GEOLOGY & GEOPHYSICS NEWS

Yale University | Department of Geology and Geophysics Spring 2007

Chairman's Letter

David Bercovici

The Department of Geology and Geophysics continues to be a vibrant community of scientists with a tremendous diversity of interests. Our student body, both graduate students and undergraduate majors, is truly impressive and increasingly international. This year's entering class of graduate students includes people from Denmark, Japan, China, and even Lowell, Massachusetts. Our growing postdoctoral program numbers nearly 20 scholars and we have plans to increase it considerably in the next few years; this program draws scientists from around the world, including Australia, Korea, Israel, Japan, France, Ireland, Canada, and Russia.

Our young faculty colleagues continue to win awards and bring distinction to the Department. Most recently **Jun Korenaga** was awarded the Macelwane Medal, the outstanding young scientist award, by the American Geophysical Union. We are also presently running two faculty searches, in isotope geochemistry and mineral physics, and so by this time next year we hope to have even more new young colleagues. Given the outstanding students, postdocs, and colleagues in this department, it is truly a privilege to have been asked to serve as Chairman.

I also report with great pleasure the promotions of **Ruth Blake**, **David Evans**, and **Mark Pagani** to Associate Professor on term. Regretfully, I must also report the departure of **Peter Reiners**, who in the late summer of 2006 accepted a position at the University of Arizona. We were sad to see Peter leave but wish him well in his new position.

One of our distinguished senior colleagues has decided to retire. **Bob Berner** stepped down from Professor and up to Senior Research Scientist at year's end. The department held a symposium in Bob's honor, the details of which appear later in this newsletter.

I close with two bits of sad news. First, the death of **Betty Waage** on August 4, 2006. Betty was the wife of the late Karl Waage, longtime

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Living Fossil Garden Planted in Front of KGL

A garden of ancient living plants has been planted in front of the KGL on a small plot formerly graced by blacktop and dumpsters. Each of the plants (except for the inevitable weeds) belongs to a species or genus that has survived for tens of millions of years. Unlike animals, plants evolve very slowly. Thus, the otherwise unremarkable yew shrub in this garden belongs to a genus that dates back some 175 million years and may have provided graze for the sauropod dinosaurs. Several other genera, like the plum-yew, the kadsura tree, and the pachysandra that forms the ground cover, survived the gigantic asteroid impact that incinerated the dinosaurs and about 80 percent of terrestrial life-forms at the end of the Cretaceous. Several of the species, like the dove tree, date back some 55 to 65 million years to the time when earth's vegetation was regrouping after the catastrophe.

The species were selected because fossil or molecular evidence points to their longevity. They also have to be able to survive the rigors of our New England climate and not grow too large for the space.

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faculty member, former Director of Peabody Museum, and former Chairman of the Department. Second, the passing of **Albert Lincoln (Linc) Washburn G '42**, and former faculty member, on January 30, 2007. Our sympathies go out to the family members of these former colleagues.

About the New Chairman

David Bercovici *assumed the role of Chairman of the Department of Geology and Geophysics on July 1, 2006. His appointment is for three years. He joined the Department in January 2001 as a professor of geophysics.*

David's tertiary education commenced at Harvey Mudd College, Claremont, California, where he earned a BS, with a major in Physics and a minor in History, in 1982. His graduate studies were at UCLA where he earned a PhD in 1989 in Geophysics and Space Physics. His mentor at UCLA was Gerald Schubert, and his thesis was on convection in the mantle of the Earth and other solid planets.

From UCLA David moved to Woods Hole for a year as a postdoc, then it was on to the University of Hawaii for ten years where he eventually became Chairman before leaving in December 2000 to come to Yale. (Yes, that's right, he left Hawaii in December to move to New England). He has received several prestigious awards, including a Macelwane Medal from the American Geophysical Union in 1996, the same year he was elected to Fellowship in the Union. David's research interests continue to be focused on mantle convection and geophysical fluid dynamics and he has attracted a very active group of graduate students and postdocs to work with him. You can learn more about David's activities on his web page at www.geology.yale.edu/~dberco.

FACULTY NEWS

Symposium "Changes on Earth" Honors Bob Berner

Robert A. Berner, the Alan M. Bateman Professor of Geology and Geophysics, joined the faculty in 1966 and retired December 31, 2006. Bob has pioneered in several topics during his career; most recently the geologic history of atmospheric oxygen and carbon dioxide. In recognition of his seminal studies he was honored with a two-day symposium December 8 and 9, 2006. The symposium, titled "Changes on Earth: Processes and Records," included presentations by past students and collaborators. All of the papers are available at http://www.geology.yale.edu/seminars/bernersymp.html.

Widely known for his modeling of the carbon and sulfur cycles, Bob has calculated the evolution of atmospheric CO_2 and O_2 over the Phanerozoic era. His studies have encompassed the effect of CO_2 on climate and the atmospheric greenhouse effect, and the effect of changing O_2 on animal evolution. Among the topics of his current research, Berner studies weathering and the resulting effects on the geochemical carbon cycle. His recent work has also interfaced with paleobiologists who study the emergence of vertebrates as land animals. Field studies over the course of his career have taken him to such disparate locations as Hawaii, Bermuda, Iceland, New Hampshire (Hubbard Brook), and the Pacific Cascades.

Bob Berner and former student **Bernie Boudreau G '85**

Bob is a Member of the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences. He is the recipient of the Doctor Honoris Causa from the Université Aix-Marseille (France). He has also been awarded the Huntsman Medal in Oceanography (Canada), the Goldschmidt Medal of the Geochemical Society, the Arthur L. Day Medal of the Geological Society of America, and the Murchinson Medal from the Geological Society of London. Recently the Geochemical Society dedicated an issue of its journal, *Geochimica et Cosmochimica Acta*, to his long career in geochemistry.

A festive dinner on December 8 provided the opportunity for remembrances of Bob's long career from graduate school days to the present. The chief roaster and master of ceremonies was **Pat Wilde '57**, a graduate-school classmate.

Garden *continued from page 1*

A set of permanent labels introduces the plants and tells a little of their history. If you come to visit the department, take a few moments to get acquainted with these incredible survivors or just to relax on the bench in their midst. The garden was planned by Leo Hickey, our paleobotanist, with design and layout by Walter Debboli, Jr., Manager of Yale's Grounds, whose department maintains it by their dedicated labor.

FACULTY NEWS

Andrew Scott, the Professor of Applied Paleobotany at the Royal Holloway University of London, is with us as Visiting Professor for parts of 2006 and 2007. Andrew is a specialist on the role of fire in the environment and especially the past, present, and future of wildfires; the entombment and preservation of plants by volcanic processes; and geological uses of charcoal. While at Yale, he is interacting particularly with Bob Berner on issues of climate and composition of the atmosphere and on paleontology issues with Leo Hickey and Derek Briggs.

As we were going to press word came in that Andrew is to be awarded the 2007 Gilbert H. Cady Award of the Coal Division of the GSA. Our congratulations to Andrew. The award is named for **Gilbert Cady G '11**.

At the 2006 Fall meeting of the American Geophysical Union, **Jun Korenaga**, Assistant Professor of Geology and Geophysics, was awarded a Macelwane Medal. The award is given for "significant contributions to the geophysical sciences by an outstanding young scientist." Jun's citationist was Tom Jordan, formerly of MIT, now of USC. When Jun was enrolled in the Wood's Hole-MIT Joint Program, he recruited three advisors, Steve Holbrook, Peter Keleman, and Tom. It was for his work on the North Atlantic igneous province and conclusions drawn from that work concerning mantle convection that Jun was awarded the medal. With Steve he collected marine seismic data on the oceanic crust, with Peter he looked at the igneous petrology of the province, and with Tom he looked hard at the data and drew conclusions, a real tour de force.

Stephen Sparks, the Director of the Research Center for Environmental and Geophysical Flows at the University of Bristol in the UK, is visiting for six months in 2006 and 2007. Steve's position at Yale is the Edward P. Bass Distinguished Visiting Scholar. Steve was formerly the Chief Scientist at the Montserrat Volcano Observatory; his research interests range from the generation of magmas and the role of fluids in the crust, to nonlinear dynamics of volcanic eruptions, and the effects of volcanism on the environment. While at Yale, he is addressing two major issues: global risks from extreme natural hazards, and access to scientific information in the developing world.

The American Geophysical Union elects very few of its members to Fellowship, but Professor **Jeffrey Park** was so honored in 2006.

The Vening Meinesz Research School of Geodynamics, University of Utrecht in the Netherlands, awards the VMSG Medal annually to a "distinguished scientist who has contributed significantly to the field of geodynamics." The 2006 award was won by Professor **Shun-ichiro Karato**, for his work "Mapping the water content in the Earth's mantle."

Recent Graduate Students

The following have received graduate degrees over the past three years, or will get a degree at Commencement 2007.

Mathias Bernet, now Assistant Professor of Tectonics, University of Grenoble, France.

Christopher Breeding, Research Scientist, Gemological Institute of America, Carlsbad, CA.

Jason Downs, Postdoctoral Fellow, Philadelphia Academy of Sciences.

Walter Joyce, Collections Manager, Vertebrate Paleontology, Peabody Museum, Yale University.

Yuhong Liang, Postdoctoral Fellow, Emory University, Atlanta, GA.

Rebecca Masters, Teaching at Collegiate School, Richmond, VA and parttime Instructor, Mary Washington College, Fredericksburg, VA.

Ian Miller, Postdoctoral Fellow in Paleobotany, Denver Museum of Natural History, Denver, CO.

Jeffrey Rahl, Assistant Professor of Tectonics, Washington and Lee University, Lexington, VA.

Krister Smith, Postdoctoral Associate in Paleontology, University of Texas, Austin, TX.

James Stevenson, Risk Analyst, Eraring Energy, Sydney, Australia.

Takanobu Tsuihiju, Postdoctoral Fellow, Ohio University, Athens, OH

John van den Brooks, Postdoctoral Fellow in Vertebrate Paleontology, Arizona State University, Tempe, AZ.

Dru Wilbur, Environmental Scientist at Brinkerhoff Environmental Inc., NJ.

Ben Zaitchik, Postdoctoral Fellow, NASA, Goddard Space Center, Maryland.

Paleomagnetism at Yale

The Department now hosts a world-class paleomagnetic facility, designed and maintained by **David Evans '92**, with a mission to solve problems of global paleogeography and related issues of deep-time processes in geophysics, paleoclimate, and evolution. The primary research goals of this facility's first few years of operation are diverse, spanning nearly three billion years of Earth history and a variety of topics. These include Paleogene magnetostratigraphy of the North American Western Interior, terminal Proterozoic to Cambrian paleoclimate and true polar wander, Rodinia and Nuna supercontinent reconstructions, and Archean-Paleoproterozoic "supercratons" and growth of the Earth's magnetic field.

Fig. 1. Sampling Early-Middle Cambrian sedimentary rocks in the Flinders Ranges, South Australia. The goal is to capture a detailed kinematic documentation of continental rotations that, in this instance, have been proposed as rapid episodes of true polar wander (TPW).

Work in the North American Western Interior involves graduate student **Daniel Peppe**, who is compiling a litho-, magneto-, and biostratigraphic reference section of the Paleocene. Thus far, the research team has worked steadily through the lower half of the section, finding geomagnetic chrons 29R through 27N, or about 65 to 62 m.y. ago. They can correlate their composite section directly to fossil flora and pollen zones in collaboration with Leo Hickey, and carbon isotope variations in collaboration with Mark Pagani. They are finding that floral recovery after the mass extinction occurred about twice as fast as previously thought. Their work during the coming years will continue through the section, approaching the Paleocene-Eocene Thermal Maximum and assessing rates of paleobotanical changes through that period of intense global warming.

Graduate student **Tim Raub** is tackling the Proterozoic-Cambrian transition, with an integrated paleomagnetic study that addresses such varied topics as Snowball Earth, true polar wander, and other global environmental changes surrounding the early evolution of animal life (Fig. 1). Snowball Earth is the hypothesis that the planet entered an ice-covered climate regime, lasting potentially millions of years during each of several postulated episodes in the late Neoproterozoic (750–580 Ma). One of the foundations of the Snowball theory is the often-reproduced measurement of near-equatorial paleomagnetic latitudes from Precambrian glacial deposits and stratigraphically related rocks. The work focuses primarily in Australia, where the glacial successions are particularly well preserved and widespread. They are finding some elements of support for the Snowball theory but are also presenting it with some challenges. In support, they find that the strange carbonate unit "capping" the glacial diamictites gives a similar paleomagnetic direction to that borne by the glacial sequence, and that geomagnetic reversals can be correlated among at least four different and correlatable stratigraphic sections; thus imparting more reliability to the inferred tropical paleolatitude of the glacial deposits. However, those geomagnetic reversals suggest a substantial duration for cap carbonate deposition, at least tens of thousands of years if the modern geodynamo is an accurate model for that of the late Precambrian. Such a longtime span conflicts with most Snowball-supportive interpretations of the cap carbonates manifesting a global "rain-out" of alkalinity during the planet's recovery from a thick greenhouse atmosphere needed to escape from the ice-covered state. The Australian project also aims to test controversial hypotheses of rapid true polar wander (TPW) previously proposed by Evans and colleagues for the Neoproterozoic-Cambrian interval.

Jumping another 500 m.y. back in time, Evans is currently attempting to find an accurate reconstruction of the Rodinia supercontinent, which was Pangea's predecessor that formed in the earliest Neoproterozoic. Most Rodinia models incorporate a direct juxtaposition between western North America (precise

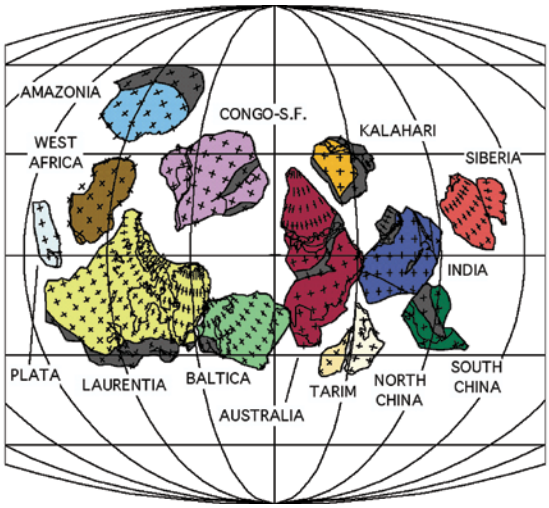

FIG. 2. Radically revised Rodinia, reconstructed to 780 Ma, or a few tens of m.y. prior to breakup. Late Mesoproterozoic ("Grenvillian") orogens are shaded gray. This model, or with possible minor variations, is the only long-lived (1050–750 Ma) reconstruction that satisfies all currently available paleomagnetic data of high reliability.

FIG. 3. David Evans gives "thumbs-up" for Paleoproterozoic red beds of the central Canadian Shield, Baker Lake basin, Nunavut. Paleomagnetic study of these and related rocks documents aggregation of the North American craton and will help build a database for reassembling Earth's oldest supercontinents.

positions vary) and Australia-Antarctica. Recent high-quality paleomagnetic results from Western Australia, however, refute all such connections, unless they were so short-lived so as to escape detection by the current database. Evans's alternative Rodinia configuration differs radically from all previous versions, mainly by using the opposite polarities of the most widely accepted paleomagnetic poles and consequently placing most cratons on the other side of the world relative to North America (see Fig. 2). This revised Rodinia will force a new look at the Proterozoic geology of many regions of the world in order to evaluate tectonostratigraphic comparisons with potential neighbors.

Because several of the proposed Rodinia reconstructions tie together much older tectonic elements from the Archean and Paleoproterozoic, the search for Rodinia is intimately linked to the quest for the older Proterozoic supercontinent Nuna (a.k.a. Columbia), formed at about 1800 Ma. The Precambrian tectonics community is only beginning to propose solutions for Nuna, but a large portion of Evans's data-generating research is devoted to this problem. One recently completed project in South Africa has generated a series of high-quality paleomagnetic poles for the Kaapvaal craton during the interval 2200 to 1800 Ma, identifying several apparent polar wander tracks and loops that may be compared with those from other cratons in the search for possible long-lived connections. This work also includes components of U-Pb geochronology and relationships between local remagnetizations and base metal mineralizing events. An active project, carried out by graduate student **Theresa Raub**, is producing a similarly high-quality paleomagnetic dataset for cratonic North America (Laurentia) through the interval 1830 to 1720 Ma and is documenting the final consolidation of the continent at that time (Fig. 3). The project is also critically evaluating the northern Australian apparent polar wander path from the same period. These efforts are all linked into a UNESCO-sponsored International Geoscience Correlation Programme (IGCP) Project, co-led by Evans with Australian and Indian colleagues, "Paleoproterozoic supercontinents and global evolution." This project brings together nearly 300 researchers in academia, government, and industry, from more than 20 nations on all inhabited continents; the goal is to summarize the state of knowledge of Earth's geological evolution between 2500 and 1600 Ma, enabling temporal connections between important events occurring at the planet's surface and within its deep interior.

Finally, activities in Evans's research group delve into the murkier history of the Archean. Postdoctoral researcher Alexei Smirnov is investigating the strength of the Earth's geomagnetic field through the Archean-Proterozoic transition, aiming to pinpoint the timing of its abrupt amplification—as predicted by models of planetary secular evolution that include initial crystallization of the inner core as a primary energy source for the geodynamo.

The Yale paleomagnetic laboratory includes a walk-in magnetic shield that houses a cryogenic magnetometer

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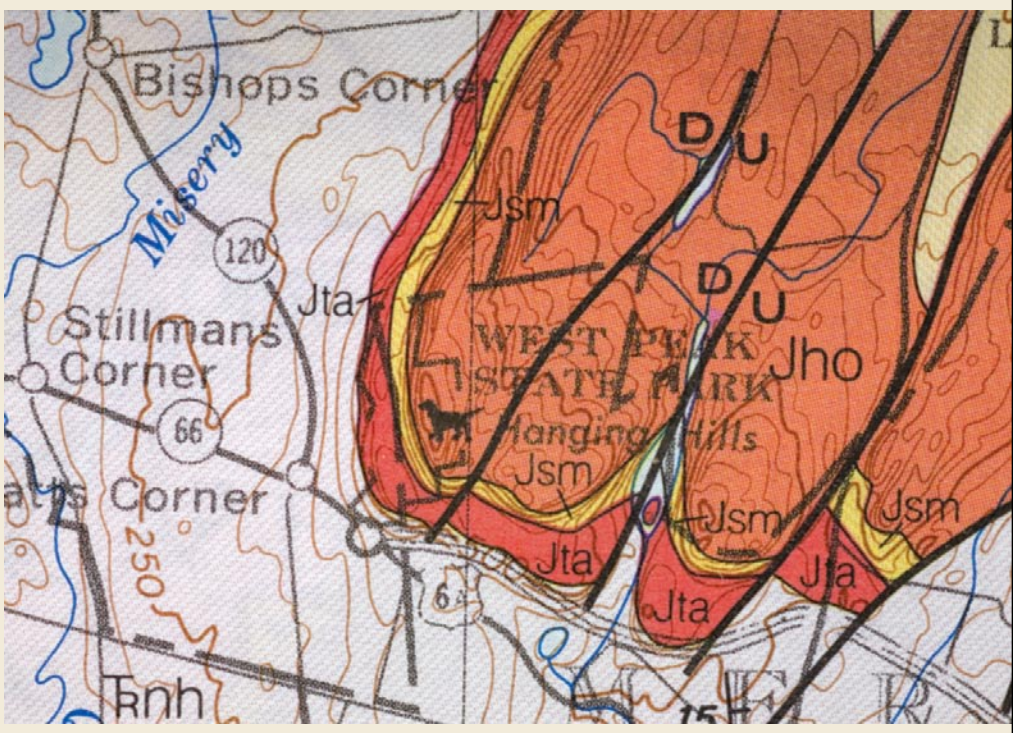
Black Dog of the Hanging Hills of Meriden



The last major work completed by John Rodgers was the Geologic Map of Connecticut, published by the Connecticut Geological and Natural History Survey in 1985. Like a striking red sash, the three Jurassic lava flows are the boldest features in the map and run north-south across the center. Look closely at the middle flow, the Holyoke, where it is folded and faulted just north of Meriden, forming the striking outcrop known as the Hanging Hills of Meriden, and you will see the small image of a black dog. The map legend doesn't shed any light on the geological significance of such a symbol. The answer lies in John's love of history and legend and, of course, his sense of humor.

In 1898 geologist W. H. C. Pynchon constructed a yarn around an old legend and published a story in the Connecticut Quarterly titled "The Black Dog." Ostensibly in the recounting of actual events, the story is a nice description of the local topography and starts with a warning that "if a man shall meet the Black Dog once it shall be for joy; and if twice, it shall be for sorrow; and a third time he shall die."

Pynchon's story concerns a fellow geologist, a friend named Herbert Marshall of the USGS. Pynchon sees the dog on a visit to the Hills, tells Marshall about the meeting, and learns that Marshall has already seen the dog twice. Neither seems to take legend seriously so the two geologists venture into the Hills again; Marshall sees the dog and moments later the ledge on which he stands gives way, plunging him to his death. The story ends with the author still alive, but a final codicil, apparently added by the editor of the Quarterly, quotes the *New York Herald* to the effect that the author fell to his death at the same spot as his friend Marshall. We are left to conclude that the Black Dog had claimed another victim. Fictitious of course, but a great story, and one that fellow geologist John Rodgers could not allow to be forgotten.

**Pynchon actually died in Oyster Bay, Long Island, in 1910.*

Paleomagnetism *continued from page 5*

with numerous demagnetization devices and the Kirschvink-designed automated sample-handling system. This system enables round-the-clock data acquisition that is necessary to maintain such a diversity of research projects as summarized above. The laboratory was funded by the NSF and Yale University. Evans's research projects have been funded primarily by NSF, the Agouron Institute for Geobiology, and a Fellowship from the David and Lucile Packard Foundation.

Links:
Evans research group webpage
http://earth.geology.yale.edu/~dae22/
Yale paleomagnetic laboratory
http://www.yale.edu/geology/facilities/paleomagnetic.html
IGCP Project 509, "Paleoproterozoic supercontinents and global evolution"
http://earth.geology.yale.edu/igcp509/

The Deep Scaly Project

Deep Scaly is a project focused on the phylogeny of lizards (including snakes); it is a component of a much larger project, sponsored by the NSF, which seeks to elucidate the broad outlines of the phylogeny of the Earth's biota. The larger project, called "Assembling the Tree of Life," is on the scale of the Human Genome project.

Yale's Jacques Gauthier is part of a team assembling a database of 50 single-copy nuclear protein-coding genes, plus a broad range of anatomical characteristics, for 200 fossil and living lizard species. The genes and morphologies were selected for their slow rates of change in the hope that they will allow the team to track early branches among major groups of living lizards that arose from mid-Mesozoic to early Tertiary times.

Lizards are a group of land-egg-laying vertebrates that first appeared in the Late Triassic. Aside from birds (9,000 living species), lizards (8,000 living species) are the most diverse group of living land-based vertebrates. Most lizards are small—less that 15 cm in length from snout to vent. Vertebrates larger than 15 cm, which includes a few lizards, typically eat plants or other vertebrates, but small size limits the majority of lizards to a diet of insects. Such a diet has its challenges, because insects have their hard, indigestible parts on the outside and the succulent comestibles on the inside. Lizards must therefore exert maximum bite forces with their mouths wide open. This has led them to evolve mobile skulls with an intricate arrangement of bony joints that are moved by two sets of jaw muscles disposed approximately at right angles to each other. Snakes have taken the arrangement to the extreme; their skull joints are mobile enough for them to ingest animals that approach their own body weight.

Fig. 1. *Huehuecuetzpalli mixtecus*, a primitive relative of all living lizards, from the Lower Cretaceous of southern Mexico; it tells us more about what the ancestral lizard looked like than does any living reptile.

Deep Scaly's early results are already yielding some surprises. Although molecular and morphological data match well near the outer braches of the tree, results from down near the roots are wildly different. The reasons for the discrepancies are still uncertain but could reflect the importance of fossils in illuminating the Tree of Life. That is to say, ancient branching events, combined with extinction and evolutionary change, could result in a sample that is highly skewed toward those species lucky enough to have survived to the Recent, which may depart radically from their ancestral form in both morphology and molecules. Successful phylogenetic inferences depend crucially on appropriate sampling. Because there are only four possible character states—A, G, C, and T—insufficiently dense sampling can result in more and more DNA sequence data for the wrong tree. Unfortunately, in the case of DNA, sampling is necessarily restricted to distantly related living species, such as the chicken and alligator. Morphological data are not so burdened because they can be derived from closely related extinct species, such as the so-called "*Archaeopteryx* of lizards," the Cretaceous-aged *Huehuecuetzpalli mixtecus* (Fig. 1).

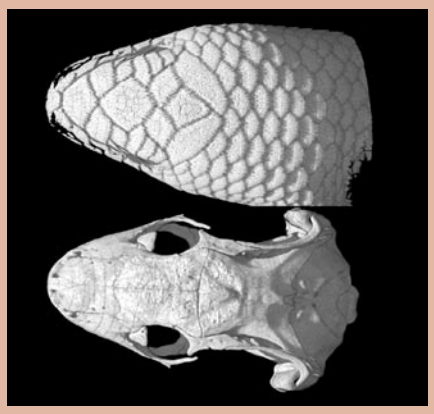


Fig. 2. HRXCT scans reveal new anatomy. A scincid lizard with osteoderms present (top) and removed digitally to reveal underlying skull bones.

To ameliorate the morphological sampling problem, which is no less severe for rare living species than it is for fossils, all specimens were imaged on the High Resolution X-ray Computed Tomography (HRXCT) scanner at the University of Texas, Austin. Fossils can now be studied digitally

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Deep Scaly *continued from page 7*

in their enclosing matrix, and the anatomy of living species can be examined beneath their coating of bony scales (Fig. 2). HRXCT has already led the team to a startling discovery. They have found previously unknown and unsuspected mobile joints in the skulls of lizards; previous workers missed these joints because they relied on dried skulls in which these connective tissue-filled joints shrank into obscurity; wet skulls were scanned for Deep Scaly, however, making these fleshy joints readily apparent.

Three different kinds of mobile joints have so far been discovered, and they show how the mobile skull has evolved differently in different clades of lizards (Figs. 3B-C, 5D). In one such joint, the jugal bone fails to form a firm union with the skull roof and is therefore unable to transmit compressive forces behind the orbit, which may explain why several lizards within the clade bearing this joint are unusual among reptiles in reducing (Fig. 3D), or losing (Fig. 3E), the jugal bone.

HRXCT scans are density maps rather than photographs. This allowed the team to locate less-dense sutural remnants where two bones had fused together during ontogeny, which were otherwise invisible in the adult (Fig. 4). They were thus able to solve some long-standing problems in primary homology estimation (i.e., How does one judge whether or not an anatomical trait shared by two lizards is the "same"?). Lizards possess two bones, the postfrontal and postorbital, just above and behind the orbits (Fig. 5A). But when only one bone is found in that position (Fig. 5B-D), is it the postfrontal, the postorbital, or both bones fused together? No paleontologist can relish being in the position of conceptualizing the postfrontal bone, for example, as being merely "present" or "absent," when "absence" could result from three different evolutionary events: postfrontal to frontal fusion (Fig.5B), postfrontal to postorbital fusion (Fig. 5C), or postfrontal fails to differentiate (Fig. 5D).

Experience thus far with Deep Scaly raises the prospects for many new discoveries as the community-wide effort "Assembing the Tree of Life" proceeds over the next decade.

Jacques Gauthier's collaborators in the Deep Scaly Project are M. Kearney, J. Maisano, T. Reeder, O. Rieppel, J. Sites, and J. Wiens.

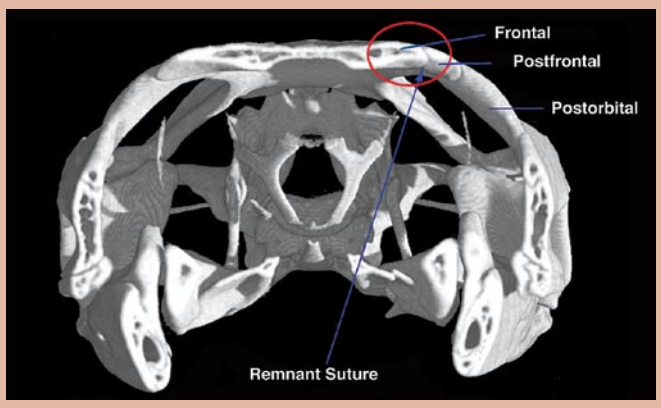


Fig. 4. HRXCT scans can reveal remnant sutures not visible externally and help to solve primary homologies. An agamid lizard displaying a remnant suture (in red circle) between the frontal and postfrontal bones.

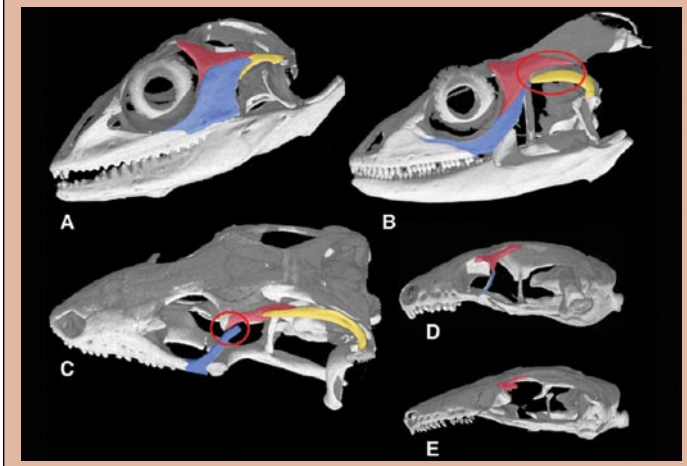


Fig. 3. HRXCT skans of skulls can show natural anatomical relations at mobile joints composed of fibrous elastic connective tissue. A. An agamid lizard showing the ancestral relations among postorbital (pink), jugal (blue), and squamosal (yellow) bones. Note that all bones are closely apposed and firmly united in this species; all dried skulls look like this scan. B. A corytophanid lizard with a mobile postorbital-squamosal joint (in red circle). C. A gerrhonotine lizard with a mobile jugal-postorbital joint (in red circle). Once the jugal bone no longer transmits compressive forces behind the eye, the jugal (blue) can be reduced (D), or lost entirely (E), as is often the case in sceleroglossan lizards sharing this loose articulation.

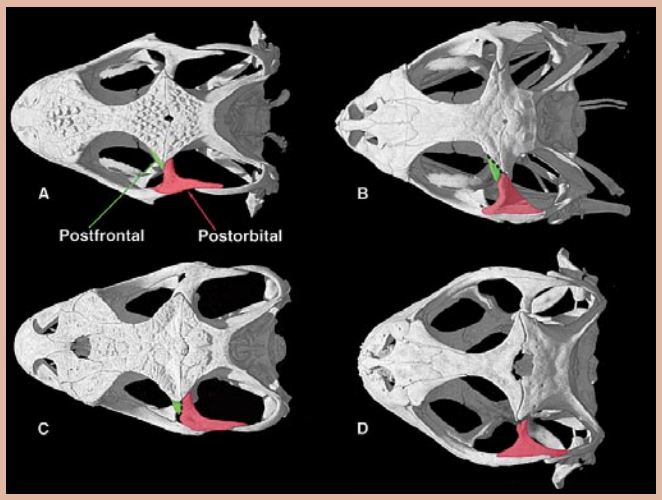
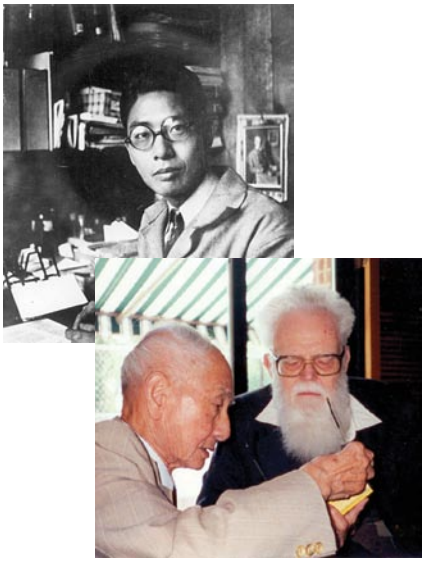


Fig. 5. HRXCT scans can help avoid errors in primary homology estimates, such as "postfrontal bone absent," an observation that could mistakenly be hypothesized as an apomorphy shared by B, C, and D. A. A leiosaurid lizard displaying the ancestral condition in which a small, subtriangular postfrontal bone (green) lies in the upper corner of the orbit, with a larger, triradiate postorbital bone (pink) sitting behind it. B. An agamid lizard in which the postfrontal is fused to the frontal bone. C. A polychrotid lizard in which the postfrontal is fused to the postorbital bone. D. A liolaemid lizard in which the postfrontal bone fails to differentiate. Note also the mobile joint between the postorbital and parietal bones in D (in red circle).

ALUMNI NEWS

We are delighted that many of you have sent in messages telling us what you have been doing. We would like to hear from all of you—please send emails to mabel.peterson@yale.edu. If you send a color photo, please be sure it meets the following digital criteria: jpg or gif format, max resolution 640 – 480 pixels.



A recent visitor from China, Shihong Zhang, brought news and photos of **Yang Zunyi G '39**. Yang, who was awarded a Wilbur Cross Medal by Yale in '94, lives in Beijing, is still actively working in geology, and will soon celebrate the beginning of his 100th year. The photos show him in his student days and with John Rodgers in 1994.

Fred Haeberle '47 has had a varied career in teaching and the business world and writes "Am glad I majored in geology, have enjoyed everything related to it. Got a great education in geology at Yale and never regretted any of it, except at times I wish I had gone on to a PhD."

Richard (Dick) Dietrich G '51 sent in this 1950 photo of Adolph and Eleanora Bliss Knopf in Hammond, NY, where Dick did his

Adolph and Eleanora Knopf.

PhD thesis. Knopf was the Sterling Professor of Geology.

Dudley Bolyard '53 was … "pleased, indeed proud, to learn of the breadth of geological and geophysical science at Yale. When I graduated in 1953 the faculty was much smaller and many of the specialized fields had not even been conceived. Oil and gas exploration has been my career. After 40 years as an independent entrepreneur specializing in the Rocky Mountain region, I am gradually decreasing those activities in favor of global geotourism."

Ross B. Macdonald '55 writes that he is saddened by the passing of John Rodgers and John Ostrom, and that he recently gave a lecture to the Sociedad Audubon de Mexico that relied heavily on John Ostrom's work.

Thomas Ovenshine '58 "I like the newsletter. It seems overdue. Virginia Tech and UCLA—other schools in my past—have had them for quite a while. Notwithstanding, yours is well done. More!"

Michael Mackenzie '60 "…for a long while have been in consulting geology in the oil patch in New Orleans (Katrina wind damage but not flooded)."

George W. Moore G '60 and his wife Ellen James Moore are enjoying the fieldwork for his forthcoming book on the geology of Oregon wine. Since 1987, George has been Courtesy Professor of Geology at Oregon State University. Earlier in the Holocene, he had a rewarding career in the U.S. Geological Survey.

Jackson (Jay) M. Barton, Jr. '67 writes " … it was through the efforts of my mentors of the time, Dick Armstrong and John Rodgers, that I went on to a career in geology. Brian [Skinner] came as I was leaving so he never taught me but he indirectly was a mentor too because he and John Rodgers inspired me to get into the geological publication game and a few years ago I became the Coeditor of the South African Journal of Geology. I retired from the University of Johannesburg as of March 31, 2006, and am now working for myself as a geological consultant. I also am an adjunct professor of geology at Fort Hare University."

Andrew (Sita) Lumsden G '70 came to Yale as a Fulbright scholar to work with A.W. (Fuzz) Crompton and, as he writes, " …ran into the Viet Nam war when crazy things were going on at Yale and grad students, at least the U.S. nationals, were being picked off for military service. The ambient atmosphere was rich in both paranoia and narcotic fumes, neither of which encouraged academic endeavour. So, regrettably, I decided to drop out before the end of the second year and return to the UK." Andrew now has a PhD in Developmental Biology, is a Professor of Developmental Neuroscience in the University of London, and a Fellow of the Royal Society.

Brian and Cathy Skinner were guests of **Yi-Liang (Leon) Chen G '76** and his wife Flora during a spectacular visit to Taiwan in August 2006. Although now active in nongeological businesses in

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Leon Chen in southern Taiwan.

Taiwan, Leon still has his heart in the right place and he showed the Skinners some remarkable geology along the eastern side of the island.

Danita Brandt G '85 (Department of Geological Sciences, Michigan State University) and one of her undergraduates Tory McCoy spent a few days in March visiting Derek Briggs and his postdoc Erik Tetlie to discuss the taphonomy of fossil scorpions and eurypterids.

Marcus M. Key, Jr. G '88 writes "As Professor in the Geology Department at Dickinson College, I am finishing my latest stint as Department Chair this fall. In the spring I have been appointed the J. A. Valentine Visiting Professor at the University of Otago in Dunedin, New Zealand. My sabbatical research will focus on using Neogene fossil bryozoans to test the midlatitude signal of the Calcite II to Aragonite III Sea transition 39 Ma. More broadly, my research uses the morphology, mineralogy, and stable isotope geochemistry (I hate to admit it Prof. Rye!) of extinct and extant bryozoans to address various biological, ecological, and evolutionary questions. On the home front, Maria and I are busy raising 5 kids with the oldest now scoping out colleges."

Paul Schroeder G '92 was Chief Scientist for a 2006 expedition to Uzon Caldera and Geyser Valley in Kamchatka far-eastern Russia. Since 2002, he has been part of a team of microbiologists and geochemists funded by NSF's Microbial Observatory program. You can visit his project at http://www.exploratorium.edu/kamchatka/index.html. Paul is specifically looking at microbial-mineral relations and the potential for biosignatures that can be left in the rock record. He's also examining the role of clay minerals in nitrogen cycling within the anaerobic hot springs.

Paul Schroeder in Kamchatka.

Vaughan C. Turekian '93 having earned a PhD in atmospheric geochemistry from the University of Virginia, is presently Chief International Officer of the American Association for the Advancement of Science. He went there in March 2006 after a three year stint as Special Assistant to the Undersecretary for Global Affairs in the Department of State. His interests are in improving the interaction of American and International scientists.

Robert (Bob) Burger '93 picked up an M.Sc. at Dartmouth and a Ph.D. at the University of Texas along the way but has returned to Yale as Assistant Provost for Science and Technology. Bob also worked for the Joint Oceanographic Institutions, and the USGS. We are pleased to have him back and pleased to see him in departmental seminars when provostial duties give him a break.

Ethan Baxter '95 earned a PhD at the University of California, Berkeley, and is now an Assistant Professor at Boston University, and father of 3-month old Katherine. He visited in early March and gave two interesting talks on his studies of the importance of kinetics in metamorphic processes.

Catherine Izard '06 is in her first year (of two) in an M.Sc. program in Industrial Ecology at the Norwegian University of Science and Technology in Trondheim, Norway. She writes "When I'm not studying, I'm working on the nearly impossible tasks of learning Norwegian and how to cross-country ski without looking foolish."

Denise Levitan '06 is an Intern in the Mineral Resources Program at the USGS. She works with a group that is researching the geochemical characterization of mine waste.

Laura Jeanty '06 is working this year at CERN (the European Lab for Particle Physics) as a Postgraduate Associate. She is participating in the installation and commissioning of ATLAS, one of the main detectors for the new proton accelerator (the Large Hadron Collider, or LHC). She works with electronics, writes software programs for the data acquisition system in the subdetector, and climbs around in the underground detector itself testing and installing (and sometimes breaking) things. She writes "I'm also eating a lot of croissants and Swiss chocolate."

The George Gaylord Simpson Prize

The name **George Gaylord Simpson '23, G '26,** looms large in the pantheon of vertebrate paleontologists. He was only 24 years old when he was awarded his PhD for a thesis on Mesozoic mammals, even though, at the time, evidence of the existence of Mesozoic mammals rested largely on a few jaw and teeth fragments in the collections of Yale's Peabody Museum and the British Museum.

George Gaylord Simpson, 1952, at the American Museum of Natural History. He is examining a fossil of the Dawn Horse, "*Eohippus*" (now known as *Hyracotherium*) from the American west. Simpson is in the center; the others are museum staff members, George Whitaker (L) and Joseph Nocera (R).

Simpson next joined the staff of the American Museum of Natural History in 1927 where he rose, eventually, to Curator in Charge of Geology and Paleontology. In 1958 he was appointed the Alexander Agassiz Professor of Vertebrate Paleontology at Harvard, in which position he continued until 1971 when he moved to Tucson, as Professor of Geosciences in the University of Arizona until his retirement in 1982.

Simpson's interests ranged widely, from his seminal studies of Mesozoic mammals, particularly those from the Cretaceous of North America and Mongolia, to the Tertiary mammalian fauna of South America. He is also known for the Neodarwinian Paradigm and his ideas on new species evolution and the role that environmental conditions plays in this process.

Simpson died in 1984, and that same year the Peabody Museum of Natural History instituted the **George Gaylord Simpson Prize**. The award is for a published paper on "Evolution and the Fossil Record," and is open to Yale graduate students and past graduates no more than five years after the award of their PhD degree. The joint winners of the award in 2006 were **Julia A. Clarke G '02** and **Ian Miller G '07**.

Julia Clarke is an Assistant Professor at North Carolina State University and Director of Paleontology at the North Carolina Museum of Natural History. She was awarded the prize in 2006 for a paper on "Definitive fossil evidence for the extant avian radiation in the Cretaceous," *Nature*, v. 433, p. 305–308. The paper presents evidence that duck, chicken, and ratite bird relatives were coextant with non-avian dinosaurs, and that a minimum of five divergences occurred within Aves before the K/T boundary.

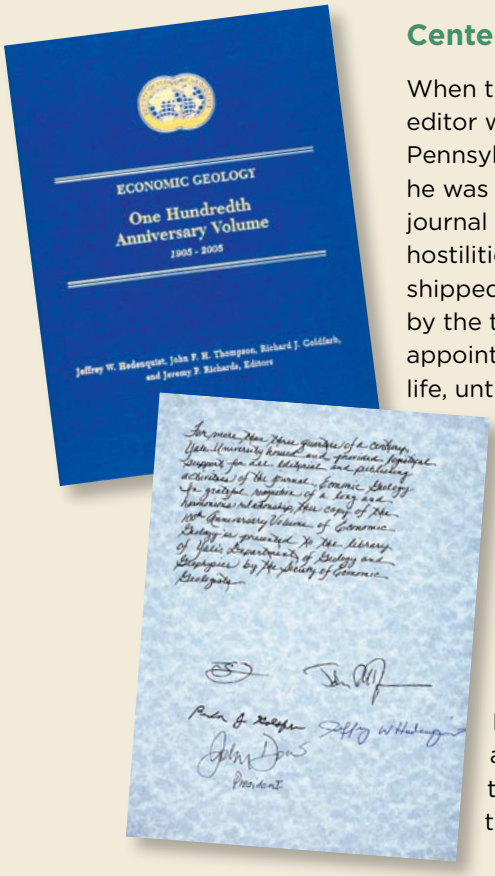
This is Julia's second prize. In 2001, she co-authored a prize-winning paper with **Mark Norell G '88**, American Museum of Natural History, on "Fossil that fills a critical gap in avian evolution," *Nature*, v. 409, p. 181–184. The paper describes a new taxon of Mesozoic ornithurine birds found in Mongolia.

Julia is actively engaged in fieldwork in Mongolia, China, and Peru.

Ian Miller will get his PhD at Commencement 2007. His current position is postdoctoral fellow at the Denver Museum, where he is associated with **Kirk Johnson G '89**, Vice President of Research and Collections and Chief Curator.

Ian's research concerns the plant fossil record in the Denver basin, with an aim to estimating Cretaceous and Paleocene climates, tracing the origins of rainforests, plant extinction at the K-T boundary, and the paleoelevation of the Rocky Mountains during the Laramide orogeny.

He won the prize for a paper titled "Using leaf margin analysis to estimate the mid-Cretaceous (Albian) paleolatitude of the Baja BC block," in *Earth and Planetary Science Letters*, v. 245, 2006. p. 95–114. The paper demonstrates that leaf analysis correlates well with the mean annual temperature of a site, and therefore the latitude. The paleoflora of the Winthrop Formation, a mid-Cretaceous unit in northern Washington state, is shown to have formed in a subtropical to tropical climate at an estimated latitude of 38 · 4° N. The evidence supports the hypothesis that the flora, and therefore the Baja BC block, has been translated 2,200 km northward relative to stable North America.



Centennial of *Economic Geology*

When the first issue of *Economic Geology* was published in 1905, the editor was J.D. Irving, a professor at Lehigh University in Bethlehem, Pennsylvania. Irving had studied and earned a PhD at Yale, and in 1907 he was appointed to the faculty as Professor of Economic Geology. The journal moved to Yale with him. When the United States entered the hostilities in World War I Irving enlisted in the Army Engineers. He was shipped to France and died, tragically, in 1918. His former student, and by the time of Irving's death, his junior colleague, Alan Bateman was appointed editor and continued in the post for most of his professional life, until 1969, when Brian Skinner became editor. Skinner continued in the job until 1995, when Marco Einaudi of Stanford University was appointed editor. From 1907 to 1995, 88 years, Yale University provided space and access to facilities without charge. It is difficult to imagine how the journal could have risen to the influential publication it is today without Yale's help.

In 2005, the *One Hundredth Anniversary Volume of Economic Geology* was published, and in recognition of the singular role Yale played in the history of the journal, a specially bound copy of the volume was presented by the Society of Economic Geologists to the Library of the Department of Geology and Geophysics. The volume carries a laudatory inscription and the signatures of the editors of the volume and the President of the Society.

GEOLOGY & GEOPHYSICS NEWS

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