derived deep water, if transported to the surface, would be sufficient to completely melt the Arctic sea-ice cover. Since the halocline acts as a barrier to upward heat transport, the source for most of the ocean-to-ice heat transport comes not from the Atlantic-derived deep water but from incoming solar radiation through open water and thin ice. While one of the most significant recent changes to occur in the Arctic Ocean has been a further warming of the Atlantic-derived deep water, this is only of consequence to sea ice where it is possible for the heat to be transported to the surface. For this reason, the maintenance and stability of the halocline are of utmost significance for the preservation of sea ice.

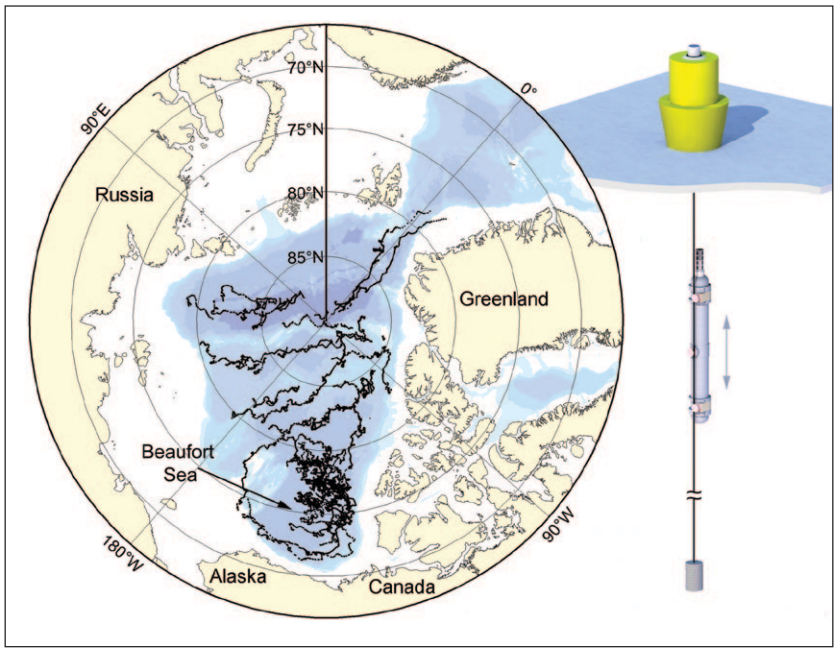

Fig. 1. Map of the Arctic Ocean showing tracks of drifting Ice-Tethered Profilers (ITPs). Schematic of an ITP system.

Recent advances in our understanding of the dynamics of the Arctic Ocean have been made using autonomous ice-based instrumentation. These instrument systems combine suites of different sensors mounted in the drifting Arctic ice pack, providing, via satellite, year-round automated measurements of the ocean, ice, and atmosphere. The use of such automated instrumentation is indispensable for Arctic Ocean research. Standard observational practice, which has been to sample in August-September (when the sea-ice coverage is at its seasonal minimum and the Arctic is accessible by research icebreakers) and in April-May (when the sea ice is sufficiently strong and there is adequate daylight to use aircraft), does not capture seasonal and

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FACULTY RESEARCH

ARTIC OCEAN *continued from page 3*

shorter time scale variability, and provides only limited spatial coverage. Much of our research is therefore based on measurements from automated drifting ocean profiling instruments—Ice-Tethered Profilers (ITPs, Fig. 1), year-round moored instrument systems, and summer/spring ocean measurements from icebreaker and aircraft surveys.

In October 2009 a recent Yale graduate in American Studies (**Alex Kain '09**) participated in our yearly Arctic field program aboard a Canadian Coast Guard ice-breaker (Fig. 2). The purpose of the month-long expedition to the Beaufort Sea was to deploy oceanographic and sea-ice instrumentation and take seawater samples. Alex's role was to report on the research and coordinate educational outreach associated with the expedition. Scientists and the public were able to follow the latest research findings from the Arctic through Alex's captivating web dispatches and photographs, uploaded daily via satellite.

Ocean eddies are common dynamical features that can lead to disruption of the halocline, enabling heat transport from deeper layers to the surface ocean and sea ice. Using measurements from ITPs, we have identified a new class of shallow eddies that are prevalent in the halocline in the Arctic Ocean. Even in the Arctic mid-winter, we have found evidence of bottom melt of Arctic sea ice overlying ocean eddies. Our ongoing analysis of new data aims to quantify the net impact of these eddies to the surface ocean heat. In a related study, graduate student **Georgy Manucharyan** is developing a numerical experiment (configured to represent Arctic conditions) and performing

Fig. 2. Researchers deploying oceanographic instrumentation in the permanent sea ice of the Arctic Ocean's Beaufort Sea. The Canadian Coast Guard icebreaker Louis S. St-Laurent stands by in the background. Photo by Alex Kain.

different model runs to bring new dynamical insights to the eddies observed in the field data. He is testing forcing scenarios (wind and ice acting on the surface ocean) and analyzing the resulting model eddy field compared to ocean observations. Georgy's work demonstrates the potential for understanding the dynamics in the Arctic halocline through idealized numerical experiments constrained by observations. Our numerical and observational approaches complement those of Professor **John Wettlaufer** and his group, who are using laboratory models to investigate halocline processes.

Any process that draws deeper, warmer water closer to the surface is likely to be of significant consequence to the surface heat budget. Recent Arctic data have revealed cases of localized ocean upwelling that are believed to be caused by storm events and shear motion of the overlying sea ice. Undergraduate **Sarah Dewey's '10** research involves observing and characterizing these important processes through an analysis of ITP measurements over the entire Arctic Ocean, spanning several seasonal cycles.

The observed general freshening and strengthening of the stratification of the upper Arctic Ocean is likely to be associated with important feedbacks. A more strongly stratified ocean will provide even more resistance to upward mixing of deeper ocean heat. On the other hand, the surface ocean layer in contact with sea ice appears to be thinning in recent years; ocean mixing is concentrated over a thinner layer. This raises the possibility that higher ocean mixing may eventually compensate for the stratification increase, leading to more heat being stirred up from below. Detailed investigations of the surface ocean layer have been made possible in recent years by the deployment of large numbers of ITPs that measure ocean properties. Graduate student **Aaron Judah** is analyzing these new Arctic Ocean measurements to understand properties and dynamics of the surface ocean layer. Aaron's analysis indicates unexpectedly large spatial and temporal variability in surface ocean layer properties, which may be of considerable consequence to sea ice.

Fig. 3. Sarah Dewey (left) and Mary-Louise Timmermans discuss the latest Ice-Tethered Profiler measurements from the Arctic Ocean.

FACULTY RESEARCH

Regional Climate Studies in G&G

By Ronald Smith (ronald.smith@yale.edu)

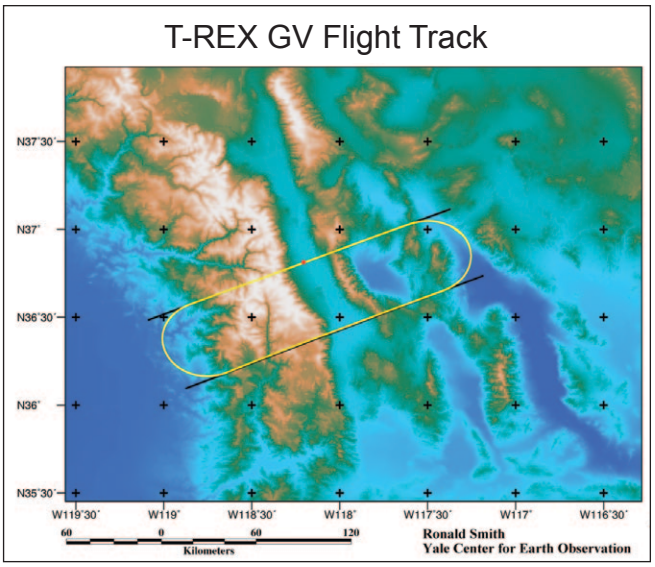

Fig. 1. Racetrack flight track of the NSF/NCAR Gulfstream-V research aircraft during the 2006 T-REX Project over the Sierra Nevada Range (left) and the Inyos (center) in California.

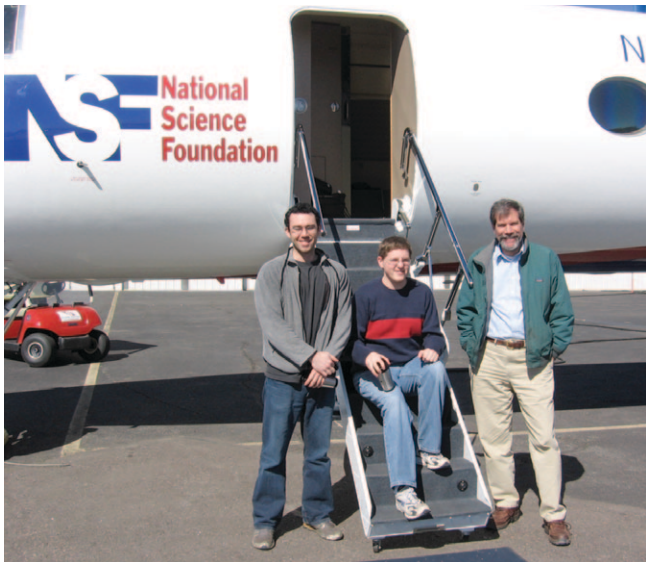

Fig. 2. The NSF/NCAR Gulfstream-V research aircraft during T-REX in 2006. Left to right are Bob Allen, Bryan Woods, and Ron Smith.

While global climate issues have drawn much attention recently, our understanding of regional climates is also advancing. Regional climates are controlled in part by latitude, but in equal measure by local processes arising from coastlines, ocean currents, land surface properties, and terrain. These can be studied using a combination of observations, computer simulations, and the principles of fluid dynamics. Here are five examples of recent regional projects involving students and faculty at Yale.

Thunderstorms east of the Rockies

Summer precipitation over the Great Plains and the Midwest is caused by thunderstorms occurring in unstable air masses that slide northward from the Gulf of Mexico. The triggering of these thunderstorms has remained a mystery, but a clearer view may follow from the recent PhD thesis and publications of **Yanping Li G '09** (yangpingl@hawaii.edu). Yanping used a 24-hour harmonic (i.e., sinusoidal) analysis of hundreds surface weather stations to derive the time of day (i.e., the phase) of maximum thunderstorm precipitation. The result was surprising. West of 105°W (the Front Range) and east of 80°W (the Appalachians), precipitation occurs mostly in the late afternoon caused by local solar heating of the earth and lower atmosphere, triggering convection. Between 105°W and 80°W however (the Great Plains and Mid-west), the precipitation occurs in eastward-moving waves, ignoring local heating. The waves move along at about 12 m/s, taking almost two days to reach the east coast. The cause of the wave-like precipitation was determined from Yanping's harmonic analysis of temperatures at the 500 hPa level in the atmosphere (i.e., about 5 km above sea level). There she found pulses of warm air (or potential vorticity) formed by daily heating over the Rockies, carried eastward by the winds aloft. These traveling pulses trigger daily thunderstorms as they pass overhead. This discovery adds to our understanding of North American weather and climate.

Yanping Li is now a postdoc at the University of Hawaii.

Buoyancy waves in the stratosphere

The generation of upward-propagating buoyancy waves in the atmosphere by steep mountains has been recognized and studied for 50 years or more. These waves amplify as they propagate into the more rarified layers of the upper atmosphere and when they break down, they supply momentum and energy to the upper atmosphere. Much of the stratospheric circulation is driven by these waves. With the intent of quantifying buoyancy wave estimates, a Yale group participated in the 2006 Terrain-Induced Rotors Experiment (T-REX) over the Sierra Nevada Range in California (Figs. 1, 2) The project was funded by the National Science Foundation and directed by **Vanda Grubišić G '95** (vanda.grubisic@univie.ac.at). Former

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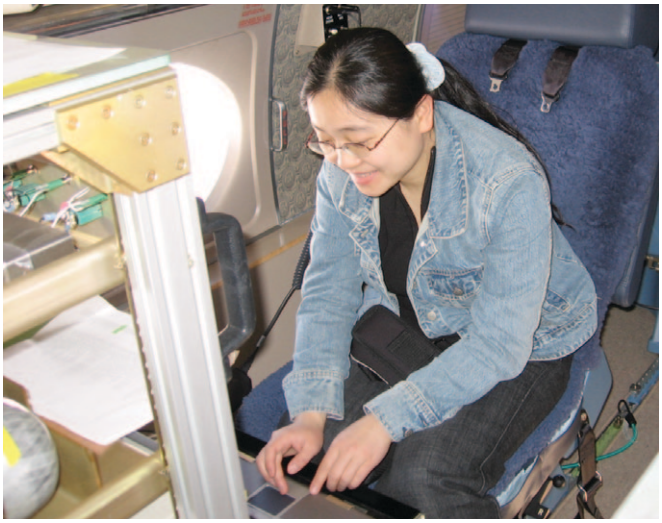

Fig. 3. Yanping Li working onboard the NSF/NCAR Gulfstream during T-REX in 2006.

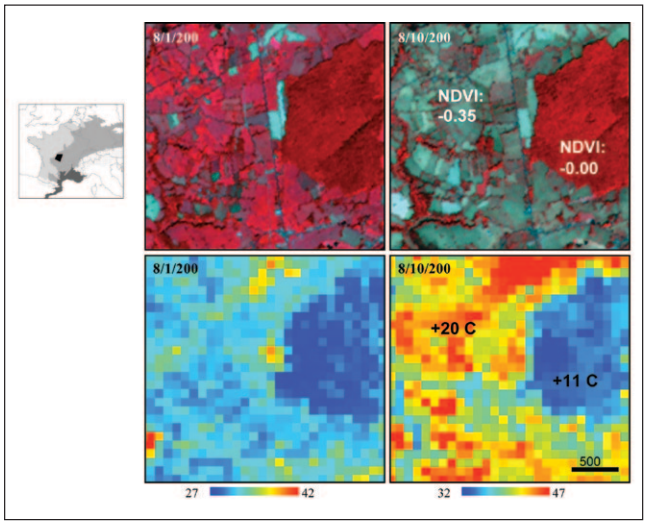

Fig. 4. Four panel display of vegetation and surface temperature response to the Heat Waves of 2003, in a small section of central France. Data is from the ASTER sensor. Upper panels show the drop in NDVI. Lower panels show the increase in surface temperature. Pasture land shows a strong drop in NVDI (Ð0.35) and rise in temperature (+20°C). The large forest patch shows no change in NDVI and less temperature rise (from Zaitchik et al., 2006).

REGIONAL CLIMATE STUDIES *continued from page 5*

graduate student **Qingfang Jiang G '01** (*jiang@nrlmry.navy.mil*) was also involved. The Yale group included **Yanping Li '09, Bryan Woods** (*bryan.woods@yale.edu*) (graduate student), **Bob Allen G '09 (***rjallen@uci.edu***), and Ron Smith** (faculty). Project scientists used the new NSF/NCAR Gulfstream-V research aircraft with a full set of fuselage and wing-mounted instruments. With improved GPS and static pressure measurements, the aircraft could determine the direction and magnitude of wave energy flux: an indicator of wave propagation direction. Flying at an altitude of 9 km in the upper troposphere, they found the expected long-upgoing waves generated by the mountains. Surprisingly, they also encountered shorter downgoing waves on almost every flight! The explanation of this phenomenon was undertaken by Bryan Woods. Using complex wavelet analysis and computer simulation he is gathering evidence that the downgoing waves are generated during the breakdown of the primary upgoing wave.

Bryan Woods hopes to finish his PhD thesis by August of 2010. Vanda Grubišić is now Professor at the University of Vienna. Qingfang Jiang is a research scientist at the Naval Research Laboratory in Monterey. Bob Allen is a postdoc at UCal Irvine.

Land-surface feedbacks during the European Heat Wave of 2003

The European Heat wave of 2003 was a devastating climate event responsible for tens of thousands of premature deaths in France and surrounding countries. It is viewed by climatologists as a possible glimpse into the future of global warming. Two Yale graduate students, **Ben Zaitchik G '06** (*zaitchik@jhu.edu*) and Alison Macalady (a student of Forestry and Environmental Studies), decided to dig further into this remarkable event. Working with ASTER images at the Yale Center for Earth Observation, they mapped out the spatial detail and extent of the heat wave and examined the role played by land-surface feedbacks (Figs. 4-6). The surface temperature anomalies in France were very tightly controlled by land use category. City and forest surfaces showed modest warming while pastureland and rainfed farmland showed nearly 20°C of warming! This amplification was caused by the mid-summer exhaustion of soil moisture and the shut-down of evapo-transpiration from shallow-rooted plants. Without this evaporative cooling, a higher fraction of the sun's radiation goes into heating the lower atmosphere. The excess heat from these regions is carried to nearby populated districts by warm winds. Their results have implications for future climate change.

Ben Zaichik has just finished a climate-related internship at the U.S. State Department and will join the faculty at John Hopkins University in Spring 2010. Alison Macalady is now a graduate student at the University of Arizona.

FACULTY RESEARCH

Fig. 5. Typical landscape in the region from central France shown in Figure 4. Pastureland and forest respond differently to heat and drought.

Orographic precipitation in the tropics

The idea that mountains force air to rise, cool adiabatically, and generate precipitation goes back more than 100 years to the first theoretical developments in atmospheric thermodynamics. Over the past 40 years these ideas have been tested in several atmospheric science field projects in mid-latitudes: e.g., the Alps, Wasatch, Sierra Nevada, Cascades, and New Zealand Alps. For various reasons, no such tests have been done in the tropics. Expectations were that the precipitation mechanisms might be the same as in mid-latitudes or that diurnal heating might have more of an influence. A first attempt at a tropical mountain project was done by a Yale group in Dominica in the eastern Caribbean. Dominica (15°N) is a forested volcanic island with peaks rising to 1,400 m sitting in the steady easterly tradewinds of the Atlantic Ocean. The Yale team included postdoc **Daniel Kirshbaum** (d.kirshbaum@reading.ac.uk), undergraduate **Phillip Schafer '06** (pbs130@psu.edu), and **Ron Smith**. Using a network of rain gauges and radar data from the adjacent islands of Guadeloupe and Martinique, a new conceptual model of orographic precipitation in the tropics was developed. According to this model, the air approaching the island already contains humidity fluctuations which, when lifted, trigger shallow, closely packed, and energetic convection. This repetitive triggering brings large annual rainfalls (e.g., 7 m) to the high ground of the island while the lee-side descent prevents precipitation from reaching the lee slopes. Daily heating plays no role at all! It remains to be seen if this mechanism is active in other tropical regions.

Dan Kirshbaum is now a Lecturer at the University of Reading in the UK. Phillip Schafer is now a graduate student in Physics at Pennsylvania State University.

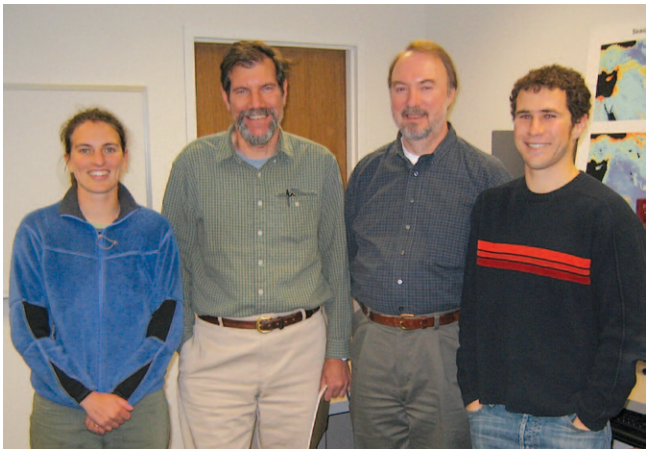

Fig. 6. The research team on the European Heat Wave Project. Left to right are Alison Macalady, Ron Smith, Larry Bonneau, and Ben Zaitchik

Airmass drying over the Coast and Sierra Nevada Ranges

Moist air masses moving northeastward from the tropical Pacific lose much of their water vapor as they cross the mountainous west coast of North America. The proportion of the water lost from the air by orographic precipitation is called the Drying Ratio (DR). Improved estimates of the DR would contribute to a better understanding of North America's dry continental interior. If linked with isotope ratios, this information might extend our knowledge of continental dryness into the past. For this dual purpose, undergraduate **Anthony Didlake '06** (didlake@atmos.washington.edu), grad student **Brett Tipple G '09** (brett.tipple@utah.edu), and Flint postdoc **Alison Anders** (amanders@uiuc.edu) compared rain gauge and balloon DR estimates with water samples from two 2007 transects of northern California. Both transects (June and September), both water sources (stream and stem water), and both isotopes (deuterium and oxygen-18) gave DR values in the range 35 to 45%, in agreement with conventional data. This intensive analysis will serve as a reference point for paleo-climate and paleo-elevation studies.

Alison Anders is now an Assistant Professor at the University of Illinois (UIUC). Brett Tipple is a postdoc at the University of Utah. Anthony Didlake is finishing his PhD at the University of Washington.

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FACULTY NEWS

Welcome to Trude Storelvmo

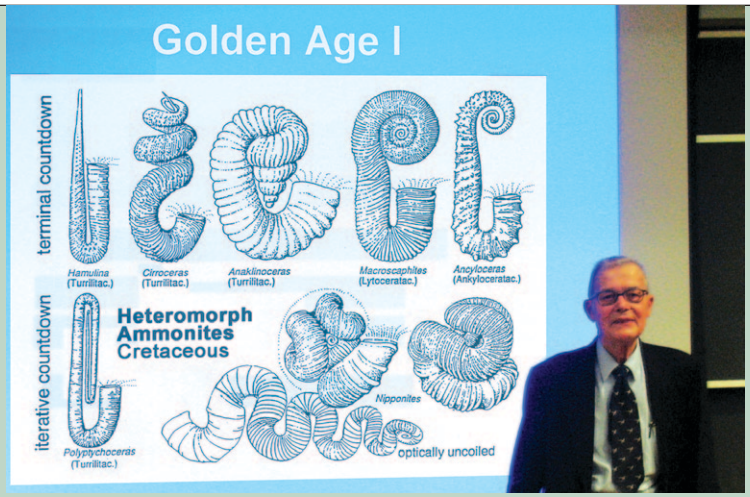
(*trude.storelvmo@yale.edu*)

Trude Strorelvmo, March 2010.

Trude Storelvmo is an expert on aerosol-cloud interactions and their effect on the earth system. She joined the Department in January 2010 and hails from far northern Norway—Narvik, to be specific—where her family roots are long and deep.

She is a graduate of the Geophysics Program at the University of Oslo (Ph.D. '06), has been an exchange student at the University of Washington, Seattle, and has worked as a postdoc at the Institute of Atmospheric and Climate Sciences, ETH, Zurich, Switzerland.

For those interested in the origins of names, Storelvmo records the farming location of one branch of her family—it means "Big river hill."



Dolf Seilacher at his farewell lecture, in the main lecture hall, Kline Geology laboratory, December 8, 2009 (photo taken by his son Peter).

Adolf Seilacher Retires

When Dolf Seilacher joined the Yale faculty as an Adjunct Professor in 1987, he was already one of the most distinguished paleontologists of his, or any other, generation. The eminence of his reputation was confirmed in 1992 when the Royal Swedish Academy awarded him the Crafoord Prize. He is the only paleontologist to have received this seminal honor. Every year since 1987, Dolf has spent half the academic year at Yale teaching both graduate and undergraduate classes and directing a number of Ph.D. theses. Dolf's final term at Yale came to a close in December 2009 and he entertained us all with a final lecture expounding some of his controversial ideas. His years at Yale were exciting and challenging. We will miss his inquiring mind and provocative questions.

RECENT AWARDS

Penrose Medal of the Geological Society of America

Clark Burchfiel G '61 (bcburch@mit.edu), the Schlumberger Professor of Geology at MIT, was awarded the 2009 Penrose Medal of the Geological Society of America. Clark received the award for his seminal studies on the origin, development, and structural evolution of the continental crust.

Clark with the medal; **Jean Bahr '76** President ofthe Geological Society of America presented the medal.

Paleontological Society Medal

Jeremy Jackson G '71 (jbjackson@ucsd.edu) was awarded the 2009 Paleontological Society Medal. Jeremy is the Director of the Center for Marine Biodiversity and Conservation, and also the Mary B. Ritter Professor of Oceanography at Scripps Institution of Oceanography. Jeremy was recognized for his work on the ecology of coral reef communities, on the mode of speciation in the sea, and most recently for his research on the long-term impacts of human activities on the oceans.

RECENT AWARDS

Catching up for some recent awards we missed: Congratulations to **Steven M. Stanley G '68** (stevenst@hawaii.edu) for the following awards:

Steve reminiscing at the recent alumni Reunion, November 2009.

- Mary Clark Thompson Medal, National Academy of Sciences, for contributions to geology and paleontology (2006)
- Paleontological Society Medal (2007), for advancement of knowledge in paleontology
- Twenhofel Medal, Society for Sedimentary Geology (SEPM) (2008), for outstanding contributions to sedimentary geology

Steve is well-known for his Predation Hypothesis to explain the evolution of novelties during the Cambrian explosion. He proposed that predation stimulated prey animals to evolve defenses such as shells, rapid swimming, and burrowing. These strategies also opened new avenues of evolution through functional shifts. Hard shells allowed for filter feeding, and deep burrowing allowed animals to gain new access to food resources.

Thomas Jefferson Teaching Award

Rowan Lockwood '93 (rxlock@wm.edu) received the Thomas Jefferson Teaching Award in February 2009 from the College of William and Mary. The award, which is a tribute to the several members of the faculty who influenced and encouraged the young Thomas Jefferson, is intended to recognize today's teachers on the faculty. It is made annually to a younger teaching member of the College community *who has demonstrated, through concern as a teacher and through character and influence, the inspiration and stimulation of learning to the betterment of the individual and society as exemplified by Thomas Jefferson*.

Rowan writes, "Since graduating from Yale in 1993, I completed an MSc in biology at the University of Bristol (as a Marshall scholar) then a PhD in evolutionary biology at the University of Chicago. I accepted a position at the College of William and Mary in 2001 and am now an Associate Professor in the Department of Geology. My research focuses on the evolutionary and ecological effects of mass extinctions and climate change in the marine invertebrate fossil record. My husband, daughter (age 2), and I live in Williamsburg, VA."

Rowan communing with a giant clam on the Great Barrier Reef, Australia (Summer 2004).

ALUMNI NEWS

We would especially like to hear from you. Please send your news to mabel.peterson@yale.edu.

Steve Porter with his daughter Susannah on a remnant of China's Great Wall along the southeastern margin of the Ordos Desert (Summer 1997).

Steve and Susannah Porter on the Li River while traversing China's famous tower-karst region.

Stephen C. Porter '55, G '62 (scporter@u.washington.edu)
Susannah M. Porter '95 (porter@geol.UCSB.edu)

Spanning the Geologic Column from Neoglaciation to Neoproterozoic in Two Generations

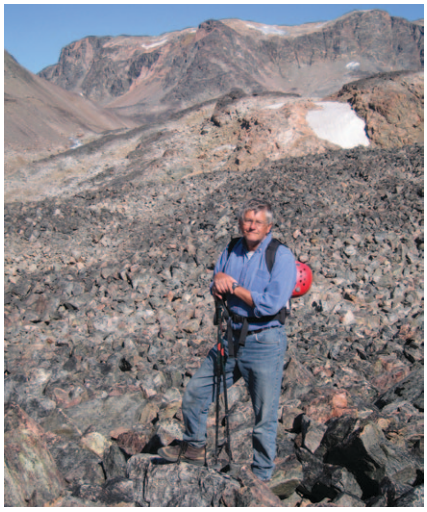
With a father whose research and teaching career at the University of Washington primarily focused on Neoglacial and Pleistocene alpine glaciation, much of Susannah's childhood was spent traveling abroad. In addition to Steve's sabbatical leaves in New Zealand, England, and Norway, the Porter family also spent summers with him in the Italian Alps and on the Big Island of Hawaii.

Susannah started working as her father's field assistant when she was seventeen; they spent that summer on the upper slopes of Mauna Kea studying the volcano's eruptive history and ice-cap glaciations. She subsequently assisted him, while a Yale undergraduate, in his paleoclimate studies in Inner Mongolia and on the northeastern Tibetan Plateau.

Although Susannah majored in mathematics at Yale and began graduate studies at Harvard with the intention of becoming an entomologist, she was drawn to paleontology with its long-term record of biotic evolution. She now studies and teaches Neoproterozoic and Cambrian paleontology at the University of California, Santa Barbara. Susannah credits those summers with her father as helping to make her eventual career choice: she always loved traveling to remote parts of the world and hiking in beautiful settings.

Steve and Susannah would like to coauthor a paper some day but admit they have not yet resolved how to mesh their very different professional interests.

Hannes K. Brueckner '68 (hannes@ldeo.columbia.edu) writes, "How subtly I was influenced by the faculty and fellow graduate students at Yale between 1962 and 1968 when I was informed I had to get my PhD and leave (What? And face the real world?)! **Matt Walton** got me interested in petrology, in particular the evolution of rocks within mountain systems. **John Rodgers G '44**, my advisor, gave me the opportunity to work in the mountains of Norway where **Ed Hansen G '63** taught me field techniques and structure. **Karl Turekian** and **Dick Armstrong**



Hannes in the field; Liverpool land, Greenland.

'59, G '64 inspired me to apply geochemistry to my work and, in particular, taught me the usefulness of isotopes. The result is that I cannot claim to be a geochemist, or structural geologist, or petrologist. But I can blend them, particularly as I get older and my field of vision expands (even as details begin to escape). I've retired from teaching at Queens College of CUNY, after 40 years! I continue to do research at Lamont-Doherty Earth Observatory of Columbia University, where I am an Adjunct Senior Research Scientist. I still study mountains and, in particular, how crust and mantle interact during continental collision. I've never been as productive as now, and I hope to keep working until I am told, once again, to leave."

G. Warfield "Skip" Hobbs '69 (gwhgeol@cs.com; and skiphobbs@ammoniteresources.com)

Skip was installed as President-Elect of the American Geological Institute at the annual meeting of the Geological Society of America in Portland, Oregon, in October 2009. He will serve until 2011.

Skip is the Managing Partner of Ammonite Resources, a global petroleum and mining geotechnical and business advisory firm which

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Skip in a President-Elect pose.

he founded in 1982 in New Canaan, CT. He is also founder and president of Ammonite Corporation, an independent oil and gas exploration and production company, and president of Ammonite Nova Scotia Corporation, a company that operates two petroleum exploration licenses offshore Eastern Canada.

After leaving Yale Skip studied Petroleum Geology at Imperial College, Royal School of Mines, in London, earning an MSc. During the 1970s he worked internationally as an exploration geologist for Texaco and then for the Amerada Hess Corporation. Prior to his involvement with the American Geological Institute, Skip was an elected official at regional and national levels of the 33,000 member American Association of Petroleum Geologists. He writes and lectures frequently on energy policy matters.

Miriam Steele-Petrovich G '84 (hmspetrovich@gmail.com) and **Radomir Petrovich G '71** (randhmspetrovich@mindspring.com) write: "We both have Ph.Ds in geology from Yale: Radomir (1971) with a specialty in geochemistry and Miriam (1984) with a much delayed degree in paleobiology. We originally expected that both of us would have academic positions that would enable us to actively pursue our respective research interests, while raising a well-adjusted family. That is not how life worked out.

After a year and half as an associate in research at Yale and four years as an assistant professor at Northwestern University, Radomir joined Phillips Petroleum Company where he was a senior research geologist, working on geothermal processes, diagenesis in deep sedimentary basins, and scaling and formation damage in petroleum production. The work, which entailed travelling to some interesting and unusual places, was in both research and development; and although some of it was quite exciting, most of it could not be published. Radomir's retirement in 1999 has enabled him to return to pure research. He is presently working on the mechanisms of fossilization (a subject on which he published in 2001) and on the theoretical study of reactions between minerals and aqueous solutions.

We were fully aware when we decided to have a family that Miriam's career would be delayed. However, the poor health of our daughter, Sophia, meant that the delay was considerably greater than originally expected, and it took years for Miriam to complete the field and laboratory work for her Ph.D. dissertation. However, while waiting to get back to her dissertation, she used data in the biological literature to publish papers on aspects of brachiopod biology that are relevant to her studies of Ordovician paleoecology. After she received her Ph.D., a permanent academic position for her meant a commuting marriage, which was unacceptable. But fortunately, her research didn't depend on a job, and its lack even saved her from the normal publish-or-perish pressures, and enabled her to spend many summers in the field, working out the Upper Ordovician paleoenvironments and fossil communities of the Ottawa Valley in exceptional detail. Because of this concentration on detail, publishing has been slow, but papers are coming out faster now.

Now we are both research associates in the Department of Geological Sciences at the University of Tulsa, where Miriam taught paleontology for about 12 years as an adjunct faculty member. We have lived in Bartlesville,

Miriam and Radomir in formal Oklahoma attire!

Oklahoma, since 1977, after arriving with the idea that three to five years was long enough to stay anywhere, particularly Oklahoma. But life in Bartlesville is not as we had expected. This city of about 35,000 people included for many years the headquarters and research facilities of Phillips Petroleum Company. There is an unusually large number of highly educated people and extraordinary facilities for a small city, many of which have been financed greatly by Phillips—not typical at all of Oklahoma."

Henry Bokuniewicz, Jr., G '76 (hbokuniewicz@notes.cc.sunysb.edu) writes, "It's pretty straightforward, really. After

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Linda and Henry in a watering hole in Venice on a research trip.

graduation, I joined the faculty at the State University of New York (now called "Stony Brook University") and I've been here for thirty-four years.

I had completed my dissertation research ("Estuarine Sediment Flux Evaluated in Long Island Sound") under the tutelage of Professor **Robert Gordon** (recently "retired"). I am forever grateful to him for setting me on the path. Linda and I then moved to Stony Brook, Long Island, NY. After having carried me through graduate school, Linda went back to finish her own degree, while I moved into an office in the University's Marine Sciences Research Center, an office I still inhabit. I am now a Distinguished Service Professor of Oceanography. I'm here in good company. **Kirk Cochran G '79** (kcochran@notes.cc.sunysb.edu), **Bob Aller G '77** (raller@notes.cc.sunysb.edu) and **Josie Aller** (former postdoc with Don Rhoads), and **Bob Cerrato G '80** (Robert.Cerrato@stonybrook.edu) are also on the faculty; we were in the same cohort at G&G, some sort of record, I'd guess. Linda is now retired after a long career in the Registrar's Office of the Fashion Institute of Technology in New York City.

Although there was a brief (decade) sidetrack into administration as Associate Dean for Education, my research into coastal sedimentary systems and coastal ground-water hydrology has taken us around the world—Mallorca, Venice, Brazil, Maurtius, Guam, Barbados.... one of these trips was a visit to the Romanian Marine Lab on the Black Sea coast just after the "Iron Curtain" fell. To make a long story short, we ended up adopting a ten-year old girl from Bucharest. Our daughter, Roxana, is now 26.

Bob Cruz at work in Montana.

Bob Cruz '79 (bobcruzjr@aol.com) writes, "I graduated with a concentration in vertebrate paleontology. **John Ostrom** was my advisor. However, I ended up working as a petroleum geologist in Denver, based on a recruiter's claim that "dinosaur geology is oil geology."

Later, I switched to computer programming and IT consulting. A few years ago I enrolled in the MFA program in Science and Natural History Filmmaking at Montana State University, a challenging mix of science, technology, art and writing—in a state that has igneous provinces, thrust sheets, canyons, dinosaurs, oil, gas, coal, etc.

I now create Earth Science-related media. For the National Park Service, I produced a video on the geology of Bighorn Canyon, located in Wyoming and Montana. For the Museum of the Rockies, I made a video on the fossil *Torosaurus*.

What's astounding, however, is how professors and students at Montana State react to any mention of **John Ostrom** and **John Rodgers** with a collective hush. What better acknowledgment of Yale's legacy in Earth Science?"

To view the Bighorn Canyon video, visit http://www.lifeonterra.com/episode.php?id=201

Jill Schneiderman '81 (jill.schneiderman@gmail.com) pictured with her partner of 17 years (wife of three years in Massachusetts!) Meg Stewart and their children Caleb and Tillie Stewart Schneiderman in front of the Josselyn residence hall at Vassar College—the place they called home for five years. Jill is a professor of earth science at Vassar and is delighted to report that when she was promoted to full professor in 2001, the first female geologist to attain that rank at Vassar, Brian and Cathy Skinner came for the celebration! Since graduating from Yale in 1981 (Jonathan Edwards college), Jill earned her PhD from Harvard studying metamorphic petrology. She began her teaching and research career at Pomona College. After earning tenure there, she took a postdoc at the Smithsonian and metamorphosed into a clastic sedimentologist doing provenance studies using heavy minerals. She feels very fortunate to have had a range of interesting opportunities over the years including a stint as a Congressional Science Fellow in the 104th Congress (1994) working for the then Senate minority leader, Tom Daschle (D-SD) and a Fulbright Fellowship (2003) at the University of the West Indies in St. Augustine, Trinidad. She has edited two books: *The Earth Around Us: Maintaining a Livable Planet* (Westview, 2003) and *For the Rock Record: Geologists on Intelligent Design* (University of California, 2009). Currently on sabbatical, she

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Jill (left) and Meg with their children Caleb and Tillie.

is a Contemplative Practice Fellow sponsored by the Fetzer Institute. You can read some of her recent writing on the subject of Buddhism and environmental change at: http://www.shambhalasun.com/sunspace/?s=schneiderman

The Wiese family in a photo taken several years ago: From left to right: Karen Wiese (Wellesley '57), Robert Wiese (Georgetown '10), Ted Wiese (back - '81), Edward Wiese (front - Yale '12), Mary Jo Wiese (Georgetown '82), Bob Wiese ('55).

Ted Wiese '81 (Ted_Wiese@troweprice.com) writes, "After graduating from Yale with a BA in Geology, I worked for a year with a DC law firm before going to business school at Dartmouth. For the last 25 years I have managed bond portfolios at T. Rowe Price in Baltimore, including a stint managing multi-currency portfolios in our London Office. I have been involved in a number of industry initiatives, mostly targeted at improving the transparency of bond market transactions.

I majored in geology not because I envisioned a career in the field but because it was interesting and fun. I found the faculty members to be enthusiastic and inspiring. It also helped me grow in my relationship with my father, **Bob Wiese '55**, who had earned a BS in Geology at Yale before completing his graduate work at Harvard in 1960. After a few years of minerals exploration field work in Colorado, Utah, and Nevada he settled into a 30-year teaching career at Mount Union College in Alliance, Ohio.

I haven't used my geology education much since leaving Yale, but when I drive through a mountain range, cross a river gorge or look down from an airplane I see aspects of God's creation that my travel companions can't appreciate."

Jeff Rubin '82 (jeff.rubin@tvfr.com) writes, "My career has been anything but linear. After leaving Yale, I got my MA and PhD at UT Austin, working on skarn deposits in central Mexico and the Ertsberg district (Irian Jaya), respectively, with a few years at the Texas Bureau of Economic Geology in between. I did not actually stay in geology. After several concurrent years as a volunteer firefighter, I took a full-time position with City of Austin Emergency Medical Services, where I worked for five years as a field medic, Hazardous Materials Captain, and mass casualty/disaster planner (sowing the seeds...). Along the way I served as Asst. Dean for Environmental Health & Safety at UT, where I developed a class in wilderness medicine. I've been working in health-system preparedness on just about every level, including a NATO Advanced Research Workshop in 2005. Since coming to Oregon in 2001, I've been heavily involved in natural hazards: I'm probably more involved

Jeff on the job, Oregon, 2009.

in geology now than I've been in the past ten years. I'm particularly proud of having taught Incident Command for Geologists, and Geology for Incident Commanders, to separate audiences in the same month. My current position is Emergency Manager of Tualatin Fire and Rescue, Aloha, Oregon."

Kim and Hugh at home in Colgate.

Kim Waldron G '86 (kwaldron@mail.colgate.edu) writes, "Brian Skinner wrote in his email to me: "the diversity of people's careers is intriguing." That made me feel a bit more confident that a note from a non-practicing geologist would be appropriate for the newsletter! After Yale, I spent five years in the UK (Manchester and Edinburgh) studying reaction mechanisms and mineral microstructures. Post-doc life was wonderful, especially in a place like Edinburgh, but I returned to the US in the early 90s to take a tenure-track position at Colgate University.

Teaching at a rural liberal arts college was exhausting but rewarding. Continuing my research, however, was more challenging.

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After experimenting with field areas and projects, I decided to pack it in and try something new. I went over to the dark side: administration.

Eventually, I became "secretary of the college," a combination of corporate secretary and chief of staff. I serve as the president's assistant, coordinate the university's legal affairs, I am secretary to the board of trustees and spend considerable time trying to figure out how complex organizations work. I reach for the odd Scottish cobblestone when the complex organization acts irrationally. My geology training translates well to this job—logic, a systematic approach, and the ability to see how all the layers fit together.

Meanwhile, my husband Hugh (a Brit) and I live in an old house on five acres, enjoy traveling back to the UK, and I (not Hugh) spend significant time digging in the dirt, another relic of careers past.

Madeline Schreiber '91 (mschreib@vt.edu) writes, "Since graduating from Yale, I have stayed in geology, taking a slight turn from "classical" geology to the field of hydrogeology. After Yale, I worked in environmental consulting on Superfund remedial investigations. The complexities of groundwater flow and chemical transport at these sites were challenging and intriguing, prompting me to research graduate programs in hydrogeology. Brian Skinner recommended that I apply to work with **Jean Bahr '76** at the University of Wisconsin-Madison, and thankfully, she took me on as a graduate student. After finishing an MS ('95) and a PhD ('99), I had another stroke of luck and was offered a faculty position at Virginia Tech. My research at VT has focused on chemical transport, including arsenic-mineral interactions,

New graduate student at Virginia Tech, Denise Levitan '09 (left) and her adviser Maddy Schreiber '91.

organoarsenic cycling, anaerobic biotransformation, and more recently, karst hydrogeology. In 2005, I received tenure and married Blaine Keesee, and in 2007, our son Jacob was born. My academic career has been extremely fulfilling; I have worked with wonderful colleagues and talented graduate students. The most recent addition to our group is **Denise Levitan '06** (dlevitan@vt.edu), who will be working on precipitation of autunite for uranium immobilization in aquifers.

My experience as a Yale G&G major provided a strong foundation for my career. Between classes with world-renowned faculty, field experiences in Newfoundland and Montana, and most importantly for my research career, the opportunity to do a senior thesis in geochemistry with **Tim Lyons G '92** (timothy.lyons@ucr.edu) and Professor **Bob Berner**, I couldn't have asked for better academic preparation. Many thanks to the department for all of their support not just of me, but of all G&G majors!"

Mark Davis G '96 (mark.davis@us.schott.com) writes, "I got my Ph.D. in 1996 in the field of crystallization kinetics of silicate melts and ended up staying at Yale another three years as my principal advisor at that time, **Phil Ihinger**, had just won a prestigious Packard Fellowship. Those three post-doc years were wonderful—more intellectual freedom than I've ever had in any job. But reality sunk in as my wife Joan and I had our second child and it became increasingly apparent that a "real" job was needed, and fast. Although I had a few nibbles in the academic job market, having to do a second or third post-doc in order to get to the market level of 10+ publications in order to land a job was out of the question. Thus, an industry job became more and more attractive, though not without second thoughts initially. A fortuitous chain of events led to

The Davis family in the Green Mountains of Vermont where they have gone camping every summer for the past 10 years or so (from L to R: Mark, Joan, Sarah (11), and Emily (15).

my being in the right place at the right time, leading to an interview and quick hire with a technical glass company in northeast PA, only some four hours from New Haven. We relocated near Scranton, in the heart of an established anthracite coal belt, surrounded by beautiful hardwood forests and quaint farms. The job is equally challenging and interesting—much of what I learned as a geologist has helped me at some point. There's considerable overlap between igneous petrology and glass science—same physics and chemistry, just different motivation and starting materials!"

ALUMNI REUNION • NOVEMBER 6–8, 2009

The Reunion, November 6-8, 2009, was a great success. Seventy alumni (44 grad school alums and 26 Yale College alums) returned and together with faculty (current and retired), current graduate students, and postdocs, the total gathering was about 200. Two and half days of talks by alumni, divided into five theme sessions, held everyone's attention. You can read all about it on the departmental web site, and see a large number of photos taken during the proceedings, at http://earth.geology.yale.edu/alumni/. Photos were taken by Tony Fiorini (husband of faculty member Maureen Long) and Harold Shapiro (Yale staff). The photos below are a small sample of what you will find at the web site.

Shun Karato (Fac) and Karen Fischer

Skip Hobbs, Tom Cranmer, and David Bercovici (Fac)

Phil Perkins and Larry Grossman

Bob Cruz, Mark Wilson, and Star Childs

Neil Williams, Joe Graf, and Danny Rye (Fac)

Baerbel and Steve Schamel, Dick Bambach (right)

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Dinosaurs had Fancy Feathers

An innovating study by graduate students **Jakob Vinther** (jakob.vinther@yale.edu)**, Julie Clark G '02** (Julia_clarke@ncsu.edu), faculty members **Richard Prum** (richard.prum@yale.edu) and **Derek Briggs** (derek.briggs@yale.edu), together with colleagues from other institutions, has put some color into dino feathers. You can read the complete report in www.sciencexpress.org/5February2010/10.11.26/science.1186290.

Vinther was studying fossilized squid-ink under the electron microscope when he discovered little sacs, called melanosomes, full of ink. He hypothesized that objects tentatively identified as bacteria in some fossilized dinosaurs might actually be melanosomes. Shapes of melanosomes are color specific. Study of a suitably preserved specimen, a chicken-sized Jurassic dinosaur *Anchiornis huxleyi* from Liaoning Province, China, revealed enough melanosomes to allow the team to complete a full-feather reconstruction. *Anchiornis* shows that when feathers appeared in the fossil record they were already distinctively striped and colored. They also preceded flight; commented Prum, "a more likely function than flight for the first feathers was communicating and signaling."