Geology Department
Newsletter

Union
College

Newsletter 69, October 1995

Message from the Chair

The past year has been a bit more interesting than usual. I have completed a year as chair of both Geology and Civil Engineering. As you might guess, much of my time has been taken up with the CE Department: acquainting myself with the faculty, learning the ins and outs of the CE curriculum, and carrying out a search for a new faculty member. Fortunately, the situation in Geology has allowed me to direct my efforts toward CE. On the other hand, the year has not been without significant events in Geology, including a successful tenure decision, the addition of a new visiting faculty member, and several new research projects.

Kurt Hollocher chaired the search committee for our new vsiting faculty position. After sifting through dozens of applications we interviewed three highly qualified individuals and made a selection. I am pleased to say that we were able to attract our first choice and **Sharon Locke** joined us just last week. She comes to us from the Department of Geology and Geophysics and the Limnological Research Center at the University of Minnesota. She has a broad range of interests, covering hydrogeology, climate change, limnology and surficial geology. She will be teaching courses in Environmental Geology, Earth Sysytem Science, Groundwater Geology, and Limnology. It's a great plus to have a fifth geologist in the department.

John Garver successfully completed the tenure review process and has been promoted to Associate Professor. He has maintained the contacts with Russia which were established when we had visitors from the former Soviet Union, and last summer he took two students with him to do field work for a National Science Foundation funded project in Kamchatka. You can read the report on that trip elsewhere in this newsletter. John's wife, **Jacquie Smith**, continues to work for a local consulting company, Alpha Earth, which is run by **Eric Eslinger**, who has been teaching evening courses in the Department for a number of years as an adjunct Professor.

Don Rodbell has now completed a very successful first year in the department. He has quickly become a valued member of the faculty, and it is a delight to have him as a colleague. Don received a major grant from the National Science Foundation for research in South America. Last summer he took two students with him to the Ecuadoran Andes. The research also involves faculty from Syracuse University and the Limnological Research Center at the University of Minnesota, and the field party consisted of about a dozen scientists. Don really had his work cut out for him, keeping a group that size functioning in a remote part of Ecuador. You can read about his adventures in his report.

My activities have been somewhat circumscribed by administrative duties. Fortunately I had made some plans well before I ended up chairing two departments, and thus had a built-inexcuse for getting away for awhile. In late June my wife, son and I left for a trip to Arizona. It was a combination working/holiday trip, but even working time in Arizona feels like a holiday! I visited an old friend who recently stepped down as chair of the Department of Geosciences at the University of Arizona in Tucson. I also had a chance to talk with the new chair, Joaquin Ruiz. Kurt spent his sabbatical leave in Joaquin's lab, and we had a nice chat. Joaquin was full of praise for the hard work Kurt put in during his sabbatical year. Part of the "work" of my trip was trying to get some samples of bentonite and unaltered volcanic ash from a locality in east central Arizona. An emiritus faculty at Arizona had done field work at the site and I hoped to get information from him, and possibly some samples. Unfortunately he was in New Hampshire! Even more unfortunately, the Navajo Reservation boundaries have been changed since the publication of the most recent USGS maps and the mine site I hoped to collect from is now on the Reservation, which requires a somewhat complicated process for obtaining permits for collecting samples. Such are the vagaries of field geology.

After a few days in Tucson we drove up to Flagstaff to begin a 12 day raft trip through the Grand Canyon. This was my seventh trip down the Colorado, and it was one of the best yet, because there was a large group of friends going with us. These included David and Susan Hayes from the Chemistry Department (and their three sons), Hilary Tann (Chair of Performing Arts), and Yu Chang from the Electrical Engineering Department. There were also other friends not associated with Union. We all had a great time. I spent a fair amount of time examining sites of special interest to me in considering my projected walk through the canyon, which I have been planning for a number of years, and which I hope to do next spring. There is a lot of fascinating geology down there, and I hope to have time to look at it more closely during my more leisurely hike through the canyon. My son and I followed up on the river trip with a week of hiking, again examining some critical locations. One day we hiked 17 miles from the Marble Platform to the Colorado River, with over a mile of descent on a trail which was often of marginal quality. Then we had to hike back out! All in all it was a useful and welcome trip, and went a long way toward recharging my batteries.

At the Commencement in June we graduated eight geology majors, one environmental studies major with a geology concentration, and one master's in teaching (Earth Science) student. In spite of the loss of so many of our major's at one stroke, we still have thirteen majors coming back for the fall term, including several new freshman. We also have two of last year's seniors returning in the master's in teaching program. They will be completing the requirements for teaching certification. As usual, we expect that the number of majors will increase substantially as the year passes and more students discover geology!

From October 13 to 17, the Geology Department hosted a joint meeting of the New York State Geological Association and the Eastern Section of the American Association of Petroleum Geologists. Prof. Garver was the meeting organizer and is the current President of the NYSGA. John did an outstanding job organizing the meetings and preparing/editing the field trip guidebook. He was honored by a special award from the ES-AAPG at the meeting. Among the field trips were three led by Profs. Hollocher and Rodbell,and by Janet Hollocher. Phil Hewitt also led a field trip. The field trip volume included an article on the history of Geology at Union

College. I am enclosing a copy of that article with this newsletter. Perhaps reading it will trigger some memories, which you might relate to me.

The effort to fund a new building to house the Geology Department has not yet borne fruit, but we still have hope. This is an evolutionary process, and revisions to our proposal are in progress, but facilities for geology remain a central part of the project. Perhaps my next newsletter will carry long-awaited good news.

New Graduates

Kevin Allison completed a thesis on "The Sedimentologic History of Collins Lake, Scotia, New York." Prof. Rodbell was his thesis adviser. Kevin will be staying at Union in the Masters in Teaching program, with an emphasis in Earth Science.

Jason Baker's thesis, "Comparative Rare Earth Element Study of the Apatite Crystals from Sandstones of the Great Valley Sequence, California and Bentonites from Pennsylvania and Western, New York" was under the direction of Prof. Shaw. Jason has been accepted into dental school, where he will study a different form of apatite!

April Bemis completed her study, "Controls on Peat Landform and Hydrology by Subsurface Stratigraphy and Bedrock Topography". She has been working on this project, which involved three field trips to northern Minnesota, since she began working with Prof. Shaw during the summer of her sophomore year. April will also be staying on in the Master's in Teaching Program at Union, also with Earth Science in mind.

Jeffrey Bigelow determined: "Fission Track Ages of Plutons in the Footwall of the LaGrange Fault, Klamath Mountains, California" as his thesis project with Prof. Garver. Jeff has entered graduate school in the Department of Geology at Utah State University.

James Dlubac minored in geology (his major was Environmental Science) and did a thesis with Prof. Rodbell. His thesis was entitled; "Fossilized Pollen Grain Analysis and Downcore Determination of Exchangeable Metal Concentrations in Collins Lake."

Andrew Frisbie counted fission tracks in a phenomenal number of zircon grains in his thesis with Prof. Garver;" A Fission Track Study of Detrital Zircons from Pacific Northwest River Sediments." Andy will be studying Russian language at Middlebury College in preparation for a career which he expects to take him to Russia!

Stephanie Howk, whose degree is in Environmental Studies with a concentration in Geology, completed a thesis directed by Prof. Rodbell: "A Record of the Frequency of Fires as Derived from the Abundance of Charcoal in a Sediment Core from Collins Lake, Scotia, New York."

Scott Lewis completed his thesis with Prof. Shaw, combining his interest in paleontology with the Department's ICP-MS in an: "Analysis of Rare Earth Element Concentrations in Paleozoic Conodont Elements." Scott will be attending graduate school in the Department of Geology at Old Dominion University.

Craig Prunier's thesis: " Determination of the Bedrock Topography in a Peat Bog Using Seismic Analysis" was completed under the direction of Prof. Shaw. Craig is attending Graduate School at the University of Nevada-Reno.

Gaela Schweizer worked on apatite samples from Russian diamond pipes provided by Nik Sobolev. Her work, supervised by Prof. Garver, involved: "Fission Track Dating of Apatite from Kimberlite in Siberia, Northern Russia." Gaela has taken a job with a local consulting company, Longworth Environmental, and now lives in Saratoga, N.Y..

Paul Hays completed an M.A.T thesis entitled " Determining the dimensions and probable cause of a stream -induced rotational slump in the Plotterkill Preserve, New York" under Prof. Rodbell's supervision. Paul is presently teaching at a High School in Boston.

Response of lake-groundwater interactions to climate change

Sharon M. Locke

The chemical composition of lake water, and thus the lake sediment and its geologic record, are strongly influenced by the lake's long-term water budget. In determining modern lake hydrologic budgets it is generally assumed that precipitation and evaporation, which are in turn a function of climate, are the primary inputs and outputs. In highly permeable geologic substrates, however, a lake may be in direct contact with the ground water and may receive or lose a significant amount of water through the lake bed in any given year. Indeed in glaciated regions with thick blankets of sand and gravel outwash, lakes can be thought of as surface expressions of the ground-water table, and lake behavior is strongly related to the behavior of the regional water table.

A small chain of lakes in north-central Minnesota is being intensively studied by researchers across the country in order to better understand the relationship between a lake's hydrology and its other physical, chemical, and biological characteristics. The study area is located about 60 km southeast of the headwaters of the Mississippi River in a region near the juncture of two prominent end moraines. Two lakes at the site in particular are representative of the variety of possible interactions between a lake and the surrounding groundwater system. Williams Lake at the southern end of the chain has no surface inlets or outlets and is dominated by groundwater flow-through and atmospheric exchange, whereas Shingobee Lake located 5 km to the north is dominated by stream inflow and outflow.

On a global scale, it has been widely observed in historical times that lake levels are strongly influenced by regional climate, and that in general periods of low annual precipitation are characterized by low lake levels and periods of excess precipitation are characterized by high lake levels. Similarly, the geologic record is full of evidence for lake-level variations on longer time scales. Climate researchers use the magnitudes of these lake-level changes as "paleoclimatic" indicators to estimate past changes in precipitation and evaporation. The paleo-lake levels are included in relatively simple water budgets, or combined water-energy budgets, to calculate the climatic conditions necessary to account for the varying lake levels. This approach has yielded much information on past climates, but it is not appropriate for all lakes, particularly those in unconsolidated sediments where groundwater can be a significant portion of the lake water budget.

One aspect of my research involves the characterization of lake-groundwater interactions on both long and short-term time scales. My approach has been to study lake-level changes from the perspective of groundwater modeling. The lakes at the Minnesota site are in permeable outwash sands and gravels and therefore can be considered as a feature of the regional surficial aquifer in computer models. A computer model that uses "analytic-element" techniques can produce simulations of the Minnesota lake levels and the associated water table that closely match modern field observations. In order to examine the response of the lakes to changing climate, the water-balance parameters of the model, namely evaporation minus precipitation over the entire region of interest and precipitation minus evaporation at the individual lake surfaces, are systematically varied in a series of modeling exercises. The model predicts that lake levels are primarily responsive to changes in the elevation of the regional water table rather than to local inputs and outputs at the lake surface. The model also predicts that lakes at higher elevations will experience greater lake-level changes than those at lower elevations, closer to the stabilizing effects of streams.

The models make it possible to simulate past or future climatic scenarios and then test the model predictions in the field. The climate of much of the northern Midwest, including north-central Minnesota, was drier and possibly warmer during the mid-Holocene, from about 8000 to 6000 yrs. B.P. (years before present). The lithology of sediment cores from Williams and Shingobee Lakes indicates that lake levels were significantly lower during the mid-Holocene, and as predicted in the computer model, Williams Lake at the higher elevation experienced a greater lake-level lowering. The computer-generated "best fit" of the modeled lake levels to the estimated past levels indicates at least a 40% reduction in annual precipitation during the mid-Holocene relative to today.

Geochemical evidence has provided further insight into the long-term interactions between lake and ground waters. The stable isotopic composition of ostracod shells preserved in the sediment cores is a record of the lake water's isotopic composition through time. The modern waters of Williams and Shingobee Lakes are chemically different because of the lakes' contrasting hydrologies: Williams Lake is evaporatively enriched in oxygen-18 because it is a closed basin with a relatively long residence time, whereas Shingobee Lake water is isotopically similar to rain water. Detailed analysis of the ostracods in Williams and Shingobee Lake sediments show that the isotopic compositions have not always been different. At the beginning of the Holocene Williams and Shingobee lake waters were isotopically similar, and in fact were probably part of the same large lake possibly formed by an ice-block damming a river. By the mid-Holocene the lakes' isotopic compositions had diverged, with Williams Lake becoming a closed basin influenced primarily by groundwater flow-through.

Questions concerning the details of past and present-day groundwater-lake interactions remain. The complicated patterns of groundwater flow near lakes are difficult to evaluate because of the necessity for an extensive network of monitoring wells, yet the need to understand these patterns in light of contaminant transport is clear. For longer time scales, the effects of sediment infilling of the basin on lake-bed permeability (and thus on local groundwater flow paths) has not been explored. This information has practical applications related to the long-term impacts of reservoirs on environmental quality. These questions clearly require study from several perspectives, and will require a combination of field-based observations and numerical modeling.

Donors to the Field Geology Fund

John Dreier '64

Clark Alberts '44

Robert T. Brady '47

James H. Scott '51

Donald M. Hoskins '52

Philip L. Perkins '62

Bernard McGrath '47

Andrew D. Lent '87

Todd Smick '91

Carl H. Hobbs III '68

Philip Royce '92

George H. Shaw

Raymond Robinson '36

Grants

From National Science Foundation

$79,000 to John Garver: "Cenozoic collision of the Olutorsky Volcanic arc, Northern Kamchatka, Russian Far East"

$173,000 to Donald Rodbell: "High resolution glacial geologic and palynologic records of the last deglaciation in the tropical Andes"

From the National Aeronautics and Space Administration

$50,000 to Sharon Locke: "A cooperative program in Earth System Science education at Union College"

From Union College Faculty Research Fund

$1430 to John Garver: " Fission-track dating of rocks along the El Pilar Fault, Venezuela"

$2700 to Kurt Hollocher: "Completion of a laser-ablation microprobe for ICPMA analysis"

From the Union College Internal Education Fund

$2640 to John Garver: "Carbonate Sedimentology"

$2500 to Donald Rodbell: "The integration of the study of aerial photographs into Geomorphology and Glacial Geology"

From the New York State Pew Cluster

$2500 to Michael Bullen: Undergraduate Research participation grant

Check us out on the WEB!

The Union Geology Department is now on the World Wide Web. You can find the Union College Home page at "http://tardis.union.edu" and the Geology Department's home page is "http://zircon.geology.union.edu". If you are not yet into the Web, you can get to our gopher site from the directory at "gopher.union.edu". If you can only handle email, email us at "shawg@kaibab.geology.union.edu" or "garverj@zircon.geology.union.edu" If you don't know what any of this means, and you still want to find out more about the Department, give us a call the old fashioned way at (518) 388-6310.

Field Trips

Field Work in Ecuador

Last spring I was awarded a three-year grant from the National Science Foundation to assess the timing and magnitude of climate change at the end of the Pleistocene in the tropical Andes Mountains of Ecuador and Peru. This research project, an outgrowth of my PhD research on the glacial history of northern Peru, involves colleagues from Syracuse University, the University of Minnesota, and the University of Maryland. Our research will focus on continuous paleoclimatic proxy records preserved in lacustrine sediment cores from alpine lakes in glaciated regions, and mapping the extent of paleoglaciers for specific time intervals during the last deglaciation. For our first field season, we chose to focus on glacial lakes on and around a 13,000-foot-high ignimbrite plateau in southern Ecuador. This plateau, part of which is within Las Cajas National Park, is only 75 km (as the condor flies!) from the Pacific Ocean and thus the relief is spectacular. The plateau was overlain by a large ice cap as recently as 11,000 yr. BP and is dotted with hundreds of glacial lake basins. During the last glacial maximum, the ice cap fed several large outlet glaciers which descended to well within the modern rain forest on the eastern side of the plateau. Step-wise deglaciation from terminal moraine positions at about 8000' has left a series of glacial lakes which preserve a sedimentologic record of deglaciation and a palynologic record of vegetation change.

In mid-June, Adam Goodman ('96) and Jeff Nebolini ('96) and I left Butterfield Hall with an overloaded rent-a-car headed for J.F.K International Airport. From there we flew to Quito Ecuador where we met the other members of our field expedition and embarked on an arduous 10 hour bus ride down the axis of the Ecuadorian Andes to the city of Cuenca. There, we spent a day buying supplies in the local market and arranging for transportation into the Park.

We had anticipated working out of our tents for the next 5 weeks, but by sheer good fortune were able to rent a chalet the likes of which (sky lights in the ceiling; pool/ping pong tables in the basement!) I have never encountered in my previous 10 years working in the Andes. The chalet is part of a trout farm, which is nestled on the floor of a spectacular glacial valley and is surrounded by hanging valleys and breath-taking waterfalls. The owners, who have high expectations of developing their property into a mountain resort, were more than pleased to make us their very first customers. Initially we were a bit uncomfortable with the thought of doing field work out of such luxurious accommodations but we managed to accept our plight!! In the end, it was good we had a solid roof to come home to as the weather was miserable for much of the first 3 weeks. Daytime temperatures hovered between 40¡ and 45¡F and an incessant rain and blowing mist greeted us nearly every morning. Field work typically amounted to hours of hiking up and down steep, wet slopes carrying coring equipment, which included an 80 lb. inflatable raft. The text-book glacial geomorphology beckoned us to explore cirque after cirque, and inspired Adam and Jeff to bag the highest peak in the Park (14,600'). In the end, we collected some 50 m of lake core, including one 15 m core that may extend through the last ice age. If substantiated, this would be a rare find indeed!

On our final day in Ecuador, Adam and Jeff convinced me to burn what little energy I had left to climb Nevado Cotopaxi, which at 19,300' is one of the world's highest active volcanoes. At 2 AM, we donned our head lamps, crampons and ice axes, and roped-up for a steep ascent of one of Ecuador's largest modern glaciers. By 6 AM, we had climbed to about 18,000' where the light snow turned into a horizontal blizzard. With avalanche danger mounting, we took a few photos of our flag emblazoned with Union Geology in Ecuador and decided to make a hasty retreat. In short, our field expedition was a great success. We collected enough core and soil samples for several years worth of lab work. The geochemistry of tephra preserved it the cores will be the basis for Jeff's senior thesis and Adam will concentrate on sediment and soil samples from moraines.

Field Work in Kamchatka by Michael Bullen

Close your eyes and imagine an orange and blue helicopter the size of a school bus. Picture the pilot; a man of moderate stature, garbed in jeans and a black button-down shirt, with a smile crowded with gold-capped teeth. Now, envision the lift off, slow and awkward, as if the helicopter was carrying just one pound over its maximum weight. Distressing as it may be, imagine yourself on that unwieldy bird flying north, into the heart of north-eastern Siberia; only to be dropped in a land of tundra, grizzly bears, and mosquitoes the size of hummingbirds, with no radio, telephone or source of rescue for 28 days. This fantasy, or nightmare, depending on your preference, records the slightly exaggerated first day of three Union Geologists, as they conducted research on the Kamchatka Peninsula in the Russian Far East. Professor John Garver led this challenging expedition with students Michael Bullen ('97)and John Kronholm ('97) as field assistants. This 'Union Triad' worked with two geologists from Yale University, two from the Institute of the Lithosphere (Russia), and one from the University of Mainz (Germany).

Intrigued by the tactical challenge and ambiguous geologic history, John Garver decided to study the remnants of a relict foreland basin formed from the collision of a volcanic island arc with the Siberian mainland. By examining the Ukelayat Flysch, a turbidite sequence, the Union group attempted to reconstruct the paleogeography and orientation of the volcanic arc and the mainland. Bullen and Kronholm proved their worth in the collection of coarse, immature sandstones for fission track dating of the orogenic event. This technique of sampling involved maximum vertical and horizontal traverses, collecting a number of 12 pound sandstone specimens. The tectonism in question was previously assumed to have occurred at 45 Ma or at 20 Ma, and with the extensive dating program a more accurate date is expected in the near future. As Garver and his students analyzed the flysch sequence, Mark Brandon from Yale University studied kinematic indicators, and Galya Ledneva (a former visiting researcher at Union College) studied ultramafic plutons associated with the active volcanism; thus researchers at the three institutions are collectively studying the many facets of this arc-continent collision.

To obtain the fission track, kinematic, and petrologic aspects of the area, the geologists went through the rigors of Russian travel, as they flew extensively across along the easternmost side of Siberia. One solid week was needed just to arrive at, and then get out of, the Koryak Mountains at ~62¡ N latitude. The group initially embarked from Seattle on July 10, flying to Anchorage, Alaska and then over the Bering Sea to the arctic village of Anadyr for refueling. It was at this stop that a remarkable first impression was received, as an Aerophlot plane lay on its side without half its landing gear- a comical, yet subtly disturbing first view of Russia. The group soon discovered that when travelling in Russia 'if you are in a hurry, sit down'. After enduring this test of patience the days disappeared, as the weary travelers proceeded south to a city near the northern tip of China (Khabarovsk), north to Petropovlosk-Kamchatsk (the capital of the Kamchatka Peninsula), and then finally to the arctic village of Korf. It was at this town that the geologists boarded an orange and blue army helicopter that flew them 3.5 hours north into the Koryak Mountains. After recovering from jet-lag, 4 straight days of travel, and the shock an unfamiliar language and culture, the group found a great deal of exciting work to do.

Magnificent basalt and chert ridges and hungry 10 pound trout were secondary to the fantastic geology along the Matysken, and Il' Pivem Rivers. Two base camps were set up approximately 18 km apart, allowing the group a two-pronged geologic attack. Field groups were organized daily, as each party set forth to study rock exposures in gullies, cirques, and mountain tops. 'Spike camps' were also established by the Union group, as they ventured away from the base camp for 3 days, to climb the highest peak for a vertical profile of fission track ages. Although ferocious mosquitoes proved a damper on the majestic surroundings, the grizzly bears stayed away, and the group was usually left to eat, sleep and fish in relative solitude.

Finally, with data to be processed and rocks to be crushed, Team Kamchatka flew home to the wonderful land of the Big Mac a bit surprised they survived a summer in Siberia. Frenzied research will continue in the respective institutions throughout the year, with the lingering memories of a barren, distant land propelling new geologic theories for the future.