



Geology Department Newsletter

**Union
College**

Newsletter 63, September 1989

Message from the Chair

The past year, my first as chairman of the Union College Geology Department, has been both exciting and productive. The department has made considerable progress in reestablishing geology as a major field of study at Union. This has taken a number of forms: new personnel, new equipment, and numerous educational and research activities on the part of faculty and students. A year ago we had one student majoring in geology, now there are six or seven (depending upon how you count them). Enrolments in both introductory and advanced courses are on the rise, and we have expanded our course offerings. While there is much yet to be done, we are well on our way. Over the next few years I hope to be able to report to you on modest expansion in the size of the faculty and student body in geology, continued improvements in our equipment and facilities, and a variety of activities including field trips, research projects and departmental gatherings.

The search for someone to fill a permanent position in sedimentation- tectonics took up a large part of winter term. We had over eighty applications for the position, and the quality of those was so high that we ended up interviewing six finalists. The result was the selection of **John Garver** from the University of Washington. John will be joining us in January and will teach courses in structural geology, historical geology, and sedimentology. We will also be joined by **John Damanti** from Cornell University. He will be in a temporary position funded by a grant from the Pew Foundation. The purpose of the grant is to give new PhD graduates some experience in teaching. John will be teaching courses in environmental geology, physical geology, and geomorphology.

Paul Ryberg will be leaving us in January. It has been a pleasure working with him. He is a dedicated teacher and a fine geologist. We wish him well.

The departmental technician, **John Smith**, left us during the winter term, and I have been looking for a replacement. Given the current employment situation in geology, I hope to hire someone with a master's degree in geology. Our new technician should be joining us soon, and will be responsible for running and maintaining departmental equipment, making thin sections, assisting with setting up laboratory exercises and on field trips and field work, and some curation.

Teaching and research in modern geology require a certain amount of sophisticated equipment. During the past year the department has been fortunate in being able to make significant additions in this area. We have purchased a new x-ray diffractometer, a twelve-channel digital

floating point field seismic recorder, a cathodoluminescence attachment for a microscope, a shatterbox for crushing rock and mineral specimens, and a petrographic microscope (we have been adding one microscope each year for the past four years or so). We have ordered an inductively coupled plasma quadrupole mass spectrometer, a state-of-the-art analytical instrument which will allow us to chemically and isotopically analyse rocks and minerals for essentially all of the elements. We also obtained a used, but quite functional, gravimeter. In addition, I was able to bring with me, from my laboratory at Minnesota, a significant amount of high pressure equipment and electronic instruments for measuring properties of rocks and minerals. All told, we have added about \$500,000 worth of equipment to the geology department. Our plans include adding another \$500,000 worth of equipment over the next five years, so we're off to an excellent start.

During the past year faculty have attended national meetings and conferences where they presented the results of some of their research, participated in field trips, and renewed old friendships. Faculty and students have been on a number of field trips, both local and to distant places, including a dinosaur dig in Montana. We are planning more field trips, and I invite any of you to join us, however briefly, should we pass your way. Our next trip will be in late November and early

December to the southern Appalachians, westward to Arkansas. There is a possibility that the Continuing Education office will be arranging a geological study tour of the Grand Canyon by raft! If any of you might be interested in such a trip, please let me know and I will have further information sent to you.

New Faculty

John I. Garver, age 28, single, BA Geology (Middlebury College, '84), MS and PhD, Geology (U. of Washington, '85, '89). Asst. Prof. (Union '90), Teaching: Strat., Sed., Structure, Tectonics, Historical. Research: Sedimentology and stratigraphy of accreted terranes, structure and tectonics of active plate margins, fission track analysis of detrital minerals.

John Damanti, age 29, married - no children, BS Geology (Queen's College-CUNY, '84), PhD Geology (Cornell U. '89), Visiting Asst. Prof. (Union, '89-90). Teaching: Env. Geol., Phys. Geol., Geomorphology. Research: Sedimentation and stratigraphy in tectonically active terranes, relationship of sedimentation to geomorphology, remote sensing of surficial processes.

Alumni News

While I have heard directly from a few of you, I have taken the liberty to use additional information from various sources to report in this letter.

Alvin Van Valkenburg ('36) was awarded the John Price Wetherill Medal in 1986 for his work in developing the diamond anvil pressure cell. This device has revolutionised high pressure research, by allowing static pressures equivalent to that in the earth's core to be produced in the laboratory. He retired from his position at the Geophysical Laboratory of the Carnegie Institution in 1980.

William E. McClelland ('50) retired from teaching in 1980. He was an adjunct professor in the NSF Earth Science teaching program at Union during the '70's. He speculates that while a student at Union he may have had more geology instructors than any other student. His instructors included **Maurice Deul ('42)** [economic geology], **Robert Brady ('47)** [petroleum geology and stratigraphy], and **George Hanson ('43)** [glacial geology and mineralogy].

Louis M. Martucci ('56) is manager of research and development analysis at Batelle Management Institute in Richland, Washington.

Edward Buchwald ('60) is Lloyd McBride Professor of Environmental Studies and Chair of the Geology Department at Carleton College

Elkanah A. (Ken) Babcock ('63) recently moved to Ottawa from Alberta to become the head of the Geological Survey of Canada.

Jack Bird ('55) visited the geology department last spring as a Pew Cluster Visiting Scholar. Jack gave us a stimulating presentation on trends in geological science. We had a very long talk about geoscience, crustal evolution, and the future of geology at Union.

[Communications from alumni are very important to the geology department, not only as a means of staying in touch with one another, but as a vital source of ideas about the directions of geology, and ways in which we can improve our work. I sincerely hope that more of you will drop us a line. To make this a little easier, I have included a postcard in this newsletter!]

Why cratons formed at the end of the Archean.

by George H. Shaw

The development of large cratonic masses and the change in large-scale tectonic regimes near the end of the Archean mark what is arguably the most profound transition in the geologic record. Considerable speculation has centered around the causes of the "event." Indeed, there is a lively debate concerning whether the global plate tectonic pattern so important in the Phanerozoic can be applied to geologic interpretation of the Archean at all. Virtually all of the ideas about the change in tectonics at the end of the Archean involve a vague reference to "cooling of the Earth," and stabilization of continental masses as a result. On the other hand, there is no well defined evolutionary model of thermal history of the Earth that points to a special change at the end of Archean time ... until now!

The main element to consider in assessing thermal history, especially for the Archean, is the significantly greater heat production from radiogenic sources at early times. Presently the Earth loses much of its heat through convection by means of generation and cooling of oceanic lithosphere, or plates. The heat that flows out of the continental crust appears not to have changed significantly with time, as evidenced by reconstructed geothermal gradients for Archean terranes. Assuming that is true, then the higher heat output for the earlier Earth must have escaped by some kind of convective process associated with the oceanic areas of the Earth, and earlier convection must have been, on the average, more vigorous.

More vigorous oceanic convection implies a generally hotter and less dense oceanic lithosphere and upper mantle (and shallower oceans) and this is part of the basis for a model of the Earth which leads to a remarkable result. The Archean ocean is something about which we have little direct information, but a reasonable assumption is that the amount of water available was, to a first approximation, the same as that in the present oceans. It is an even better assumption that isostatic equilibrium has applied to continent- and ocean-sized masses throughout geologic history. In addition, consideration of the processes by which continental crust is produced suggests that it has been generated in decreasing amounts through geologic times as the radiogenic heat source has been depleted, starting from essentially no continental crust in the earliest Archean.

The assumptions above (which can be fairly well justified) can be put together to produce a model which gives the thickness of the continental crust through time (Fig. 1). This model ties crustal thickness to thermal evolution by assuming that the average elevation of continents above sea level has not changed significantly through time. This final assumption is also well justified since this "freeboard" of the continents is based upon the greater long-term effectiveness of erosion compared to orogeny. The two curves in Figure 1 represent different degrees of differentiation of radiogenic elements into the continental crust as a result of igneous processes. The striking feature of this figure is the maximum in crustal thickness near the end of the Archean (since this is only a model, a precise correspondence with the end of the Archean is not to be expected). This figure implies that continental masses had to be tectonically mobile throughout the Archean in order to undergo the thickening required to keep their "heads above water." At the end of the Archean, stabilization of cratons was possible, since freeboard could be maintained by a process not requiring tectonic mobility, namely erosion. In other words, the cratons have simply been eroding since they were stabilized at the end of the Archean. I believe this is the first "mechanistic" model which identifies something unique about the end of the Archean relating to the stabilization of continental masses into cratons. More detailed consideration of the model may lead to insights into important aspects of Archean geology, perhaps even including processes responsible for the production of Archean gold deposits. The mechanism by which continental submergence leads to tectonic instability is another part of the story, which I don't have space to go into here, and is also a potentially fruitful area for continued research.

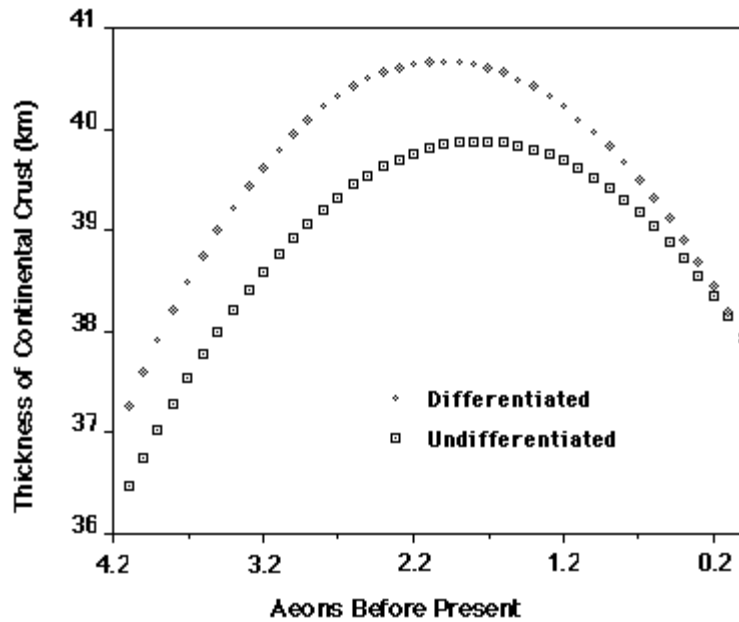


Figure 1. Thickness of continental crust through time. Differentiation of radiogenic elements into the crust shifts the peak of the curve to earlier time.

Grants received

W. M. Keck Foundation - \$200,000 This grant is for instrumentation in geology to enhance teaching and research capabilities of the geology department at Union College. The funds have been used for the purchase of a new X-ray generator and diffractometer, a 12-channel seismic recorder, and an inductively coupled plasma-quadrupole mass spectrometer.

Pew Foundation - \$20,000 Teacher Training Program for appointment of **John Damanti** as a Visiting Assistant Professor.

- **\$10,000** Undergraduate Research Participation to support four students on the dinosaur dig in Montana.

Both of these awards are part of a larger grant from the **Pew Foundation** to the New York Pew Cluster in Undergraduate Science Education.

NSF Instrumentation and Laboratory Improvement - \$50,250 "Chemical Analysis in Mineralogy, Petrology, and Geochemistry" This is for partial funding of the inductively coupled plasma - quadrupole mass spectrometer.

Empire State Challenger Fellowship - Linda Garbellano, our first student to pursue a Master's degree in earth science teaching, was awarded a fellowship to help defray the cost of tuition and fees. Linda has a health sciences degree, but will fulfill the undergraduate requirements in geology in order to become an earth science teacher. Prior to enrolling at Union she held an administrative post in the district office of the Red Cross.

Faculty activities

Prof. Shaw continued his activities as a member of the American Geophysical Union Committee on Public Affairs, and the American Institute of Physics Committee on Public Policy. He chaired the AIP subcommittee for selection of Congressional Science Fellows this past spring. His editorial on "Priorities in Science Funding" was published in Eos last spring. In April he accompanied President and Mrs. Morris on a west coast trip to visit alumnae clubs in San Diego, Los Angeles, San Jose, and San Francisco. He gave each club a brief presentation on the dynamic processes of geology. While in Los Angeles, he accompanied Mrs. Morris on a (too short) tour of the La Brea tar pits and the attached paleontological museum. In May Prof. Shaw was the speaker at the fourth and final Faculty Colloquium of the year. His topic was "History of the Continental Crust". The essence of the talk may be found elsewhere in this newsletter. He presented seminars on the same topic to the geology departments at Rensselaer Polytechnic Institute and State University of New York at Albany during the winter term. In June, Prof. Shaw presented a talk to Trustee's spouses on "The geology and scenery of the Grand Canyon".

Prof. Hollocher attended the Quebec-Vermont Appalachian Workshop at the University of Vermont during the spring, where he presented a poster session on "The nature of the Bronson Hill zone during the Taconian Orogeny". He also attended the meeting of the Northeastern Section of the Geological Society of America and presented a paper on "The Bronson Hill volcanic arc: old interpretations and new radiometric ages". By the time you read this he will have led part of a field trip honoring Prof. J. B. Thompson of Harvard. His contribution includes the "Basement and cover of the Acadian metamorphic high of central Massachusetts". Prof. Hollocher was also a principle in a field trip to north-central Colorado to collect samples and photographs to be used in a new set of laboratory exercises in physical geology based upon the area. He has almost single-handedly produced these exercises, and this effort is now being supported by a Pew foundation grant to the Geology Working Group of the New York Pew Cluster.

Prof. Ryberg attended the Geological Association of New Jersey field conference on the Central Newark Basin, and the NEIGC annual field conference in Keene, NH. He presented a paper at the Symposium on Paleogene sedimentation, volcanism, and tectonics of the western US at the GSA combined Rocky Mtn. - Cordilleran Section Meeting in Spokane, WA.

Field Trips



Dinosaurs in Montana!

Four undergraduate students, two from Union College, one from St. Lawrence University, and one from Barnard College joined three local earth science teachers in a dinosaur dig in western Montana over the summer. Each of the faculty from the geology department participated for four weeks, overlapping in time in order to cover the seven weeks at the dig site, a one week field trip on the way out to the site, and a two week field trip at the end. We were able to arrange participation in an ongoing dig run by Jack Horner of the Museum of the Rockies. The ten participants sponsored by Union College enjoyed the chance to excavate dinosaur remains from a rich and fascinating site containing bones of hadrosaurs, ankylosaurs and carnosaurs. Prof. Shaw was very fortunate in being in a group which unearthed a probable albertosaurus, unusual, in that much of the skeleton seemed to be present (although not articulated). Jack Horner said this was his first such find in thirteen years of digging.

While most of the excavated material will go to the Museum of the Rockies, Union has a few representative samples, and we hope to get a cast of a complete hadrosaur specimen for assembly and display.

The trips out and back were almost as interesting as the time in Montana. On the way out we looked at geology in Letchworth State Park in western New York, the classic Van Hise rock near Baraboo, WI where ideas about the relationship between fold geometry and cleavage were first worked out, the South Dakota Badlands and the Black Hills (including a tour of Jewel Cave). John and Jane Wold extended us most gracious hospitality overnight at their home in Casper.

On the return trip we took a detour to the west to see sediments and structures along the rugged Oregon coast, Crater Lake, Mt. St. Helens (including a thrilling helicopter ride into the crater), Glacier Park and Devil's Tower. This was a highly educational trip for all concerned, and we expect just the first of many.