GEOLOGY & GEOPHYSICS NEWS

Yale University | Department of Geology and Geophysics **Fall 2009**

Chairman's Letter

David Bercovici (david.bercovici@yale.edu)

Dear Friends and Alumni of Yale Geology & Geophysics,

This year is the start of my second three-year term as Chair of Geology & Geophysics and I'm very happy to report on recent and upcoming events, as well as changes and growth in our fine department.

David Bercovici and some students from G&G 100, "Natural Disasters," on a field trip in Hawaii, March 2008. He was assisted by Madalyn Blondes G '09 (next to Dave), Abigail Fraeman '09 (kneeling, glasses on cap), and Chloe Michaut (far left; postdoc, now Assistant Professor at Institut de Physique du Globe).

You've perhaps seen reported in previous issues of this newsletter that in the last two years we've added four new junior faculty: geochemists **Zhengrong Wang** and **Hagit Affek**, and geophysicists **Kanani Lee** and, most recently, **Maureen Long**.

This academic year we will see at least two new faces on our faculty, **Mary-Louise Timmermans** and **Trude Strorelvmo**. Dr. Timmermans is an arctic oceanographer whose PhD is from Cambridge University and was until recently an Assistant Scientist at the Woods Hole Oceanographic Institution. She started her position at Yale as an Assistant Professor July 1, 2009. Dr. Strorelvmo is an atmospheric physicist who specializes in the role of aerosols in climate models. Her PhD is from the University of Oslo and she is presently a Postdoctoral Fellow at ETH-Zurich; she will begin her position as an Assistant Professor January 1, 2010. As of this writing we are still in negotiations for yet another junior faculty position, as well as exploring a senior target of opportunity hire, and I hope to be able to report more on these next year.

Last academic year we also saw three of our Associate Professors reach Tenure and promotion to Professor. As reported last Fall, **David Evans** was promoted to Professor, effective January 2009. In the following Spring, both **Ruth Blake** and **Jun Korenaga** were likewise promoted to Professors, effective July 2009.

George Veronis, who was a Professor at Yale since 1966, retired this year from his faculty position. George was department Chair from 1976–1979, the Henry Barnard Davis Professor since 1985, the founder of both the Yale Applied Mathematics Program and the Woods Hole Oceanographic Institution's GFD Summer School, the Editor for the *Journal of Marine Research* since 1973, and a Member of the National Academy of Sciences. George will continue in the department as a Senior Research Scientist effective this fall.

In 2008 we matriculated 21 new graduate students, and this coming year we will have a healthy in-take of 10 new students. Growth of our graduate

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SAVE THE DATE!

ALUMNI REUNION AND CONFERENCE
FRIDAY–SUNDAY, NOVEMBER 6–8, 2009
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program is a credit to **John Wettlaufer**, who served as Director of Graduate Studies these last three years and has stepped down to return full-time to his research and teaching duties. **Elisabeth Vrba** has kindly agreed to assume the role of Director of Graduate studies. To adjust to the growth of our program, we will move to a DGS and Deputy DGS rotation, and **Ruth Blake** will be our first Deputy DGS. The new face of departmental governance also includes a new Director of Undergraduate Studies: while **Brian Skinner** kindly served as DUS during 2008-2009, **David Evans** will assume the role for a three-year term starting this fall.

We congratulate the seven seniors who graduated this year. Elsewhere in this Newsletter you can see diversity of their research topics. In the same entry you will find information on the 12 graduate students who earned their PhDs during the last year.

Since 2007, our department has been leading the effort to build the new **Yale Climate and Energy Institute,** designed to integrate science and engineering with social sciences throughout Yale on critical problems of the causes and effects of climate change and a clean energy future. I'm happy to report that the YCEI was formed this year, and there is an accompanying article explaining progress on that effort.

Finally, as many of you know, this November we will host the Yale Geology & Geophysics Alumni Reunion, November 6–8, 2009, so that all our former graduate, undergraduate, and postdoctoral alumni can come visit old advisors and professors and meet the newest faculty and students and scholars. You will find details of the program and how to register elsewhere in this Newsletter.

It is 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, and hope to see you this November!

Congratulations!

To the seven seniors who graduated this year. The topics of their senior research projects are a measure of the growing diversity in the department.

Claire Bucholz studied *Fluid flow and Al transport during quartz-kyanite vein formation,Unst, Shetland Islands, Scotland*. This work has been submitted for publication.

Andrew Delman researched *Erosion and overwash: Tracking and numerical modeling of coastal barrier evolution at Little Homer Pond, Martha's Vineyard.*

Abigail Fraeman researched *The thermal evolution of Mars modulated by mantle melting*. This work is being prepared for publication.

Kimberley Lau investigated *Paleoecology and paleogeography of the New York Appalachian Eurypterids.*

Brent Lowry investigated *The tectonic implications of ultrahigh-pressure metamorphism.*

Ian Rose investigated *Paleomagnetism of the Pilbara Craton, Western Australia.*

Nat Wilson reported on *Modeling Patagonian ice sheet extent during past glaciations.*

David Gerstle, a physics major, carried out his research in our department on *Leaving Dorothy behind: Studying severe storms outside Kansas.*

To the twelve graduate students who were awarded their PhDs within the last year.

Robert Allen, for *Late 20th century atmospheric changes: Implications for tropical tropospheric warming and the role of absorbing aerosols.* Bob is currently a postdoc at the University of California, Irvine.

Megan Andrews, for *Quantification of the effects of Angiosperms and Gymnosperms on silicate weathering and related soil nutrient cycling.* Megan is now a postdoc at the University of Sheffield in the UK, working with David Beerling.

Madalyn Blondes, for *Single eruption temporal-compositional variation in basalts.* Madalyn is now a postdoc at the University of Maryland, working with Roberta Rudnick.

Jung Hyo Chae, for *Seasonal cycle of the tropical tropopause and its influence on tropical deep convection.* Jung Hyo is a postdoc at NASA's Jet Propulsion Lab.

Alana Kawakami Gishlick, for *The Ontogeny, Phylogeny, and Ecology of the Herpestid Auditory Bulla.* Alana is currently considering her options.

William Landuyt, for *The generation of Plate Tectonics on a planet.* Billy is a Green's Scholar at Scripps Oceanographic Institution and in 2010 will join Exxon Research in Houston.

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CONGRATULATIONS

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Garrett Leahy, for *Structure and dynamics of a mid-mantle melt layer. Predictions and observations of hydrous melting above the Transition Zone.* Garrett is now employed at Exxon Research in Houston.

Jerome Neufeld, for *Natural and forced convection during solidification.* For his thesis research the AGU has awarded Jerome the Donald L. Turcotte Award for Nonlinear Geophysics. Jerome is the Lloyds Tercentenary Fellow in the Dept. of Applied Mathematics and Theoretical Physics, University of Cambridge, UK. In October Jerome will become a Junior Research Fellow in Mathematics at St. Catherine's College, University of Cambridge.

Daniel Peppe, for *Magnetostratigraphy and paleobotany of the Fort Union Formation in the Williston and Powder River Basins (North Dakota and Montana, USA).* Dan is now an Assistant Professor at Baylor University, Waco, TX.

Theresa Raub, for *Paleomagnetism of the Dubawnt Supergroup, Baker Lake Basin, Nunavut, Canada; Refining Laurentia's Paleoproterozoic apparent polar wander path.* Theresa is now a postdoc at California Institute of Technology.

Tim Raub, for *Prolonged deglaciation of 'Snowball Earth.'* Tim is now a postdoc at California Institute of Technology.

Brett Tipple, for *Leaf waxes and environment recorders: An empirical evaluation and paleoclimate applications.* Brett is now a postdoc at the University of Utah working with Jim Ehleringer.

The Yale Climate and Energy Institute

Rajendra K. Pachauri

In March of 2009, at the International Scientific Congress on Climate Change in Copenhagen, Yale's President Richard Levin announced the formation of the Yale Climate and Energy Institute, and its first Director Rajendra K. Pachauri, the Head of the Intergovernmental Panel on Climate Change (IPCC), which shared the Nobel Peace Prize in 2007 with Al Gore.

The YCEI was initiated in the Department of Geology & Geophysics in Fall 2007 with an exploratory G&G faculty committee appointed by the G&G Department Chair and chaired by Prof. Mark Pagani. The Department hosted a Yale-wide workshop in March 2008 to inventory and share progress in climate and energy research presently occurring at Yale, and to discuss how an interdisciplinary umbrella institute might be formed to foster practical solution-based research. Following this highly successful workshop, the Department spear-headed a team, made of faculty from various Yale departments, from natural sciences, engineering and social sciences, to propose a new Yale institute that would bring together Yale's talent and stature to address the global problems of climate change and renewable energy. President Levin received the proposal in the summer of 2008 and the Department negotiated and worked with the Administration to bring the institute into existence. It is a testament to President Levin's commitment to this issue that he personally recruited Dr. Pachauri to be the YCEI's first Director.

At present the institute is establishing its first activities through interdisciplinary grants, workshops, postdoctoral fellowships and symposia, in addition to helping sponsor a Yale "side event" at the COP15 International Climate Congress in Copenhagen this December. Possible future research activities include carbon sequestration, spread of vector borne disease during climate change, and natural biochemical fuels, to name a few. One project already underway is a collaboration between Yale and the USGS to evaluate potential changes in groundwater in New Haven as a result of rising sea level. The Institute's governance is, in addition to the Director Pachauri, a faculty Deputy Director (currently G&G Chair David Bercovici) who also Chairs the YCEI Executive Committee made up of Yale faculty from across the university, and an Assistant Director (at the time of this writing, not yet hired) to over-see day-day operations of the Institute.

The goals of the YCEI are to bring the weight of Yale to bear on some of the most pressing issues of our generation. The YCEI puts Yale on the international stage as an important player in addressing monumental global problems, and we hope its future contributions will be lasting and profound.

G&G ALUMNI REUNION, NOVEMBER 6–8, 2009




You are warmly invited to a special weekend in New Haven for alumni of the graduate and undergraduate programs in Geology and Geophysics

- See old friends, colleagues and mentors.
- Attend a major conference on the future of the earth sciences featuring department alumni as panelists.
- Tour the new 136-acre West Campus, straddling the towns of Orange and West Haven, to see the array of facilities available for medical and scientific research at Yale.
- Talk with current graduate students about their research at a poster session to be held in Kline Geology Laboratory.
- Explore Kroon Hall, the new “ultra-green” building for the School of Forestry and Environmental Studies (and the most sustainable building at Yale) where our Saturday sessions will be held.
- Enjoy festive meals and receptions with fellow alumni in Geology and Geophysics from all eras.

Topic Areas and Speakers:

Friday, November 6, 4:30–5:45 pm:
Earth’s origin and interior
Henry J. B. Dick G ’86, *Woods Hole Oceanographic Institution*
Karen Fischer ’83, *Brown University*
Lawrence Grossman G ’72, *University of Chicago*
Garrett M. Leahy G ’08, *Exxon Research*
Peter M. Shearer ’78, *University of California, San Diego*

Saturday, November 7, 9:00–10:15 am:
Resources and energy
Michael L. Oristaglio ’74, *Schlumberger Ltd.*
Robin L. Petrusak ’79, *Advanced Resources International*
Donald F. Schutz ’56 G ’64, *Geonuclear Inc.*
Neil Williams G ’76, *Geoscience Australia*

Saturday, November 7, 10:45 am–noon:
Geological evidence for past climates
Timothy D. Herbert ’80, *Brown University*
Thomas M. Marchitto ’94, *University of Colorado*
Stephen C. Porter ’55, G ’62, *University of Washington*
Daniel P. Schrag ’88, *Harvard University*

Saturday, November 7, 1:30–2:45 pm:
The climate system: Recent studies and implications for future climatic change
Vanda Grubišić G ’95, *University of Vienna*
Dorothy M. Koch G ’93, *Columbia University*
Michael E. Mann G ’98, *Penn State University*
Karl E. Taylor G ’78, *Lawrence Livermore National Laboratory*

Saturday, November 7, 3:15–4:30 pm:
Marine life, evolutionary transitions to land, and biogeochemistry of oceans and atmosphere
Richard K. Bambach G ’69, *Smithsonian Institution*
Steven M. Stanley G ’68, *University of Hawaii, Honolulu*
John M. Vanden Brooks G ’07, *University of Arizona, Tempe*

Sunday, November 8, 10:30–11:45 am:
Terrestrial life, evolution, and biogeochemistry
Julia A. Clarke G ’02, *University of Texas at Austin*
Kirk R. Johnson G ’89, *Denver Museum of Natural History*
Mark A. Norell G ’88, *American Museum of Natural History*
Dana L. Royer G ’02, *Wesleyan University*
Krister Smith G ’02, *Forschungsinstitut Senckenberg*

Please register at:
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FACULTY RESEARCH

Investigating Earth's Interior and Other Extreme Environments

by Kanani Lee

***Kanani K. M. Lee** (kanani.lee@yale.edu) joined the department in July 2008. She is working on high-pressure and high-temperature experiments in the context of reproducing the extreme conditions in the Earth and other planets' interiors. In particular, she is investigating the composition of the Earth's mantle and core, and the interactions in between the two vast regions that are essentially inaccessible to us here on the surface.*

Earth's bulk composition is fundamental to understanding the formation and evolution of not only Earth but also other planets in our own and other solar systems. However, estimates of the Earth's bulk composition remain controversial and elusive.

To determine the composition and structure of Earth's deep interior, one must employ both geophysical and geochemical techniques. Structure is primarily determined by seismology, which shows global discontinuities in seismic-wave velocities at approximately 410- and 660-km depths, defining a transition zone where upper-mantle mineral olivine (Mg, Fe)$_2$SiO$_4$ undergoes two structural transitions (α olivine → β wadsleyite → γ ringwoodite) and finally decomposes into magnesium silicate perovskite (Mg, Fe)SiO$_3$ and magnesiowüstite (Mg, Fe)O. The velocity structure changes again near the core-mantle boundary, the D'' layer, and likely reflects a change in chemistry, thermal structure and/or mineral structure in the high-pressure transformation of perovskite to post-perovskite. The final major global discontinuity is within the core and defines the boundary between the solid inner and liquid outer core. Additionally, high-resolution tomography of body waves shows that subducting slabs penetrate the transition zone and plunge into the deep mantle, confirming earlier claims of whole-mantle convection based on geophysical observations of the geoid and seafloor topography.

Geochemists, geodynamicists, seismologists, and mineral physicists have long debated the nature of the Earth's mantle, which comprises more than three-quarters of the Earth's volume and nearly two-thirds of its mass.

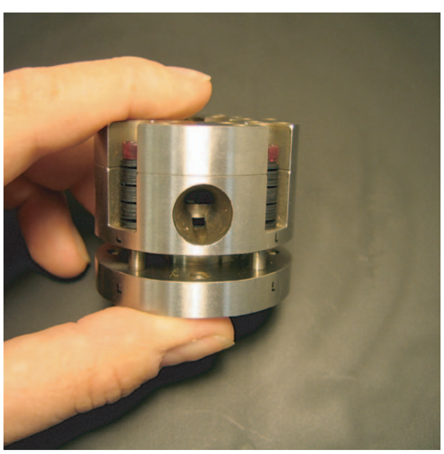

Fig. 1. Left. A typical diamond-anvil cell used to create all of the pressures throughout the Earth's mantle. Right. Close-up of the pair of diamonds used to create high pressures. Diamonds are typically 1/4 to 1/3 carats each in size.

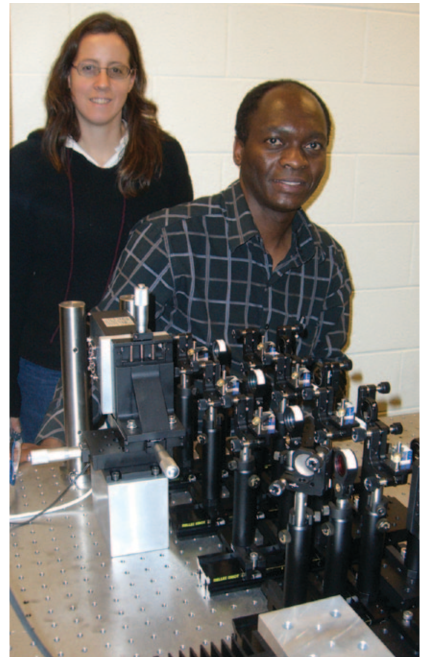

Fig. 2. Visiting research scientist Laura Robin Benedetti and lab manager George Amulele in front of the 4-color laser-heating temperature measurement system. The laser-heating system can heat samples up to several 1,000 K under pressures of the Earth's interior.

The chemical makeup of this region is especially important for understanding heterogeneity, which constrains deep structure and mixing and is crucial for inferring the thermochemical evolution of the Earth, from planetary accretion and the magma ocean, to continental growth and the formation of the oceans and atmosphere.

Mantle rocks are rare at the surface, but those that are found are predominantly peridotites (igneous rock consisting mostly of olivine and pyroxenes) and representative of the upper ~150 to 200 km of the mantle. Do these peridotites represent the rest of the mantle, down to ~2,900-km depth?

This is where my research begins. We can recreate the

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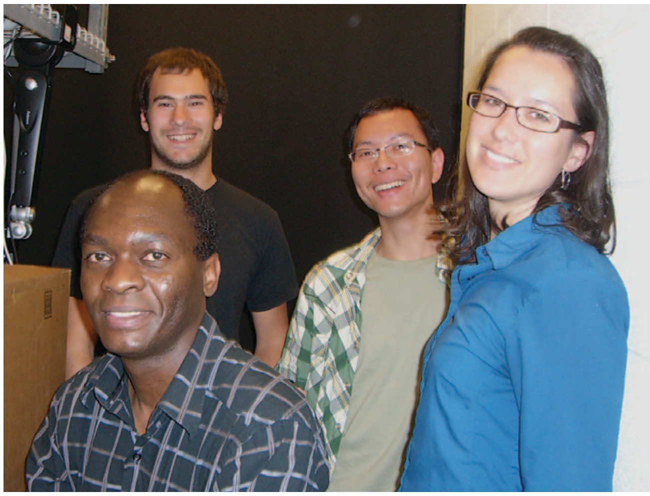
Fig. 3. From left to right, lab manager George Amulele, graduate student Joseph Panzik, graduate student Zhixue Du and Kanani Lee take a break from calibrating the laser-heating system in Yale's High-Pressure Diamond-Anvil Cell Lab.

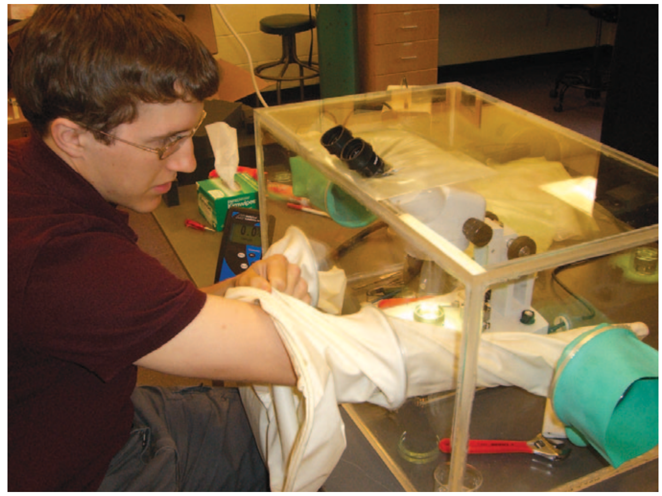
Fig. 4. Undergraduate student Joseph O'Rourke loads potassium metal in a glove box under an inert argon atmosphere.

EARTH'S INTERIOR *continued from page 5*

conditions within the Earth (and other planets) with the use of a diamond-anvil cell (Fig. 1) and use the results to compare with other geophysical and geochemical observables and models. The cell uses two gem-quality diamonds and exploits the fact that they are hard and are transparent to many wavelengths of light. Only minimal amounts of force (equivalent to a few 100 kg) are needed to produce the highest pressures attained in the Earth, >3.5 million times room pressure! This is due to the small sample area that is compressed—just a tiny fraction of a square millimeter. To recreate the Earth's high temperatures, we focus a high-powered infrared laser onto the sample, thus achieving simultaneous high pressures and high temperatures (Figs. 2, 3). Doing so can produce temperatures greater than ~2,000 K and can reach the highest temperatures expected in the Earth and beyond.

To first order, experiments show that the mantle is not homogeneous in composition, and that the peridotites that we sample on the surface do not represent the bulk composition of the mantle. We have determined this using *in situ* high-resolution X-ray diffraction and electron microprobe analyses on quenched samples.

The technique is versatile as it can be used to probe not only mantle rocks or core constituents, but virtually any material. Graduate student **Joseph Panzik** is investigating the high-pressure and high-temperature behavior of *ices*: molecular compounds, such as water, methane and ammonia, thought to be the primary components of planets like Neptune and Uranus. Undergraduate student **Joseph O'Rourke** is investigating the melt behavior of potassium metal under pressure (Fig. 4). Potassium is interesting on several levels: as a heavy alkali metal, potassium undergoes a pressure-induced electron transition that changes its normally lithophile affinities to siderophile ones. Additionally, as has been shown in metallic sodium, the melting curve is expected to turn over and at high enough pressure may melt at room temperature. This behavior is also relevant to our understanding of the lightest "alkali metal" and most abundant element in the universe, hydrogen. Newly arrived postdoctoral researcher, **Yuejian Wang**, is using the diamond-anvil cell to study graphite and other, superhard forms of carbon (besides diamond).

Petrology and Mineralogy

by Jay J. Ague (jay.ague@yale.edu)

Our research group studies heat and fluid flow through rocks and soils with applications ranging from metamorphism to carbon sequestration. Target hypotheses are firmly rooted in fieldwork and are then tested using geochemical laboratory data and numerical modeling results. My philosophy for selecting field sites is to always focus on areas around the globe that provide world-class examples of important phenomena, such as the Sierra Nevada (granitic batholith generation), the Scottish Highlands and New England (regional metamorphism), and Greece and

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New Zealand (subduction zone processes).

In recent years, much of our field study has centered on the Scottish Highlands and has involved four graduate students and one undergraduate major (Fig. 1; work supported by the NSF). This region includes the classic-type locality for Barrovian metamorphism, the most common type of metamorphism recognized in mountain belts worldwide. Why study heat and mass transfer during metamorphism? Here are a few reasons. Metamorphic water released from subducted slabs causes partial melting in the mantle, ultimately resulting in arc volcanism and the associated volcanic hazards. The release of metamorphic volatiles like water and carbon dioxide into the pore space of rocks causes rock weakening, hydrofracture and, in tectonically active areas, seismic energy release. Metamorphic fluids transport many valuable ore metals from the middle and deep crust to shallower levels where they may be precipitated in ore deposits. Finally, the release of greenhouse gases like methane and carbon dioxide during metamorphism influences the long-term evolution of climate and remains as a major unresolved flux in the global carbon cycle.

Heat input is a fundamental driver of metamorphic processes. The traditional view is that heating of regional metamorphic rocks in the middle and lower crust is a relatively sluggish process that takes place on timescales of many millions or even tens of millions of years. However, recent work together with **Ethan Baxter '95** at Boston University has resulted in a radical new interpretation. (Ethan did his Senior Thesis research with me in the Scottish Highlands).

Fig. 1. Field work in the Scottish Highlands with PhD student Sarah Vorhies and Jay Ague.

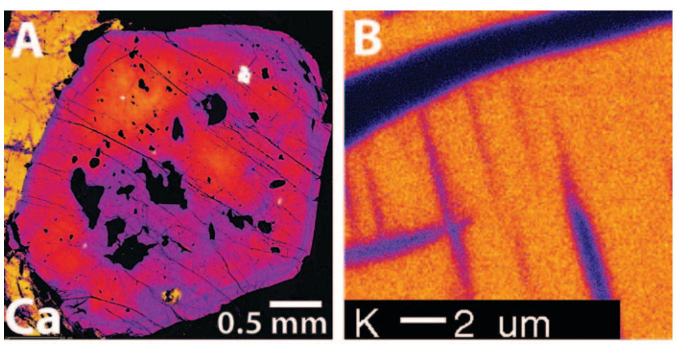

Fig. 2. Two-dimensional, false-color chemical maps made using the new electron microprobe. A. Map of calcium concentrations in thin section of high-temperature garnet crystal from the Scottish Highlands. The preservation of steep chemical gradients between high (orange) and low (purple) concentrations in the crystal shows that diffusion did not have time to homogenize the mineral composition. The timescales of metamorphic heating must have been very short ($<10^6$ years) for this to be the case. Dark inclusions in garnet are mostly micas and quartz. Yellow crystal at left is plagioclase. B. Chemical map of potassium in alkali feldspar which has exsolved albite. High concentrations (orange) are K-feldspar, low concentrations (darker regions) are albite. Note spatial resolution of submicron scale exsolution lamellae.

We measured chemical diffusion profiles preserved in the minerals apatite and garnet from rocks in the Barrovian-type locality (Fig. 2A). The basic idea is simply that original chemical growth zoning in a mineral will be smoothed to some degree by diffusion during metamorphism. The degree of this "blurring" is a function of temperature and time. For example, the longer a crystal is held at a certain temperature, the more diffusional smoothing there will be. Thus, if the temperature history of a rock is known from thermobarometry and the diffusion characteristics of an element or group of elements in the mineral of interest are known, then the extent of smoothing constrains timescales of heating.

To our great surprise, we discovered that the heating history of the Barrovian rocks was punctuated by a brief thermal pulse or pulses which in total lasted only a few hundred thousand years (Fig. 4; Ague and Baxter, 2007). Although brief, we conclude that these "peak metamorphic" pulses were responsible for producing the classic sequence of Barrovian metamorphic rocks in the northeastern Highlands. What could cause such thermal pulses? Magmatism, and the associated fluid flow, is a likely possibility. It turns out that a suite of igneous rocks intruded the metamorphic sequence at the time of "peak" thermal conditions, and geographically the metamorphic sequence is centered on this zone of magmatic activity. Magmatism has long been recognized as the key source of heat for contact metamorphism, but our findings are now showing how important it can be for the middle and deep crust as well. Testing

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the hypothesis of such deep, "ultrafast" heat transfer is proceeding on several fronts. PhD student **Sarah Vorhies** will be measuring the age of metamorphism using U/Pb dating of zircons at UCLA, and will also be measuring and modeling diffusion profiles across the Highlands to identify areas of pulsed heating. PhD student **Tanya Lybetskaya** has constructed a range of numerical models that explore the impact of fluid flow, chemical reactions, and magmatism on the thermal evolution of mountain belts (Lyubetskaya and Ague, 2009a, b). And **Claire Bucholz '09**) has just completed her senior project (now accepted for publication) on fracturing and vein formation in Scotland showing that deep (~35 km) fractures transported immense volumes of fluid during Barrovian metamorphism (Bucholz and Ague, 2009).

The study of heat and fluid flow has broad applicability to countless other areas of study in the geosciences. Carbon sequestration is of potentially great societal relevance today for remediating greenhouse gas emissions. One model for sequestration is to inject waste CO_2 into deep underground reservoirs where it would be held in the pore space of rocks. This process might be able to sequester many gigatons of CO_2, but critical questions remain. One key consideration is that the CO_2 has to stay sequestered and not leak out back to the surface. If the CO_2 reacts with and dissolves the storage rock matrix, it could create porosity, increase permeability, and facilitate leakage. On the other hand, other reactions might precipitate new minerals that would clog pores and diminish the reservoir's capacity to hold CO_2.

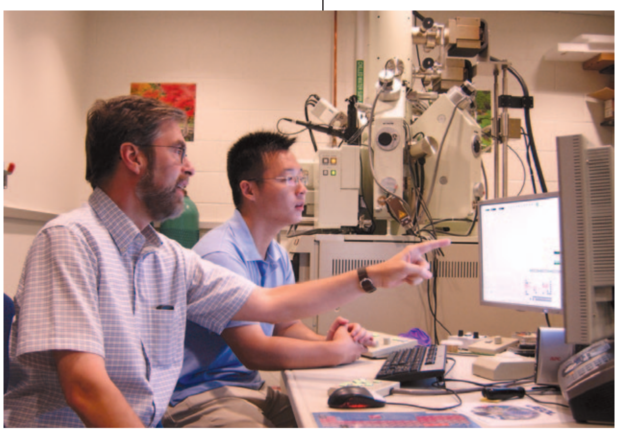

Fig. 3. Jay Ague and newly arrived PhD student Meng Tian inspect chemical data being gathered by the new electron microprobe.

Addressing these kinds of questions demands that we know the rates and mechanisms of fluid-rock reaction so that appropriate reservoir rocks can be selected and the long-term evolution of reservoirs can be modeled. Traditional fluid-rock reaction models widely used in industry and academia do not consider the effects of surface free energy on reaction rates and processes. However, work with Bateman postdoctoral Fellow **Simon Emmanuel** has led to the discovery that such effects are more and more important the smaller the pore sizes, and the crystals filling them, become (work supported by ACS-PRF). Using both modeling results and laboratory measurements of porosity distributions in sedimentary samples we have found that the effect may be widespread in pore sizes of around 10 microns in diameter or less—a critical range that commonly accounts for 50 percent or more of the total pore space in sedimentary rocks (Emmanuel and Ague, 2009, and in prep.). One consequence is that precipitation rates in this pore-size fraction for typical reservoir targets like sandstones will be reduced by an order of magnitude or more relative to standard model predictions. These new results could lead to a major reevaluation of long-term predictions for the safety and stability of potential underground CO_2 sequestration sites.

The above examples, as well as our other ongoing research programs, depend critically on laboratory data. With support from NSF and Yale University, a new, state-of-the-art, JEOL JXA-8530F field emission gun electron microprobe has been installed in my laboratory on the third floor of KGL (Fig. 4). Managed by **James (Jim) Eckert**, the facility is the first of its kind in an academic setting in the United States. The instrument is capable of vastly improved performance relative to our previous microprobe and can produce two-dimensional chemical maps of samples with submicron-scale spatial resolution (Fig. 2B). Applications include qualitative and quantitative chemical analyses and maps of a huge spectrum of materials including fossils, bones, alloys, ceramic and metallic artifacts, soils and, of course, minerals in rocks.

As Curator-in-Charge of Mineralogy for the Yale Peabody Museum of Natural History and the Museum's Acting Director in the latter half of 2008, I am heavily involved in the Museum's research, teaching, and outreach activities. I was the lead curator for the Peabody's new Hall of Minerals, Earth, and Space (HoMES), an interactive, multimedia exhibit that facilitates integration of research results into Earth science displays viewed by over 150,000 visitors each year. Many of these visitors are schoolchildren from the urban centers of New Haven, Bridgeport, and other Connecticut cities. The Yale Peabody Museum

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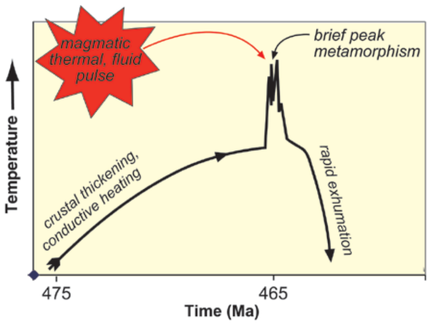

Fig.4. Cartoon of temperature-time history for mountain building and Barrovian metamorphism, Scottish Highlands. Modified from Ague and Baxter (2007).

PETROLOGY *continued from page 8*

has provided a critical introduction to science for countless children (and their parents!) through the years and, with ongoing educational programs, will do so well into the future. The newly opened HoMES exhibit draws upon the vast collections of the Peabody Museum (dating back to Silliman and Dana) as well as the latest scientific research to unlock the mysteries of the rock record. Education and public outreach are central to the Peabody's mission and are fundamental to the HoMES exhibitition. Ague has received separate funding from an NSF educational grant to develop geoscience educational resources for area schoolteachers as part of the "Peabody Fellows Program." Our program is filled for summer 2009 and will comprise 50 teachers from area schools.

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RECENT AWARDS

Larry Grossman and his wife Karen vacationing near Jasper, Alberta.

Leonard Medal

Lawrence Grossman G '72 (yosi@uchicago.edu) was awarded the Leonard Medal, the senior award of the Meteoritical Society in 2009. Larry worked with **Karl Turekian** for his PhD research, which resulted in two influential papers that launched him into the topic of his life's work. His 1972 paper was on the condensation of a sequence of minerals from the gas of solar composition, and his 1973 paper presented analyses of the Ca-Al-rich inclusions from the Allende Meteorite. Larry has been at the University of Chicago since leaving Yale, and along the way he has received the Clarke Medal of the Geochemical Society (1974), and a Macelwane Award from the American Geophysical Union.

Ken Farley, 2009

Day Medal

Kenneth A. Farley '86 (Farley@gps.caltech.edu) was awarded the Arthur L. Day Medal of the Geological Society of America for 2008. This prestigious medal is named for the first Director of the Geophysical Laboratory, who also happened to be educated at Yale (AB 1892, PhD 1894). Ken was a chemistry major at Yale but discovered geochemistry along the way and did his senior thesis research with **Karl Turekian** on ^{210}Pb in circumpolar waters of the South Atlantic. For his PhD Ken worked with Harmon Craig at Scripps on the geochemistry of ^{3}He, then after terms as a postdoc at Rochester and Lamont-Doherty, he joined the faculty at Caltech, where he is currently Chair of the Division of Geological and Planetary Sciences. Among other awards, Ken has received the Houterman's Prize from the European Geochemical Association in 1997, and in 1999, a Macelwane Award from the American Geophysical Union.

AGU Education Award

This spring **Kim Kastens '75** (kastens@ldeo.columbia.edu) was honored to receive the 2009 Award for Excellence in Geophysical Education from the American Geophysical Union (AGU). The citation for the award was "for pioneering work educating journalists about the geosciences; for playing a foundational role in establishing geoscience learning as a field of research; and for work with teachers and teaching materials to improve geoscience education." This is the second year in a row that AGU's education award has had a Yale connection; **George Veronis** was corecipient of the 2008 award, along with the other

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founders of the Geophysical Fluid Dynamics program (see Winter 2009 newsletter).

Kim writes "in the summer after graduation, I had my first encounter with innovative approaches to geoscience education, TA'ing **Robert Gordon's** field-based course on "Long Island Sound: Science & Use." This was during Yale's fleeting experiment with a summer semester, and the course was taught almost entirely in the field, traipsing through salt marshes and out on the Sound in small boats. I then spent a year as a technician at the Marine Science Research Center at Stony Brook, continuing my work on Long Island Sound and expanding into New York harbor.

In the summer of 1976, I drove across the country and fetched up in the PhD program at Scripps Institution of Oceanography. The Plate Tectonics revolution was in full swing, and my declared research concentration in near-shore processes did not survive my exposure to the wonders of deep-sea marine geology during its era of most rapid discovery. I switched research groups to the Deep Tow group and spent the remainder of my graduate school years researching the interplay between tectonic and sedimentary processes at transform faults in the Pacific and the convergent plate margin of the Eastern Mediterranean.

After grad school, I moved to Lamont-Doherty Earth Observatory of Columbia University, where I worked with a research group that was pioneering new high-resolution seafloor mapping technologies. Between my time at Scripps and my early years at Lamont, I spent more than two full years at sea, participating in or leading 25 oceanographic expeditions, aboard U.S., Italian,

Kim Kastens doing research on children's map skills.

French, and Canadian research vessels. I loved being at sea, mapping terrains that no one had ever seen before; I felt close to the secrets of the universe. I also got to know my husband, Dale Chayes, at sea, and we married in 1985, on a boat.

But by the early 1990s, I was the mother of a lively and inquisitive toddler and feeling a sense of frustration that all the energy I had been pouring into my science wasn't doing much to make the world a better place for my daughter and her generation. I began looking around the periphery of science for a way to use my expertise while doing something that felt useful as well as interesting.

First, I found instructional technology. Like marine geology in the 1960s and 70s, instructional technology in the 1990's was a wide-open field attracting innovative thinkers from many fields. With colleagues, I developed software and accompanying curriculum materials to help children learn to read maps. It was exciting to see our materials published and feel the enthusiasm of teachers and students, but the empiricist in me wondered what the kids were actually learning. With no inkling of how hard it is to do education research well, I began to develop methods to investigate children's strategies and difficulties as they struggle with the complex cognitive task of translating information from the three-dimensional, large-scale, visually intricate, constantly changing landscape that they see around them into the two-dimensional, small-scale, abstract representation we call a map. This led to an entirely new and vibrant line of research on spatial thinking in geosciences. That, in turn has brought me to the leadership of a national effort to develop a synthesis of research on thinking and learning in the geosciences. Our team of geoscientists, geoscience educators, a developmental psychologist, a cognitive psychologist, an anthropologist, and a philosopher of science is synthesizing what is known and articulating what is most in need of further research on four themes: thinking about time on geological timescales, understanding the Earth as a complex system, learning in the field, and spatial thinking as applied to geosciences.

And about those journalists mentioned in AGU's citation? I noticed that through shear historical coincidence, my university happened to have both a world-class Earth science institute and a world-class journalism school. Working with a J-school colleague, I founded and now direct Columbia's dual masters degree program in Earth & Environmental Science Journalism. Our students split their time between the Department of Earth & Environmental Sciences and the Graduate School of Journalism. They graduate with two masters

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degrees, plus the knowledge and skills to report on discoveries, insights and controversies about the Earth and environment in a way that is simultaneously interesting and accurate.

It looks to me that humanity faces profound problems in its relationship with planet Earth; non-negotiable problems such as ensuring sufficient food, potable water, energy, and a stable climate. Throughout history and prehistory, *Homo sapiens'* most effective survival strategies have hinged around the ability to think and to combine the thinking of multiple individuals through mechanisms of distributed cognition. If our descendants look back on the 21st century and see that society survived and thrived, it will likely be because current generations managed to think their way, and collaborate their way, through the problems at hand. I am trying to improve our chances by helping to create a populace that knows more, understands more, and cares more about the Earth and the environment.

The 2009 Simpson Prize Recognizes Research on Miocene Fossils

The Yale Peabody Museum presents its 2009 George Gaylord Simpson Prize to **Faysal Bibi**, a doctoral student in Geology and Geophysics, for his paper "Dietary niche partitioning among fossil bovids in late Miocene C3 habitats: Consilience of functional morphology and stable isotope analysis," published in *Palaeogeography, Palaeoclimatology, Palaeoecology* 253(3-4):529–538.

Faysal Bibi's research investigates the evolutionary history of mammals over the last 10 million years of life history through his work on fossils, mainly

Faysal Bibi (photo: Mark Beech).

from Ethiopia, Kenya, Pakistan and the United Arab Emirates. For his doctoral thesis, Faysal focused on the fossil record of bovids (antelopes, sheep and oxen).

One particular avenue of this work concerns the adaptation of herbivores such as bovids to changing vegetational habitats. For example, major environmental changes that took place around 7 million years ago produced the earliest tropical grassland ecosystems, akin to those of modern savannas, and was also the time of the earliest representatives of modern grazing bovids such as bovins (buffalo, cattle, yak, bison and banteng, among others).

Faysal is studying the way in which these animals evolved adaptations to survive in grassland environments. His work has proposed a southern Asian origin for the bovine group, and a dispersal from southern Asia to Arabia and Africa in conjunction with the global spread of tropical grasses at low latitudes around 7 million years ago. Faysal also works on describing new bovid fossils from Kenya, Ethiopia and Turkey.

Faysal Bibi is also co-director with Andrew Hill, the J. Clayton Stephenson Professor of Anthropology and Curator of Anthropology at the Peabody Museum, of the Baynunah Paleontology Project, leading annual expeditions to recover fossils from the deserts of Abu Dhabi, United Arab Emirates.

The George Gaylord Simpson Prize is awarded annually by the Yale Peabody Museum of Natural History to a Yale University graduate student or recent doctoral candidate for a paper concerning evolution and the fossil record. The prize is named for George Gaylord Simpson (1902–1984; Yale G '26), the most influential paleontologist of the 20th century and a major proponent of the modern evolutionary synthesis.

Karl Turekian

William Kaula Award

Karl K. Turekian was presented with the William Kaula Award "for unselfish service to the scientific community through your innovative leadership and editorial contributions beyond expectations" at the American Geophysical Union meeting in San Francisco in December 2008.

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

Ed Ghent at Seiad.

Edward D. Ghent '59 (ghent@ucalgary.ca) writes, "I am currently a Faculty Professor at the University of Calgary. This is a special brand of emeritus. It involves three-year contracts to continue to do research, supervise graduate students, and apply for research grants. I am not formally teaching any courses. My research grant with NSERC has been renewed for a five-year term. I currently have one MSc and one PhD student.

After graduating from Yale, I received my PhD from the University of California, Berkeley, in January 1964. I have been at the University of Calgary since 1967. I briefly taught one semester as a sabbatical replacement at San Jose State (1964). I taught at Victoria University in Welllington, New Zealand, from 1964-1967. The latter period involved a field season in Antarctica.

My research has focused on metamorphism and I have studied rocks with a range of metamorphic grade, from zeolite to granulite facies. My current research involves the study of very high pressure eclogites, amphibolite facies pelites and metabasites, and crustal and mantle xenoliths.

I fondly remember my undergraduate education at Yale (including climbing up the fire escape in the old geology building).

John Livingston and Brian Skinner discussing structures in the Cape Fold Belt, South Africa, 2007.

John Livingston '62 (john42540@aol.com) writes, "after collecting my undergraduate degree at Yale in 1962 and PhD at Rice as **Clark Burchfiel's G '61** first graduate student, my professional career in geology began at Shell Development Research Co. Here I spent 5 years doing lab and field studies on the west coast in structural geology focusing on the emerging concept of plate tectonics. In 1973 I founded Geo-Logic, Inc., a geophysical/geological consulting firm specializing in natural gas exploration in the Sacramento Valley. Ten years after moving this company to the Napa Valley in 1976, I made a career change into the wine business and founded a small family winery which continues today. Most recently I have transitioned back to geology with the development of an earth science curriculum for Napa County schools where I both teach and train docents to present these materials at the elementary grade levels. I actively lecture, write, lead field trips, and do volunteer consulting about Napa County geology.

George Veronis Retires

Kim and George Veronis with George's daughter Melissa.

George Veronis retired from the faculty on June 30, 2009. He joined the Department of Geology and Geophysics in 1966, directed the Applied Mathematics Program from 1979 to 1993, was Chairman of G&G from 1976 to 1979, and edited *Marine Research* from 1973 to the present. He was given a thank-you dinner on Saturday, May 16, at the Quinnipiac Club, at which time his colleagues presented him with an original drawing of a wading bird called a Stilt, which appeared in Compte de Buffon's *Histoire Naturelle des Oiseaux*, 1786. The connection is that George is both an avid bird-watcher and a mathematician, and Buffon first gained fame and recognition for his work in mathematics. George may have retired from the faculty but he has not retired professionally—he has been appointed as a Senior Research Scientist, so we expect to see him regularly around the department.

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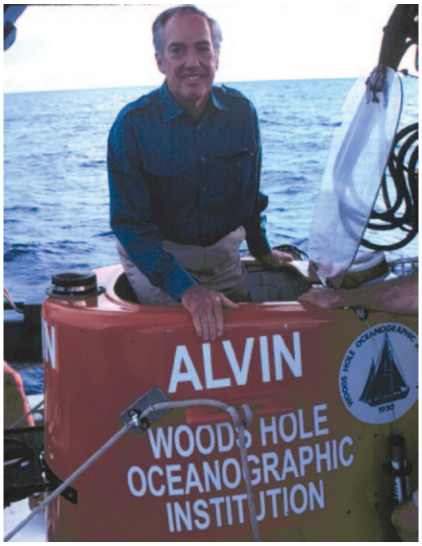

Peter Rona entering the submersible *Alvin* for a dive at the TAG hydrothermal field on the Mid-Atlantic Ridge.

Peter A. Rona G '67 (rona@marine.rutgers.edu) writes, "The Yale G&G heritage takes us all in a variety of directions. Recent experiences for me in my present role as professor of marine geology and geophysics at Rutgers University have taken me in an expected and an unexpected direction. The expected direction pertains to incisive questions of what we do and do not know about ancient hydrothermal mineral deposits posed by Brian Skinner in an article he published in 1997 (Skinner, 1997). Seafloor hydrothermal mineralization is an ongoing theme of my research, so I took the opportunity to address Brian's questions about what we do not know in a review paper that I published in 2008 (Rona, 2008). What a surprise to realize the rapid progress we are making in elucidating unknowns of duration, timing and controls of hydrothermal mineralization from our seafloor studies of active ore-forming systems!

An unexpected direction is an improbable journey with paleontologist Dolf Seilacher of the G&G faculty. In 1976 during my early exploration for hydrothermal activity on the Mid-Atlantic Ridge, my camera tow imaged a field of strikingly hexagonal forms each a bit bigger than a poker chip in sediment on a wall of the axial valley. After consulting experts on every marine invertebrate phylum without identifying the forms, I published the images as an unknown benthic invertebrate. Dolf wrote me an excited letter from his position then as professor at the University of Tuebingen saying that he was thrilled that the living forms imaged on the seafloor were identical to a fossil form believed to be extinct that he described as *Paleodictyon nodosum* in Eocene deep sea flysch deposits exposed at sites in Europe. Our opportunity to pursue this past-present connection came in 2001 when our hydrothermal research group at Rutgers with Rich Lutz, former Yale G&G postdoc, made an IMAX film of seafloor hydrothermal sites (*Volcanoes of the Deep Sea;* http://www.volcanoesofthedeepsea.com). Our search to solve the mystery of *Paleodictyon* became the thread that ties the film together. More recently, the film's director supported an *Alvin* dive for Dolf and me to find out what made the hexagonal form on the seafloor. The results of that investigation are reported in our current paper (Rona, Seilacher et al., 2009). So the Yale G&G connections continue.

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John B. Fisher '73 (bfisher@lithochim.com) writes: "I've had a number of career turns, some unexpected, since leaving Yale in 1973. Just after leaving Yale, I joined Normandeau Associates in Manchester, NH and worked on evaluating wastewater treatment alternatives for the Merrimack River Basin in Massachusetts. After a year on that project, I entered graduate school. My first attempt to gain a graduate degree involved work on beach geomorphology at the Virginia Institute of Marine Sciences in Gloucester Point, VA. This was cut short by lack of funding, and I moved on to Case Western Reserve University in Cleveland, OH, where I worked on the effects of benthic organisms on the exchange of phosphorus and other materials between sediments and water in Lake Erie. After finishing my PhD in 1979, I spent one year at the University of California at Santa Barbara where I worked on the sediment-water exchange of polychlorinated biphenyls, before returning to Case Western Reserve University as a Visiting Assistant Professor in 1981. In the late fall of 1981, I joined Amoco Production Company at their research center in Tulsa, OK. In 1990, Amoco transferred me to their Environmental

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Research Group and I began working on the biogeochemistry of the contamination of soil and groundwater by crude oil, saltwater and oil and gas production wastes. In 1995, I left Amoco to work for Gardere & Wynne, a law firm. The Tulsa office of Gardere & Wynne specialized in environmental matters, and I worked as the in-house technical expert to assist the attorneys. In 2000 I left Gardere & Wynne to become a Principal Scientist with Exponent, a science and engineering consulting company. In 2004 I had the opportunity to join the geosciences faculty at the University of Tulsa and to form my own consulting company. Although I loved working with students, I could not serve two masters, and I left the University of Tulsa in 2007 to devote all of my efforts to my consulting company. My consulting company continues to focus on the geoscience aspects of environmental litigation, and I provide expert testimony in this area. Our primary focus has been assisting the Oklahoma Attorney General in his lawsuit to stop water pollution from poultry production in eastern Oklahoma and western Arkansas . Along the way, I have taught physical geology, historical geology, geochemistry, statistics, environmental engineering, environmental geochemistry and statistics as an adjunct professor at Tulsa Community College, Oklahoma State University, and the University of Tulsa, and I have had the pleasure of supervising masters students at Oklahoma State University and the University of Tulsa.

Joseph L. Graf, Jr., G ’75 (graf@sou.edu) writes “I started in the graduate program at Yale in the fall of 1968 after receiving my Bachelor’s degree from Columbia. Although my major interest was economic geology and Brian Skinner was my advisor, I spent a good deal of time during my first year at Yale doing experiments on deformation of sulfide minerals with Neville Carter and Brian, which ended up as a publication in *Economic Geology*. After the 1968-69 academic year, I was drafted into the Army and served two years as a Military Policeman, stationed primarily at Fort Bragg, North Carolina. In addition to Fort Bragg, I had the opportunity to spend time at Fort Campbell (KY), Fort Gordon (GA), and Fort McClellan (AL).

Joe Graf and Sandra Coyner on vacation in the Canadian Rockies last summer (2008)

I returned to Yale in 1971, and received a PhD in 1975. My PhD research focused on the use of rare earth elements (REE) as tracers of ore-forming processes in the massive sulfide deposits and iron formations of New Brunswick, Canada. My first post-PhD professional work was as a geologist for Oremco, Inc., a small company based in New York City doing mineral exploration in Brazil. The majority of my time in Brazil was spent in the States of Minas Gerais, Bahia, and Paraiba, mostly in small, interior towns. I was fortunate to pick up a decent working knowledge of Brazilian Portuguese. I worked at Oremco for five and one-half years and left in 1980 to take a faculty position in geology at Kansas State University in Manhattan, Kansas, moving from Manhattan, New York to Manhattan, Kansas (the Big Apple to the Little Apple). My 15-year KSU career included ten years as Head of the Department of Geology. At KSU, though still stuck on REE, I shifted my research interests from massive sulfide deposits to Mississippi Valley-type deposits in the Viburnum Trend and the Tri-State Districts.

Also at KSU, I met my life partner, Sandra Coyner, who was Director of Women’s Studies at KSU, and our son was born. Starting in 1995, I went fully over to the administrative dark side and became Dean of Sciences at Southern Oregon University (SOU), a small, largely teaching institution located in Ashland, Oregon, with strong, student-centered programs in the sciences. While I was being a Dean, Sandra was Honors Director and co-Director of the first-year program. In addition to endless administrative meetings, some of the perks for me of being at SOU included lecturing on three Alaska Cruises, leading backpackers down the Wild and Scenic Rogue River, teaching various geology courses to majors and non-majors, and going to Crater Lake as often as possible. Our son received his B.S. Degree in Biochemistry from SOU and was working as a chemist in San Diego, California. He passed away suddenly in late March of 2008, and we continue to struggle with this tragic loss. In his honor,

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we have started a scholarship fund at SOU to support students like him, who love chemistry and love research.

Both Sandra and I retired from SOU in June 2008, after a major reorganization changed our jobs and helped us start thinking about what we really wanted to do with our lives, a process that continues. We love living in Ashland, a wonderful place with many recreational and cultural activities and a great community. It is the perfect place for us, and we are in the process of connecting with various community organizations, including volunteering at the Oregon Shakespeare Festival. The geologic setting is not too shabby either. We live on the east flank of the Klamath-Siskiyou Mountains and look across the valley at the Cascade Range. I am working part time on the Deer Creek Center for Field Research and Education, a partnership between SOU and the Siskiyou Field Institute, right on top of the Josephine Peridotite. Yalies of my generation will remember the Josephine Perididotite as the field area made famous by Henry Dick. Either the world is small or the reach of Yale is large, or both. I look forward to seeing many Yale colleagues at the reunion in the fall.

I recently presented two scientific papers concerning my work on the pollution by poultry wastes at the 2009 International Symposium on Environmental Science and Technology held in Shanghai, China. Afterward, I took a train trip across the north China loess plateau which is the world's largest quaternary loess deposit, from Shanghai to Xi An, and then from Xi An to Beijing. The loess is enormously thick and fertile in this area and much wheat is grown there. In addition, the engineering properties of the loess make it perfect for making rammed earth structures. No wonder the area around Xi An has been urbanized for about 3,000 years.

Jill Dill and Arthur Pasteris '78 Administrative Science (taken July 4, 2009)

Jill Dill Pasteris G '80 (pasteris@levee.wustl.edu) writes "after finishing my PhD work on oxide minerals in kimberlites under Brian Skinner, I joined the faculty at Washington University in St. Louis, where I have been for 30 years. My early interest in mantle processes led me to study fluid inclusions in mantle xenoliths and to set up a laser Raman microprobe facility to make more detailed analyses. The Raman microprobe enabled me to undertake studies on a number of magmatic-hydrothermal ore deposits, which gradually brought my research closer to the earth's surface. I also began spectroscopic studies of solid phases, such as graphite. About a decade ago, a colleague challenged me and my research group to apply the Raman microprobe to minerals in biologic tissue. Thus began our multidisciplinary work on bone and tooth mineral, i.e., bioapatite. We now collaboratively investigate the synthesis of bone-like mineral and its physical-chemical properties, the chemistry and micromorphology of rare types of "super-mineralized" natural bone, and the physical-chemical properties of natural tissue as it grades from unmineralized (tendon) to densely mineralized (bone), as in the rotator cuff. This biomineralization work has led to a number of interesting discussions with Dr. Cathy Skinner of G&G. We also have made a few excursions into the research and literature on the origin of life."

Jill and her husband Arthur saw their twin daughters graduate from their respective colleges last year. One daughter works for an energy company in Houston and the other for a magazine in St. Louis.

Kate studying climate change.

Kate Kressmann-Kehoe '84 (kressmann@frontiernet.net) after a varied career is raising two children and working on a documentary about the effects and response to climate change in the Rochester, New York region. The documentary examines the local forecasts, some of the community reaction, and the broader issues of how people react to information about climate change. "One of the challenges is that the local effects are subtle, and people need to understand so much about how science works to grasp them," she says. "People like clear unambiguous answers, and scientific forecasts about complex systems usually don't come out that way. One of our missions is to give people a better understanding of how science works." She was also drawn to telling the story in film because it helps people make

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forecasts vivid. “When people hear that there will be lower lake levels, they think ‘Great, more beach’!” she says. “They don’t picture mud flats, having to move intake pipes, or disruption of lake ecosystems.”

The film is scheduled for April 2010. More about it, including a slide show and trailer, is at www.lastexperiment.com.

Kathleen Ruttenberg and Greg Ravizza with their children, Elena, 11, and Luke, 4.

Kathleen Ruttenberg G ’90 (kcr@soest.hawaii.edu) and **Gregory E. Ravizz G ’91** (ravizza@hawaii.edu) write “a few months ago Mabel Peterson suggested that Kathleen draft a short piece for the alumni newsletter. How could we say no? The task went on the list of things to do: a couple of reviews, a letter of recommendation, GSA abstract, proposal for mid-August, final report for a project winding down, flesh out the syllabus for a new course in the fall and finishing a manuscript before classes begin again. Many of you know lists like this all too well. Of course we had seen Mike Velbel’s and Danita Brandt’s very nice story in the last issue. This set the bar high for our write-up, providing ample reason to procrastinate. The actual writing has fallen to me. Kathleen leaves shortly for the Chemical Oceanography Gordon Conference and has her hands full with that. I have learned that when Kathleen is away it is pointless to try to work, so I am packing our two kids (Elena, 11, and Luke, 4) off for a visit to see family in California, and to try our hand at panning for gold for a day or two in the foothills of the Sierra.

This morning’s circumstances match pretty well the general flavor of our lives, both of us heading in different directions, scrambling to make deadlines, and at least one of us with kids in tow. Getting all four of us heading in the same direction at the same time is somehow harder than it should be. When it happens it is always a pleasure, whether it is the beach, horseback riding lessons or hiking. The underlying point here is that we do not have much time to look back and think about where we’ve been and how we got here. When we do, we are always stunned by our remarkable good fortune.

Kathleen and I are part of the big group of geochemists that passed through the G and G, arriving in the mid-eighties and moving on toward the end of the decade. Both Kathleen and I went on to post-doc at Woods Hole Oceanographic Institution and eventually moved onto the scientific staff there. In 2002 we relocated to faculty positions here at the University of Hawaii, Manoa, in Honolulu. Kathleen’s primary home is in the Oceanography Department, and I am in the G&G department. So far we’ve been able to beat the odds, staying together as a family without having to give up our work. Whether here in the middle of the Pacific or on Cape Cod, we’ve enjoyed great colleagues and a stimulating scientific environment.

Over the years we’ve learned to be flexible. While we were in Woods Hole Kathleen’s research shifted from early diagenesis of phosphorus (P) up into the water column, focusing on the significance of dissolved organic P in coastal and river systems. This was a field-intensive research program with cruises or river sampling trips nearly every other month. Having a family has made this type of schedule impractical, or at least undesirable. Since moving to Hawaii, Kathleen has developed a number of interesting projects focusing on nutrient cycling in native Hawaiian fishponds. These are dynamic systems with interesting biogeochemistry: benthic photosynthesis, strong redox gradients that vary diurnally, and tidal forcing. They are essentially natural mesocosms, situated at the interface between the watershed and the coastal ocean.

Changes for me have been less obvious, but similar. Since moving to UH I’ve been relying mainly on samples from IODP for my research. So, just like when I was in grad school, I am once again referring to my mailbox as my “field area.” Over the years I jumped from SIMS to TIMS to ICPMS, but the focus of my analytical work has been and remains Os isotopes in marine sediments. There are more fun projects than there is time in which to do them.

We have given up on going to meetings together for now, with the kids its just too much hassle. When we do get off island it is always a pleasure to bump into our old friends from New Haven, but for every person we are lucky enough to cross paths with there are several more we’ve lost touch with. This is perhaps the price of living in the middle of the Pacific. When friends do come through Honolulu, though, it is always a treat. It is only these few who can verify that we are indeed a family in spite of always appearing separately on visits to the “mainland.”

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Hélène and Craig on the summit of La Soufrière volcano, Guadeloupe island, Lesser Antilles.

Craig A. Johnson G '90 (cjohnso@usgs.gov) and **Hélène Grall-Johnson G '83** (hgralljo@du.edu) write, "What have we been up to since Yale? Well, Hélène departed New Haven in 1984 to follow her advisor, Emil Okal, to Northwestern. She ultimately finished her PhD (on Tambora volcano) at the Graduate School of Oceanography in Narragansett, RI, within commuting distance of New Haven where I was finishing my dissertation on the Sterling Hill zinc deposit with Danny Rye and Brian Skinner. In 1988 we moved to New York City where I took an NASA postdoc in meteoritics at the American Museum of Natural History. Hélène landed a lectureship at Hunter College, right across Central Park. We had a very productive four-year period pursuing geoscience in New York. Surprisingly, we stayed in pretty good physical shape too, thanks mainly to the daily stair climbs to our miniscule, fifth floor, walk-up apartment in Brooklyn Heights. In 1992 I took a position with the USGS in Denver in stable isotope geochemistry. Hélène, being French, fretted leaving cosmopolitan New York for the American heartland. However, she quickly warmed to Denver, as did I. Hélène has continued to pursue a career in teaching, in particular the teaching of science in bachelor of fine arts and other university-level curricula where science has traditionally been a dirty word. I have pursued a career in basic and applied research implementing stable isotopes in a broad array of USGS programs. Several of my current research themes involve problems that I first encountered at Yale: ore genesis, source and fate of solutes in natural waters, characteristics of paleoenvironments. Other research themes are new: nutritional ecology of wildlife, forensics. We have a 16-year old son, Adrian, who thrives on skiing, tennis, and debate competitions (in that order). Kudos on establishing the Geology and Geophysics News!

Ruth Yanai '81 G '90 (rdyanai@syr.edu) reports that "she is quite happy to be studying nutrient cycling in forests, except that biology perpetuates thermodynamically unlikely configurations of matter, such that the laws describing the behavior of forests are purely descriptive and poorly predictable." Ruth graduated from G&G with a BA in 1981 and returned to Yale in 1983 to begin a PhD in Forestry and Environmental Studies, so that she could continue to crash Dana Club parties throughout the '80s. Her current projects include a study of nutrient co-limitation in forests—she hopes to show that young northern hardwood forests are P-limited, although N is the nutrient that gets all the attention. This would resolve a deep-seated insecurity stemming from her choice of P cycling as a dissertation topic. (Please note that in the interim she has worked on many other elements, with the study of Ca supply from apatite eventually leading her back to P). To combat her disappointment over the poorly predictable behavior of organisms, she has maintained an interest in simulation modeling and is helping to develop soil sampling methodologies that involve nuclear physics, i.e., inelastic neutron scattering and thermal neutron capture. She is a Professor at the SUNY College of Environmental Science and Forestry and lives in Syracuse, NY, with her 11-yr old daughter, a cat, a parakeet, and two hens."

Henrietta (Hedy) Edmonds '91 (hedmonds@nsf.gov) writes, "I was a Chemistry major, and have no "formal" connection to the department but fell into the G&G orbit when taking a math class from **George Veronis** my junior year. That connection led to a summer fellowship at the Woods Hole Oceanographic Institution, two courses in G&G my senior year (including **Karl Turekian's** marine and surficial geochemistry), and

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a PhD in Oceanography from the MIT/WHOI Joint Program. After postdoctoral positions at the University of Rhode Island and the Southampton Oceanography Center (UK), I took a faculty position at the University of Texas at Austin's Marine Science Institute, located on the Gulf Coast in Port Aransas, TX. There my research included the geochemistry of hydrothermal plumes, hydrothermal exploration on the Arctic ocean's Gakkel Ridge, submarine groundwater discharge to Texas bays, and the marine geochemistry of uranium-series isotopes. I spent several summer months on icebreakers in the high Arctic and highly recommend it as an alternative to summers in south Texas. Following my Arctic interests, this summer I moved to Arlington, VA, to become Program Director for Arctic Natural Sciences at NSF. It's a challenging and interesting position, as our portfolio includes everything from microbiology to glacier seismology. I miss some things about research and teaching, but I am excited to be in the DC area and doing new things. I've already reconnected with several Yale friends here and hope to see more soon.

Vanda Grubišić G '95 (vanda.grubisic@univie.ac.at) reports that "she has recently been appointed Professor and Chair for Theoretical Meteorology at the University of Vienna, the same position once held by the famous meterorologists Julius Hann (1839–1921) and Felix Exner (1876–1930)." She is the first woman full professor of any geoscience discipline at the University of Vienna. Founded in 1365, this is the oldest university in the German-speaking world.

After completing her Ph.D. Vanda obtained the Advanced Study Program (ASP) Postdoctoral Fellowship from NCAR in Boulder, CO, where she spent four years before moving on to the Desert Research Institute (DRI) in Reno, NV. At DRI, she built a strong NSF-supported research program in atmospheric mesoscale dynamics and modeling. That included leading two large initiatives: the Advanced Computing in Environmental Sciences, a state-wide computational science program, and the Terrain-induced Rotor Experiment (T-REX), an international field campaign

focused on mountain waves and atmospheric rotors. **Ron Smith**, her mentor at Yale, was involved in T-REX as one of the principal investigators. The last two years of her DRI tenure, she retracted her career steps and spent an extended sabbatical, first at the University of Zagreb, then Yale, and lastly as an ASP Faculty Fellow at NCAR.

Vanda comments that "my husband **Boro Grubišić, Yale Physics G '95**, is also transferring to the University of Vienna, and with our 6-year old daughter Karmen, is joining me this fall. I have always had a strong family support for my career, especially from my husband. I would not have been able to achieve all of this without having him at my side."

Martha Bell, archaeological survey in Ancash Peru.

Martha Gwenn Bell '04 (martha.bell@gmail.com) writes, "Since graduation in 2004 I've been working on my PhD in Geography. I completed an MS at the University of Wisconsin-Madison (2007) and I am currently a Doctoral Candidate at Penn State University. My research is on agricultural change in early Colonial Peru. I have taken two years "off" (2004–5) and (2007–8) to work on archaeological projects in Peru. Highlights include pottery ethnoarchaeology in Northern Peru, survey/mapping of Recuay sites in the Callejon de Conchucos (Ancash, Peru) and excavation at the Inca provincial center Huanuco Pampa (Huanuco, Peru). In addition, I have also worked as a freelance cartographer, publishing maps mainly in scholarly articles/books. And of course, I have had plenty of time to travel since graduation. I have spent time in Peru, Bolivia, England, Spain, and Trinidad (to visit Katy!). Right now I am spending the summer in London with my fiancé and delving into the archives of the British Museum and British Library."

Kathryn Louise Henderson '04 (kathryn.henderson@bp.com) writes, "Since graduation in 2004, I've been working as a

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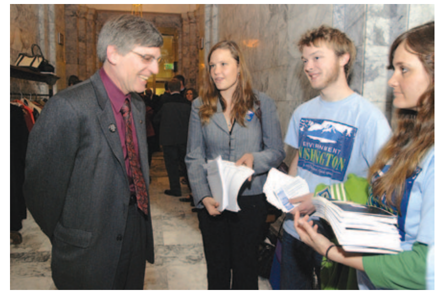
Katy Henderson, in the mudlogging cabin of the Constellation-1 rig. offshore Trinidad (looking at cuttings from a well)

petroleum geologist for BP, based in Trinidad and Tobago—I have worked in exploration looking for new prospects, as well as in the appraisal and production of our gas/oil fields offshore Trinidad. I took a year out in 2006 to complete a Master's degree in Petroleum Geoscience at Imperial College, London. For my thesis, I spent three months working with BP's three-dimensional seismic dataset to complete structural restorations of allochthonous salt structures in deepwater Angola.

I have had the chance to travel for some great field trips to Utah, South East and Northern England, Venezuela and of course Trinidad, as well as experience offshore life on the rigs while drilling wells! At present, I'm enjoying life on a sunny island and planning more travels—so far I've made it to Germany, Spain, India, and most recently, Argentina!"


Shannon O'Pray

Shannon O'Pray '04 writes, "I moved to Arlington, VA, after graduating in 2004. After four years working for the federal government I am now back in graduate school." Shannon will receive her MA in strategic studies and international economics from the School of Advanced International Studies (SAIS) at Johns Hopkins University in Washington, DC, in 2010. International relations "fieldwork" may not bring Shannon to rock outcroppings or oil platforms, but it did allow her to spend a week in Berlin and Prague last spring studying the Cold War.


Kristin Anderson delivering photo petitions with the help of some of the outreach staff of Environment Washington.

Kristen Anderson '05 (kma277@gmail.com) writes "for the past year, I worked as a field organizer for Environment Washington, advocating for clean water, preservation, and global warming solutions. In addition to getting citizens engaged on the issues, I also did media outreach and even some lobbying. Some highlights from the year include passing a new building energy efficiency standard for Washington state, securing over $1 billion in Economic Recovery Act funding to fast-track the Hanford Reactor site cleanup, and helping to start a partner state environmental group (Environment Nevada)."

IN MEMORIAM

James Lee Wilson G '49 died on February 13, 2008, in New Braunfels, Texas, at the age of 87. Jim Wilson's mentors at Yale were Professors Dunbar and Schuchert. Jim was born, raised and educated through his BA in Texas, served in the military, then came to Yale for his PhD at the end of hostilities. He had a long career in industry (Shell Development Co.) and academia, (Univ. of Texas, Rice, Universities of Houston, Miami, Calgary, and Michigan). His 1975 book "Carbonate Facies in Geologic History" is still the standard text on stratigraphy of carbonate rocks. Jim was awarded the Twenhofel Medal by SEPM in 1990 and the Sidney Powers Medal by the AAPG in 2002. More recently, SEPM has established the James Lee Wilson Award for Excellence in Sedimentary Geology by a young scientist.

Walden P. "Wally" Pratt G '49 died on August 30, 2008. Wally graduated from the University of Rochester with a BS in 1948 and then started graduate work at Yale. At the end of his first year he was hired by the USGS to work on the Michigan iron ore project under the direction of Harold James. He continued with the

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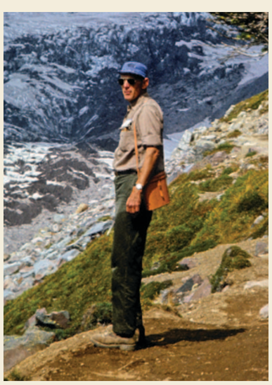
USGS for a second year, then in 1951 his assignment was terminated when he was drafted into the US Army. When he was discharged two years later he started PhD studies at Stanford, rejoined the USGS in 1956, and completed his PhD in 1964.



Rocky Crandell with the Nisqually Glacier, Mt. Rainier in the background. Photo by Steve Porter, 1965.

Dwight R. "Rocky" Crandell G '51 died on May 6, 2009. Rocky was born and raised in Illinois, served in an Army mortar platoon in WWII, and entered Yale for his PhD on his discharge. After graduation, he joined the USGS and was assigned to work in the Denver Federal Center offices, where he was based throughout his life. Early in his career Rocky was assigned to map the lowlands around Puget Sound, Washington. The standard wisdom was that the region had been shaped by glaciations, but Rocky and his colleague Donald Mullineaux demonstrated that it was giant mudslides from Mount Rainier that underlay the region, and that an interlayer of volcanic ash that was 5,600 years old came from Mount St. Helens. This led Rocky and Don to publish their famous 1978 report in which they pointed out that Mount St. Helens is an active and dangerous volcano that would likely erupt within 20 years and cause trouble over a wide area. Their prediction came true with the now-famous eruption of May 18, 1980, that killed 57 people and caused more than a $1 billion in damage.

Some of the students in G&G 205b, "Natural Resources and Their Sustainability," on a field trip to North Branford to see what a basaltic lava flow looks like, how it is quarried, and the mechanics of crushing and sizing. This popular course had 30 enrolled this last semester, but only two were G&G majors.