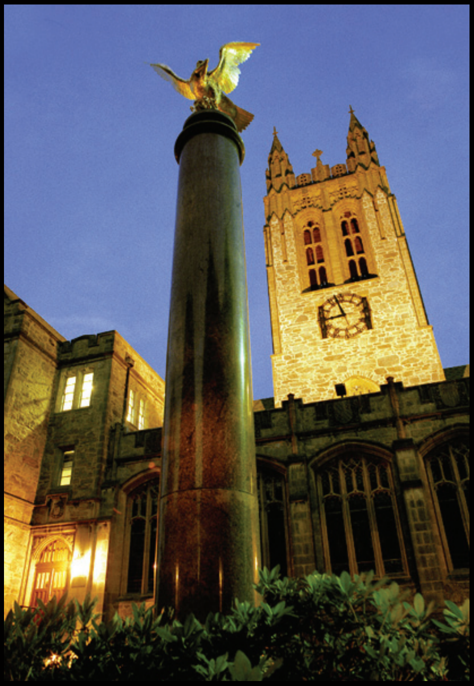
BOSTON COLLEGE

GRADUATE SCHOOL OF ARTS AND SCIENCES




GRADUATE PROGRAM

EARTH & ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

Master of Science

The department offers graduate courses and research programs leading to the M.S. degree in Geology or Geophysics. Students are encouraged to obtain broad backgrounds by taking courses in geology, geophysics and environmental areas, as well as in the other sciences and mathematics. Multidisciplinary preparation is particularly useful for students seeking future employment in industry.

The department, with approximately 20 graduate students in residence, is housed in Devlin Hall and has additional research facilities at Weston Observatory. Students enjoy close working relationships with faculty while being able to undertake research using the most modern scientific equipment available. The program stresses a strong background in the earth sciences, as well as the ability to carry out research. It prepares students for successful careers as geoscientists in industry, oil exploration or government service, or continued studies toward a Ph.D. A particularly beneficial aspect of the M.S. program is the opportunity for students to integrate studies in geology, geophysics and environmental subjects.

Research in the department covers a broad range of topics, including: Coastal and Estuarine Processes, Physical Sedimentation, Geomorphology, Earthquake and Exploration Seismology, Structural Geology, Geochronology, Field Mapping, Igneous and Metamorphic Petrology and Geochemistry, Global Change Geochemistry, Interpretative Tectonics, Groundwater Hydrology, and Environmental Geology and Geophysics, Precambrian, biogeochemistry, stable Isotopes, geochemistry, astrobiology.

The department offers a number of Teaching and Research Assistantships.

Application

Applicants to the Master of Science degree program generally fall into one of the following categories:

(1) students well-prepared in geology, geochemistry or geophysics with courses in mathematics, physics, chemistry and/or biology who are interested in broadening their experience at the M.S. degree level before employment or doctoral studies elsewhere; (2) students well-prepared in mathematics or in one or more of the natural sciences other than geology or geophysics and who wish to use the M.S. degree program to transfer into the earth sciences.

In addition to the normal application forms, applicants should submit transcripts, letters of recommendation, a personal evaluation of the strengths and weaknesses of their undergraduate education (including course and non-course experience), and their graduate study interests and current post-degree plans. Graduate Record Exam (general) scores are required. Applications may be made at any time, but to be assured of consideration for September admissions, they should be received by May 1. Applications from those applying for financial aid and assistantships for September need to be completed by February 1. Later applications will be considered for financial aid if funding is available. The application form and information on applying can be found at www.bc.edu/gsas.

M.S. Degree Requirements

No fixed curriculum is prescribed for the M.S. degree. Instead, a course and research program that is consistent with the student's background and professional objectives is developed by the student and his or her faculty advisory committee. The graduate program assumes a basic undergraduate foundation in the geosciences. Students lacking such a background may be required to complete certain subjects at the undergraduate level before or during their graduate program. Master's candidates in either Geology or Geophysics must complete or have completed a minimum of two semesters (or equivalent) of courses in calculus, physics, and chemistry.

A minimum of ten courses in the natural sciences, mathematics and engineering (numbered 300 or above), approved by the student's faculty advisory committee, must be completed in addition to a research thesis for graduation. Graduate level multidisciplinary Earth Systems Seminars are offered annually by the Department on different topics. Beginning graduate students are required to take the Earth Systems Seminar. A maximum of two thesis courses (GE 801) are allowed for M.S. thesis credit. No more than one Reading and Research course (GE 798 or GE 799) may be applied toward the minimum course requirement. All students are required to maintain at least a 3.0 average in Departmental courses, as well as in all undergraduate courses (numbered 0-299) in the other sciences and mathematics. Passing a comprehensive oral examination is required of each student before the end of their fourth semester. Three faculty signatures are required for a completed M.S. Thesis. In addition to a digital copy of the completed thesis that is submitted to the university, a bound copy of the thesis is to be submitted to the department.

Dual Degree Program (M.S.-M.B.A.)

In conjunction with the Carroll Graduate School of Management at Boston College, the Department of of Earth & Environmental Sciences offers interested students the opportunity to participate in the combined M.S.-M.B.A. degree program. Completion of this program leads to the awarding of both degrees. This program is excellent preparation for careers in industrial or financial geoscience management, including areas such as the environmental and petroleum industries, natural hazard assessment and natural resource evaluation and investment.

The combined M.S.-M.B.A. program normally takes three years for students with a good science background as an undergraduate—about one year less than pursuing these two degrees independently. Students in this program commonly take their first year entirely within the Department of Earth & Environmental Sciences. During the first summer, the student is expected to begin work on a research M.S. thesis that may be combined with an off-campus internship. The second year of the program is taken at the Carroll Graduate School of Management and the third year is split between both programs. Corporate internships are encouraged.

In applying to the program, students have two options. The first and most desirable option is for the student to apply directly to, and be accepted by, both the Graduate School of Arts and Sciences and the Carroll Graduate School of Management at the time of their initial application to Boston College. The GRE is required and GMAT tests may be requested. Students may contact the Department of Earth & Environmental Sciences for information and application materials to both programs (please indicate you are interested in the Dual Degree Program). The deadline for admission to the Department of Earth & Environmental Sciences is February 1, the same as the deadline for M.S. candidates. The deadline for application to the Carroll Graduate School of Management is January 2.

The second option is for students to apply and be accepted to the M.S. program in Earth & Environmental Sciences. During the spring of their first year, after consultation with their academic advisor, the student may then choose to apply to the Carroll Graduate School of Management for admission into the dual degree M.S.-M.B.A. program.

Further information on this program and application materials may be obtained from Professor John E. Ebel, Director of Graduate Studies, Department of Earth & Environmental Sciences, Devlin Hall 213, Boston College, Chestnut Hill, MA 02467, 617-552-3640, ebel@bc.edu or from Graduate Admissions, Carroll Graduate School of Management, Boston College, Chestnut Hill, MA 02467, 617-552-3920.

Master of Science in Teaching (M.S.T.)

The Master of Science in Teaching (M.S.T.) program is administered through the Lynch Graduate School of Education in cooperation with the Department of Earth & Environmental Sciences. It requires admission to both the Lynch Graduate School of Education and the Department of Earth & Environmental Sciences. This program, which is designed for prospective teachers, acknowledges variations in prior background and skills. For those candidates without prior teaching experience, a 36-credit minimum M.S.T. degree program is required, in which at least five courses are in earth sciences, five courses in education, and six credits are for supervised internship teaching. For experienced teachers, a 30-credit minimum M.S.T. degree program is required (since the internship is not necessary) of which at least five courses are in the earth sciences. The application procedures for the M.S.T. degree programs are the same as those for the M.S. degree program. Students seeking certification in Massachusetts are required to pass the Massachusetts Educators Certification Test. For further information on the M.S.T., please refer to the Lynch School of Education section entitled, "Master's Programs in Secondary Teaching," or call the Office of Graduate Admissions, Lynch School of Education, at 617-552-4214.

M.S.T. Degree Requirements

The five required courses in the earth sciences must be chosen from among the following: two courses from Exploring the Earth or Introduction to Structural Geology and one course from each of the following groups: (1) Earth Materials or four credits in Mineralogy or Petrology (2) Weather, Climate, Environment, Oceanography or Astronomy, and (3) Four credits in Petrology, Structural Geology or Introduction to Geophysics. Students who have previously taken these courses may substitute other graduate courses within the Earth and Environmental Sciences Department with approval. One semester of full-time residency may be necessary. A comprehensive examination is given to each student at the end of the program. This examination is in two parts: one part is oral in the earth sciences, and the other part is given by the Lynch School of Education.

Cooperative Program

The department is part of a cooperative program with the Department of Earth Sciences at nearby Boston University, as well as the Civil Engineering Department at Tufts University. This program permits degree candidates at Boston College to enroll in courses that are unavailable at Boston College, but are available at Boston University or Tufts. A list of courses is available in the department.

Weston Observatory

Weston Observatory, formerly Weston College Seismic Station (1928-1949), is a part of the Department of Earth & Environmental Sciences of Boston College. Located 10 miles from the main campus, the Observatory is an interdisciplinary research facility of the department and a center for research in the disciplines of geophysics, geology and related disciplines. Weston Observatory was one of the first participating facilities in the Worldwide Standardized Seismograph Network and operates a fifteen-station regional seismic network that records data on earthquakes in the northeast, as well as distant earthquakes. The facilities at Weston Observatory offer students a unique opportunity to work on exciting projects with modern, sophisticated, scientific research equipment in a number of different areas of scientific and environmental interest. For more information, visit the Weston Observatory website at http://www.bc.edu/westonobservatory/.

Courses

Graduate Course Offerings

GE 330 Paleobiology
Paul Strother

GE 335 Topics in Geobiology
Paul Strother

GE 380 Environmental Oceanography
Gail C. Kineke

GE 391 Introduction to Geophysics
Alan L. Kafka

GE 398 Statistical Analysis of Scientific Data
The Department

GE 400 Watershed Geomorphology
Noah P. Snyder

GE 405 Fluid Flow and Sediment Transport
Doug Edmonds

GE 410 Site Characterization, Remediation, and Long Term Monitoring for Hazardous Waste Sites
Randolph Martin, III

GE 418 Hydrogeology
Alfredo Urzua

GE 424 Environmental Geophysics
John E. Ebel

GE 440 Global Biogeochemical Cycles
Dominic Papineau

GE 455 Exploration Seismology
John E. Ebel

GE 457 Watershed Science
Rudolph Hon

GE 475 Geotechnology
Alfredo Urzua

GE 480 Applications of GIS (Geographical Information Systems)
Rudolph Hon

GE 484 Aqueous Geochemistry
Rudolph Hon

GE 485 Advanced Structural Geology
The Department

GE 490 Remote Sensing and Image Interpretation
Noah P. Snyder

GE 512 Isotope Applications in Earth Science
Dominic Papineau

GE 518 Estuarine Studies
Gail C. Kineke

GE 530 Marine Geology
Gail C. Kineke

GE 535 Coastal Processes
Gail C. Kineke

GE 543 Plate Tectonics and Mountain Belts
J. Christopher Hepburn

GE 570 Petrology I
J. Christopher Hepburn/Rudolph Hon

GE 572 Geophysical Data Processing
Alan L. Kafka

GE 574 Petrology II
J. Christopher Hepburn/Doug Edmonds

GE 580 Environmental Seminar
The Department

GE 655 Exploration Seismology
John E. Ebel

GE 660 Introduction to Seismology
John E. Ebel

GE 692 Earth Systems Seminar
The Department

GE 794 Seminar in Geology
The Department

GE 795 Seminar in Geophysics
The Department

GE 796 Seminar in Geology
The Department

GE 797 Seminar in Geophysics
The Department

GE 798 Reading and Research in Geophysics
The Department

GE 799 Reading and Research in Geology
The Department

GE 801 Thesis Seminar
The Department

GE 888 Interim Study
The Department

FACULTY

The faculty and students of the Department of Earth & Environmental Sciences conduct research on a wide variety of topics. These include: geophysics, geomorphology, exploration and environmental geophysics, structural geology, geochronology, tectonics, field mapping, igneous, metamorphic and sedimentary petrology and geochemistry, paleontology, global climate change geochemistry, coastal processes, environmental geology and geochemistry, sedimentology, stratigraphy, depositional environments, hydrology, engineering geology, astrobiology and precambrian biogeochemistry. Many students take advantage of our location in New England and the northern Appalachians in their choice of research topics, while others work on research from locations literally around the world. An international research program has been established in the Caucasus region of the Alpine Himalayan Belt, with research opportunities for students. The following is a brief description of the faculty and some of the research currently being carried out in the Department.

EMANUEL G. BOMBOLAKIS

bombolak@bc.edu
Adjunct Research Professor, Ph.D. 1963,
Massachusetts Institute of Technology

Structural Geology and Tectonics

JOHN F. DEVANE, S.J.

devane@bc.edu
Assistant Professor Emeritus, M.S. 1949,
Fordham University

Geomagnetism, Exploration Geophysics

JOHN E. EBEL

ebel@bc.edu
Professor, Director of Weston Observatory, Ph.D. 1981,
California Institute of Technology

Earthquake Seismology, Exploration Geophysics, Theoretical Seismology, Seismic Hazards

DOUGLAS A. EDMONDS

Assistant Professor, Ph.D. 2009,
Pennsylvania State University

Sedimentology and Stratigraphy, Numerical Modeling, Geomorphology, Depositional Environments

J. CHRISTOPHER HEPBURN

hepburn@bc.edu
Professor, Ph.D. 1972,
Harvard University

Regional Geology and Tectonics, Metamorphic & Igneous Petrology, Geochemistry

RUDOLPH HON

hon@bc.edu
Associate Professor, Ph.D. 1976,
Massachusetts Institute of Technology

Aqueous Geochemistry, Watershed Studies, Environmental Geology, Mineralogy, Geochemistry of Soils

ALAN L. KAFKA

kafka@bc.edu
Associate Professor, Department Chairperson, Ph.D. 1980,
Stony Brook University

Seismology, Earthquake Hazards, Science Education

GAIL C. KINEKE

kineke@bc.edu
Associate Professor, Ph.D. 1993,
University of Washington

Coastal and Estuarine Processes

RANDOLPH J. MARTIN III

martinrk@bc.edu
Adjunct Professor, Ph.D. 1971,
Massachusetts Institute of Technology

Geology, Geophysics, Rock Mechanics

DOMINIC PAPINEAU

Assistant Professor (starting January 2011), Ph.D. 2006,
University of Colorado, Boulder

Precambrian Biogeochemistry, Stable Isotope Geochemistry, In Situ Micro-Analyses, Exo/Astrobiology

NOAH P. SNYDER

noah.snyder@bc.edu
Assistant Professor, Ph.D. 2001,
Massachusetts Institute of Technology

Geology, Geomorphology, Surface Processes

JAMES W. SKEHAN, S.J.

skehan@bc.edu
Professor Emeritus, Director Emeritus Weston Observatory,
Ph.D. 1953, Harvard University

Regional Geology and Tectonics of New England and the Margins of the North Atlantic

PAUL STROTHER

paul.strother@bc.edu
Research Professor, Ph.D. 1980,
Harvard University

Paleobotany & Palynology, Precambrian Paleobiology, Origin of Land Plants

ALFREDO URZUA

urzua@bc.edu
Adjunct Professor, Ph.D. 1981,
Massachusetts Institute of Technology

Hydrology, Geoscience Engineering

RESEARCH

Geophysics

Professors John E. Ebel, Alan L. Kafka

CRUSTAL STRUCTURE AND SEISMICITY OF NEW ENGLAND

Using data from the New England seismic network, we are investigating the causes and effects of regional earthquakes. Research is in progress to better understand the seismic structure of the Earth beneath New England, to determine more reliably the sizes of local earthquakes, and to locate more accurately earthquake hypocenters. We are also exploring relationships between earthquake activity and faults or other geological features in this region.

EARTHQUAKE FORECASTING RESEARCH

Although earthquake prediction remains an elusive goal, it is possible to forecast the general characteristics of future earthquakes at some level of detail. An earthquake forecast is a long-term statement of probability of one or more earthquakes occurring in a region. Our research in this area is focused on discerning the level of detail that can be known about the spatial and temporal characteristics of future earthquake processes. We are investigating the extent to which the distribution of seismicity in a region delineates where future earthquakes are likely to occur, as well as the extent to which non-random patterns in the temporal distribution of seismicity might indicate increased probability of earthquakes occurring.

SEISMIC HAZARD STUDIES

The determination of the probabilities of different levels of expected ground shaking in future earthquakes is vital information if engineers are to successfully build structures to withstand earthquakes. The analysis of seismic hazard for New England using standard methods as well as the development of new methods of seismic hazard analyses are the major goals of this research. The spatial patterns of earthquake occurrences, the patterns of strong ground motions generated by earthquakes, and the variations of source properties from earthquake to earthquake are some of the topics addressed in this line of research. One such project is a study of the effects of ground shaking amplification due to landfill and other soft soil in the Boston area.

REGIONAL AND EDUCATIONAL SEISMIC NETWORKS

Seismologists at Weston Observatory have been recording earthquakes for many decades. We currently operate the 16-station New England Seismic Network to monitor earthquakes in the Northeastern United States, as well as an educational seismic network consisting of seismographs in high schools and middle schools. These networks provide seismological data that are used not only for monitoring regional and global earthquakes and assessing earthquake hazards, but also for exploring the structure of the Earth's interior.

SYNTHETIC SEISMOGRAMS, MODELING EARTHQUAKE SOURCES AND EARTH STRUCTURE

Modern seismic source theory and wave propagation methods can be programmed into a computer to allow the theoretical prediction of earthquake seismograms. These theoretical (or synthetic) seismograms can be used to study the details of an earthquake source or the structure of the deep interior of the earth. We are using synthetic seismogram methods to study the details of earthquake sources in such places as New England, and California to better determine the active seismotectonics of these areas. We are also applying synthetic seismograms to the study of the internal structure of the earth, particularly the crust and upper mantle.

PALEOSEISMIC STUDIES IN NEW ENGLAND

Documentation of the maximum credible earthquake that can be expected in a region is fundamental to the assessment of the seismic hazard within the region. New England and adjacent portions of the northeastern United States and Canada is a large region of active seismicity with recorded earthquakes approaching magnitude 6. Paleoseismic investigations of more active centers of seismic activity are warranted because these regions may have experienced a past, even pre-historic, large earthquake. Studies of unconsolidated sediments of Pleistocene and Holocene age may uncover deformational features characteristic of such past large earthquakes. One project under current investigation is a search for paleo-earthquake indicators in the geology of northeastern Massachusetts and southeastern New Hampshire. This area had a strong earthquake in 1727 and there is good geologic evidence for earthquakes within the past few thousand years.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

- Ebel, J.E., An Analysis of Aftershock and Foreshock Activity in Stable Continental Regions: Implications for Aftershock Forecasting and the Hazard of Strong Earthquakes, *Seism. Res. Lett.*, 80, 1062-1068, 2009.

- Cicerone, R.D., J.E. Ebel and **J. Britton**, A systemataic compilation of earthquake precursors, *Tectonophysics*, 476, 371-396, 2009.

- **Dougherty, Sara** (2008)Development of a 3-D Upper Crustal Velocity Model of the Goldstream Valley, Central Alaska, M.S. Thesis.

❖**Gruber, Matthew** (2007)Using shallow seismic reflection to resolve the glacial history along the southern coast of Cape Cod, M.S. Thesis.

❖Guidoboni, E., and J.E. Ebel, Earthquakes and Tsunamis in the Past: A Guide to Techniques in Historical Seismology, Cambridge Univeristy Press, 602 pp., 2009.

❖Ebel, J.E., A.M. Moulis, D. Smith and M. Hagerty, The 2006-2007 Earthquake Sequence at Bar Harbor, Maine, Seism. Res. Lett., 79, 457-468, 2008.

❖Ebel, J.E., D.W. Chambers, A.L. Kafka & J Baglivo (2007) Non-poissonian Earthquake Clustering and the Hidden Markov Model as Bases for Earthquake Forecasting in California, Seismological Research Letters. vol. 78, no. 1, pp. 47-55.

❖ Kafka, A.L., & J.E. Ebel, (2007) Exaggerated Claims about Earthquake Predictions, EOS Transactions of the American Geophysical Union, vol. 88, No. 1, doi: 10.1029/2007EO010002.

❖ Ebel, J. E. (2006) The Cape Ann, Massachusetts Earthquake of 1755: A 250th Anniversary Perspective, Seismological Research Letter, vol. 77, no. 1, pp. 74-86.

❖ **Yan, Jia** (2006) Using Waveform Inversion to Determine Local Earthquake Source Parameters in Northeastern United States, M.S. Thesis.

❖ **Zhu, Lieyuan** (2005) Seismic Signal Identification Based On Wavelet Transform and SNR Spectral Pattern, M.S. Thesis.

❖ Kafka, A. L. and **Rasmusson, K.** (2003) Using the AS1 Seismograph for Laboratory Exercises in an Introductory Geophysics Course: Turning Seismic Moments into Teachable Moments, Seismological Research Letters, vol. 74, no. 5, pp. 618-624.

❖ Barnett, M., Kafka, A.L., Pfitzner-Gatling, and **Syzmanski, E.** (2005) The Living Earth: Inviting Students Into the World of Scientific Research Through Seismology, Journal of College Science Teaching, vol. 34, no. 6, pp. 50-54.

❖ Ebel, J. E., Urzua, A., and **Britton, J.** (2004) The Effect of Local Surfical Geology on the Ground Motions of Future Earthquakes in Boston, Massachusetts: A comparison with Seismic Codes, Proceedings Volume 1, 57th Geotechnical Conference, paper G 33. 119.

❖ **Rasmusson, K.** (2003) Probabilistic Analysis of Social and Economic Losses due to Large Earthquakes in New England, M.S. Thesis.

❖ Kafka, A.L. (2002) Statistical Analysis of the Hypothesis that Seismicity Delineates Areas where Future Large Earthquakes are Likely to Occur in the Central and Eastern United States, Seismological Research Letters, vol. 73, no. 6, pp. 990-1001.

❖ **Smith, Dina M.** (2001) Signal Noise, and Siting Analysis of New England PEPP Stations, M.S. Thesis.

❖ **Hayles, K.E.**, Ebel, J. E., and Urzua, A., (2001) Microtremor Measurements to Obtain Resonant Frequencies and Ground Shaking Amplifications for Soil Sites in Boston, Civil Engineering Practice, 16, no. 2, 17-36

❖ Ebel, J.E. (2000). A Reanalysis of the 1727 Earthquake at Newbury, Massachusetts, Seismological Research Letters, vol. 71, no. 3, pp. 364-374.

❖ Gendron, P.J., Ebel, J.E., and Manolks, D. (2000). Rapid Joint Detection and Classification with Wavelet Bases via Bayes Theorem, Bulletin of the Seismological Society of America, vol. 90, no. 3, pp. 764-774.

❖ Kafka, A.L. (2000). Public Misconceptions about Faults and Earthquakes in the Eastern United States: Is it our Own Fault? Seismological Research Letters, vol. 71, no. 3, pp. 311-312.

❖ Kafka, A.L. and **Levin, S.Z.** (2000). Does the Spatial Distribution of Smaller Earthquakes Delineate Areas Where Larger Earthquakes are Likely to Occur? Bulletin of the Seismological Society of America, vol. 90, no. 3, pp. 724-738.

Applied Geophysics, Geotechnical Engineering and Rock Physics

Professors John E. Ebel, Alan L. Kafka, Randolph J. Martin III, Alfredo Urzua

Although geophysics is a very broad field, most professional geophysicists are involved in the exploration for natural resources such as petroleum, economic minerals and groundwater. Petroleum and mineral companies in geophysical explorations around the world spend billions of dollars each year. Geophysical methods are increasingly being used in near-surface applications to help solve complex environmental and engineering problems. In our applied geophysics program, we emphasize the basics: a solid foundation in geology, mathematics, physics, chemistry and computing. No matter what the scale of investigation, geophysical explorationists should be able to think geologically and have the technical and analytical skills to solve real world problems. Some of the applied geophysics and engineering projects that we are currently involved in are summarized below.

ENVIRONMENTAL AND EXPLORATION GEOPHYSICS

We are using geophysical methods to characterize the structure of subsurface soils and to find buried objects. Ground penetrating radar, EM, resistivity, IP magnetic, shallow seismic and sometimes gravity methods are used for these environmental applications. This is excellent training for those students who are seeking work in the environmental and geotechnical engineering industries.

The same exploration methods that are employed in environmental and engineering work are also used in the exploration for petroleum and other mineral resources. Although most of our thesis projects currently focus on problems in earthquake seismology, environmental geophysics, rock physics, and geotechnical engineering, many of our students pursue careers in the petroleum exploration business. We have found that the fundamental training that our students receive in geology and geophysics has served our graduates well. Over the years, many of our graduates have been recruited by major petroleum companies and have gone on to have very successful careers. Many of our students also have opportunities to work as summer interns with major oil companies.

GEOTECHNICAL ENGINEERING

Subsurface fluid flow patterns and geologic heterogeneity can significantly effect the strength, stability and reliability of building foundations and subsurface structures. Therefore, these hydrological and geological factors must be taken into account in the design, construction, and evaluation of engineered structures such as buildings, bridges, roads, dams, tunnels, mines, and landfills. We are involved in a variety of geotechnical engineering projects, both locally and abroad, in which we use our collective expertise in geotechnical engineering, hydrogeology, geophysics, and geology to address these complex problems of immediate and practical concern.

FACILITIES

The Earth & Environmental Sciences Department at Boston College has an extensive suite of modern geophysical exploration equipment, and extensive computing facilities. In addition to these facilities, we also have an extensive geochemistry laboratory that includes an ICP and a Gas Chromatograph, which can be used to perform detailed water quality analyses. With these capabilities, we are able to conduct integrated geophysical surveys. Students collect the data in the field, process and interpret the data using powerful computers and inversion codes, analyze core and water samples in the laboratory and integrate the results into a GIS framework, which can be easily updated and expanded upon as work continues from one year to the next.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

- **Shirley, Margela** (2008) Slope Stability Analyses Incorporating Head and Flow Anisotropy as Random Variables, M.S. Thesis. Advisor Alfredo Urzua.
- **Hormazabal, Esteban** (2006) Estimating Flow and Pore Pressures In Open Pit Mines, M.S. Thesis. Advisor Alfredo Urzua.
- **Petro-Roy, A.K.** (2003) Parametric Study of Confined Flow Under an Impervious Concrete Dam, M.S. Thesis.
- **Baker, Hana A.** (2001). Prediction of Capillary Pressure Curves using Dialectic Spectra, M.S. Thesis.
- **Wertz, David F.** (2001). Predicting Soil Moisture Dynamics & Crop Yield Using Electrical Geophysical Methods, M.S. Thesis.
- **Dolynchuk, J.** (2000). Monitoring of Groundwater Pump Tests Using GPR and Electrical Resistivity, M.S. Thesis.
- **Reila, J.** (2000). Application of Reliability Analysis to Slope Stability Problems, M.S. Thesis.
- **Huntress, J.**, (1999) Evaluation of the Dynamic Properties of Soil Cement as they Relate to Unconfined Compressive Strength, M.S. Thesis.
- **Decker, S.** (1999). A Radar Stratigraphic Approach to the Development of Multi-Scale Groundwater Models in Fluvial Environments, M.S. Thesis.
- **Sturrock, J.T.** (1999). Predictions of Hydraulic Permeability Using Spectral Induced Polarization, M.S. Thesis.

Regional Geology and Tectonics

Professors J. Christopher Hepburn, James W. Skehan, S. J.

TECTONICS OF EXOTIC TERRANES IN SOUTHEASTERN NEW ENGLAND

Southeastern New England is underlain by at least four different exotic geologic terranes. The juxtaposition and eventual collision of these terranes with North America led to the Acadian and Alleghanian orogenies in the mid- and late Paleozoic. By integrating studies in structure, petrology, and geochemistry, we are working to develop a picture of these terranes prior to their collision with North America. We are also investigating the plate tectonic processes by which these terranes were accreted to North America to better understand the resulting orogenies.

THE AVALON TERRANE OF SOUTHEASTERN NEW ENGLAND

The Avalon terrane consists of several tectonically separable blocks and units ranging in age from late Proterozoic to Pennsylvanian that have been deformed by at least two, and possibly four, late Precambrian to Paleozoic orogenic events. Preliminary research suggests that the collision of the Avalon Superterrane with North America was responsible for the Acadian orogeny in the rest of the northern Appalachians. However, the part of the Avalon terrane now making up southeastern New England was emplaced in the early stages of or prior to the Acadian orogeny. Ongoing research by graduate students is clarifying our understanding of the Avalon terrane and its origin. Additional research is related to understanding the sequence of tectonic events in this terrane, interpreted as a volcanic arc that lay off the coast of Gondwana, and to developing correlations of this terrane with those of West Africa, Amazonia, western and central Europe, and southern Britain and Ireland.

MYLONITE ZONES OF SOUTHERN NEW ENGLAND

Zones of severe brittle to ductile deformation separate many of the terranes in the eastern Appalachians. A better understanding of these complexly deformed zones will lead to a better understanding of the movements and processes of terrane accretion. Recently, we have been doing detailed analysis of the terrane boundary between the Avalon and Nashoba Terranes in southeastern New England marked by faults such as the Bloody Bluff Fault and Burlington Mylonite Zone. Here, protoliths of the mylonitic rocks include a range of plutonic and volcanic units. U-Pb microprobe monazite and $^{40}Ar/^{39}Ar$ geochronology methods are used to constrain the age of shearing on the mylonite zones. Combined with detailed mapping, petrographic, structural and geochemical studies, we are able to establish controls on the accretionary history of this part of the Appalachians. This research offers an exciting opportunity to become involved in solving complex and significant structural, stratigraphic and tectonic problems that shed light on the processes of terrane accretion in the Appalachians.

REGIONAL BEDROCK AND FRACTURE CHARACTERIZATION STUDIES IN THE NASHOBA TERRANE, MASSACHUSETTS

The Nashoba Terrane is a highly metamorphosed ancient arc-back-arc complex that lies west of the Avalon terrane in Southeast New England. With support from the U.S. Geological Survey, three students have mapped the bedrock of the enigmatic terrane at a scale of 24,000 to allow for a detail analysis of its origin, metamorphic and accretionary history. In addition, the major terrain bordering fault zone is being studied in detail to diciper its timing and direction of motion. Further, since bedrock fractures provide most of the gorundwater resources in this region, detailed fracture maps and analysis are also being undertaken. These combined studies not only help to answer fundamental questions about the Nashoba Terrane but provide environmental and hydrological data to help meet societial needs.

ASSEMBLY AND DISPERSAL OF SUPERCONTINENTS

Many of the wide ranging research projects of the Department have as their goal an understanding and reconstruction of some aspect of the assembly and breakup of supercontinents. Evidence from the Northern Appalachians and from the other circum-Atlantic continents bears on aspects of the assembly and dispersal of the supercontinents Rodinia, Gondwana and Pangea.

GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN THE ANALYSIS OF REGIONAL GEOLOGICAL/ ENVIRONMENTAL PROBLEMS

The Department has an Arc/Info based GIS capability as part of our computer facilities. We are exploring the use of this powerful tool in solving geological and environmental problems. The tremendous amount of available data and the ability to display it graphically on a geographical basis is already leading to exciting new research possibilities in regional geological and tectonic applications as well as in a variety of other research areas.

FACILITIES

An impressive array of equipment is available in the Department that can be brought to bear on problems of regional geology and tectonics. These include the full GIS Arc/Info system mentioned above, various geophysical instruments and research petrographic microscopes.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

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- **Kay, A.,** Hepburn, J.C., Kuiper, Y.D., Inglis, J., 2009. Nd isotopic constraints on the origin of the Nashoba Terrane, eastern Massachusetts. Geological Society of America Abstracts with Programs, Vol. 41, No. 3, p. 98.

- **Robbins, M.P.** (2009) Sedimentology and Sedimentary Tectonics of the Salt Wash Member, Morrison Formation, Western Colorado, Massachusetts. M.S. Thesis.

- **Markwort, R.J.** (2007) The Nashoba Terrane: New Perspectives on its Timing and Style of Accretion from Studies in the Shrewsbury Quadrangle, Massachusetts. M.S. Thesis.

- **Stroud, M.M.** (2007). Temporal and Directional Constraints on a Major Shear Zone in Eastern Massachusetts: Monazite Dating of the Assabet River Fault Zone. M.S. Thesis

- Hepburn, J.C. (2004). The Peri Gondwanan Nashoba Terrane of Eastern Massachusetts: An Early Paleozoic Arc-related complex and its Accretionary History, in Hanson, L.S. (ed.), Guidebook to field trips from Boston, MA to Saco

Bay, ME, New England Intercollegiate Geologic Conference, 96th Annual Meeting, Salem, MA, pp 17-38.

❖ **Pinan Llamas, A.** (2002). The Coastal Volcanic Belt (CVB) In Easternmost Maine, Geochemistry and Tectonic Setting, M.S. Thesis.

❖ Skehan, J. W., S.J. (2001). The Roadside Geology of Massachusetts. Mountain Press, Missoula, Montana, pp. 392.

❖ **Skillitier, D. M.** (2001). Distal Marine Influence in the Forty Brine Section, Joggins, Nova Scotia, Canada. M.S. Thesis.

❖ Goldstein, A. and Hepburn, J.C. (1999). Possible Correlations of the Norumbega Fault System with Faults in Southeastern New England, in Ludman, A. and West, D.P., Jr. (eds.), Norumbega Fault System in the Northern Appalachians, Geological Society of America Special Paper no. 331, pp. 73-83.

❖ **Kohut, E.J** (1999). The Bedrock Geology of the Weston-Lexington Area, Southeastern New England Avalon and Nashoba Terranes, M.S. Thesis.

❖ Hepburn, J. Christopher (2004), The Peri-Gondwanan Nashoba Terrace of Eastern Massachusetts: An Early Arc-related complex and its Accretionary History, in Hanson, L.S., (ed.), Guidebook to Field Trips from Boston, MA to Saco Bay, ME, New England Intercolligate conferrence, 96th Annuity, Salem, MA, pp. 17-38

❖ **Kohut, Edward J.** and Hepburn J. Christopher (2004), Mylonites and Brittle Shear Zones along the western Edge and the Avalon Terrace west of Boston, in Hanson, LS. (ed.), Guidedbook to Field Trips from Boston, MA to Saco Bay, ME, New England Intellcollegiate Geologic Conferrence, 96th Ann. mtg., Salem, MA pp 89.110

Igneous and Metamorphic Petrology and Geochemistry

Professor J. Christopher Hepburn, Assistant Professor Dominic Papineau

PETROLOGICAL AND GEOCHEMICAL STUDIES AS A GUIDE TO TERRANE ANALYSIS

Currently, much of the research in igneous and metamorphic petrology and geochemistry carried out by our students is aimed at understanding the origin and evolution of selected igneous rocks as a guide to terrane analysis. These studies are often integrated with those discussed in the previous section on regional geology. Major and trace element and isotopic analyses, carefully used, combined with petrological and regional observations can be powerful discriminators of the environments in which these rocks formed. Thus, our studies strive to not only understand the origin and evolution of particular igneous rocks, but to use these rocks as guides to understanding the larger picture of the terrane formation and plate tectonic processes in the northern Appalachians. This approach has been successfully applied to igneous and metamorphic rocks from different terrane settings in southeastern New England, Massachusetts, Rhode Island, Vermont and Maine, and other students are currently applying them in areas outside of the northern Appalachians.

GEOCHEMISTRY AS A GUIDE TO TERRANE ANALYSIS IN SOUTHEASTERN NEW ENGLAND

Southeastern New England represents a collage of tectonic terranes formed on the eastern margin of the Iapetus Ocean that collided with the North American margin during the Acadian and Alleghanian Orogenies. Using major and trace element geochemistry, we are able to understand the formation and evolution of these enigmatic terranes. For instance, it is now clear that much of southeastern New England is underlain by a fragment of the composite Avalon terrane. Geochemistry indicates it was part of a continental margin volcanic arc in the late Proterozoic. At that time mafic, mantle derived magmas, mixed with crustal material to form at least some of the intrusions of batholithic proportions in Southeastern New England. Later, this terrane was intruded by an entirely different suite of alkalic magmas in a different tectonic regime during the early and middle Paleozoic. Inboard of the Avalon terrane of Southeastern New England is the Nashoba terrane, which geochemistry indicates was part of an early Paleozovc arc, likely "picked-up" by the Avalonian margin as it closed with North America. There is yet much that needs to be learned about the terranes that make up the eastern margin of the Appalachians and their amalgamation. Geochemical studies are proving to be key to obtaining a better understanding of these terranes.

METAMORPHIC STUDIES IN THE NORTHERN APPALACHIANS

Studies of metamorphism help define the thermal evolution of an area and its relationship to deformational events. In addition, coexisting metamorphic minerals can be used to determine the pressures and temperatures of individual metamorphic rocks and constrain the pressure, and temperature time paths of a terrane. Recent metamorphic studies have included analyses of the metamorphism of the Nashoba terrane in southeastern New England.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

❖ **Kohut, E.J.** and Hepbun, J.C. (2004). Mylonites and Brittle Shear Zones along the Western edge of the Avalon Terrace west of Boston, in Hanson, L.S. (ed.) Guidebook to filed trips from Boston, MA to Saco Bay, ME, New England Intercollegiate Geologic Conference, 96th Annual Meeting, Salem, MA, pp 89-110.

❖ **Kristen Daly (**2003). A study of the Mafic Plutons Along the Bloody Bluff Fault in Northeastern Massachusetts, M.S. Thesis.

❖ **Pinan Llamas, A.** (2002). The Coastal Volcanic Belt (CVB) In Easternmost Maine, Geochemistry and Tectonic Setting, M.S. Thesis.

❖ **Pinan Llamas, A.**, and Hepburn, J. C., (2001). The Coastal Volcanic Belt (CVB), Easternmost Maine: Geochemistry and Tectonic Setting, Geological Society of America, Abstracts with Programs, v.33, #1, p. A-27.

❖ Karabinos, P. and Hepburn, J. C. (2001). Geochronology and Geochemistry of the Shelburne Falls Arc: Taconic Orogeny in Western New England, in West, D.P., Jr., and Bailey, R.H., (eds.). Guidebook for Geological Field Trips in New England, Geological Society of America Annual Meeting 2001, pp. H-1 - H-20.

❖ **Kohut, E.J.** (1999). The Bedrock Geology of the Weston-Lexington Area, Southeastern New England Avalon and Nashoba Terranes, M.S. Thesis.

Coastal Processes and Fine Sediment Transport

Professor Gail C. Kineke

Ongoing research in the Coastal Processes Laboratory pertains to sediment transport in coastal environments with the goal of understanding how physical processes associated with rivers, waves, tides and currents move sediment, transform the coasts, and deposit sediment in the marine environment. Past and present research involves investigation of fine-sediment transport in estuarine and nearshore settings. Current study areas include the Atchafalaya River, LA, and shallow shelf of the Gulf of Mexico and the Petitcodiac River, Canada. To better understand coastal processes and to evaluate sediment-transport models, we use a wide range of instrumentation for simultaneous measurements of the flow, water properties and suspended sediment. We try to understand the basic physics of a system and then make careful observations in the field, often developing new instrumentation to accomplish this, and then use the combination of models and observations to characterize sedimentation in coastal settings.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

❖ **Heath, Kristy M.** (2009) A Study of Fluid Mud Formation and Resuspension in the Petitcodiac River Estuary, New Brunswick, Canada, M.S. Thesis.

❖ Hsu, T.-J., P.A. Traykovski, G.C. Kineke (2007), On modeling boundary layer and gravity-driven fluid mud transport, J. Geophys. Res., 112, C04011, doi: 10.1029/2006JC003719.

❖ **Hart, Kathleen A.** (2006) The Distribution and Variability of the Atchafalaya River Plume, M.S. Thesis.

❖ Kineke, G.C., **Higgins, E.E.**, **Hart, K.**, and **Velasco, D.** (2006) Fine-Sediment Transport Associated with Cold Front Passages on the Shallow Shelf, Gulf of Mexico. Continental Shelf Research, 26:2073-2091.

❖ **Draut, A.E.**, Kineke, G.C., Huh, O.K., Grymes, J.M., III, Westphal, K.A., and Moeller, C.C. (2005) Coastal Mudflat Accretion under Energetic Conditions, Louisiana Chenier-Plain Coast, USA. Marine Geology, 214:27-47.

❖ **Draut, A.E.**, Kineke, G.C., **Velasco, D.W.**, Allison, M.A., and **Prime, R.J.** (2005) Influence of the Atchafalaya River on Recent Evoloution of the Chenier Plain Inner Continental Shelf, Northern Gulf of Mexico. Continental Shelf Research.25:91-112.

❖ Geyer, W.R., P.S. Hill, and Kineke, G.C., (2004) The transport and dispersal of sediment by buoyant coastal flows. Continental Shelf Research, 24:927-949.

❖ McKee, B.A., R.C. Aller, M.A. Allison, T.S. Bianchi, and Kineke, G.C. (2004) Transport and transformation of dissolved and particulate materials on continental margins influenced by major rivers: benthic boundary layer and seabed processes. Continental Shelf Research, 24:899-926.

❖ **Belaval, M.**, Lane, J.W., Jr., Lesmes, D.P., and Kineke, G.C. (2003) Continuous-resistivitiy-profiling for coastal ground-water investigations- three case histories. In Symposium on the Application of Geophysics to Engineering and Environmental Problems, San Antonio, TX, April 6-10, 2003, Proceedings: Denver, Colo., Environmental and Engineering Geophysical Society, CD-ROM.

❖ **Belaval, M.** (2003). A geophysical Investigation of the Subsurface Salt/fresh Water Interface Structure, Waquoit Bay, Cape Cod, Massachusetts, M.S. Thesis.

❖ **Velasco, D.** (2003). Shallow Stratigraphy Observations Usng Electrical resistivity and dual-Frequency Echosounding Methods, M.S. Thesis.

❖ **Higgins, E.** (2002). Effects of a Muddy Seabed on Wave Attenuation: Gulf of Mexico, Louisiana, M.S. Thesis.

❖ **Blake, A.C.**, G.C. Kineke, T.G. Milligan, and C.R. Alexander, 2001. Sediment trapping and transport in the ACE Basin, South Carolina. Estuaries, 24:721-733.

❖ **Carlson, A.** (2000). Sediment Trapping and Transport in the ACE Basin, South Carolina, M.S. thesis.

❖ **Ramsey, A.** (2000). Physical Processes Controlling Sediment Transport in Winyah Bay, South Carolina, M.S. Thesis.

Fluvial Geomorphology

Professor Noah Snyder

Rivers are conduits for transport of fresh water, sediment and nutrients throughout the landscape. At the same time, rivers are vital pathways for the migration of aquatic species, such as salmon. My research focuses on understanding how rivers respond to perturbations, ranging from long-term changes in tectonics or climate to short-term changes in management style or land use. In addition to field measurements and mapping of stream morphology, tools used for my research include numerical modeling, and analysis of high-resolution digital elevation data and other remote-sensing imagery. Much of my current research focuses on feedbacks among river morphology, salmon habitat, deglaciation, land-use change and dam removal in northern New England.

SELECTED PUBLICATIONS AND M.S. THESES

Students' names in bold

- **Wilkins, B.C.** and N.P. Snyder (2010). Geomorphic comparison of two Atlantic coastal rivers: toward an understanding of physical controls on Atlantic salmon habitat, *River Research and Applications*, DOI: 10.1002/rra.1343.

- Snyder, N.P. (2009) Studying stream morphology with airborne laser elevation data, *Eos, Transactions, American Geophysical Union*, v. 90, n. 6, p.45-46.

- **Wilkins, B.C.** (2009) Geomorphic comparison of two Atlantic coastal rivers: toward an understanding of physical controls on Atlantic salmon habitat, M.S. Thesis, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA, 219 p.

- **Kasprak, A.** (2008) Measuring sedimentation rates and land-use change in a dam-influenced lake delta: Narraguagus River, Maine, B.S. Thesis, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA, 122 p.

- Snyder, N.P., **Castele, M.R.**, and Wright, J.R. (2008) Bedload entrainment in low-gradient paraglacial coastal rivers of Maine, U.S.A.: Implications for habitat restoration, *Geomorphology*, v. 103, p. 430-446, doi: 10.1016/j.geomorph.2008.07.013.

- Snyder, N.P., and **Kammer, L.L**. (2008) Dynamic adjustments in channel width in response to a forced diversion: Gower Gulch, Death Valley National Park, California, *Geology*, v. 25, p. 187-190, doi: 10.1130/G24217A.1.

- **Castele, M.R**. (2007) Modeling sediment transport and quantifying channel morphology of the Sheepscot River, coastal Maine, M.S. Thesis, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA, 173 p.

- **Lopez, C.M.** (2007) The Evaluation of the Effectiveness of Retention Ponds at Stormwater Control and Downstream Channel Protection, B.S. Thesis, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA, 71 p

- **Gryga, M.E.** (2006) Controls on water temperature in the Sheepscot River, Maine, B.A. Honors thesis, Boston College, Chestnut Hill, MA, 48 p.

- Snyder, N.P., Wright, S.A., Alpers, C.N., Flint, L.E., Holmes, C.W., and Rubin, D.M. (2006) Reconstructing depositional processes and history from reservoir stratigraphy: Englebright Lake, Yuba River, northern California, *Journal of Geophysical Research*, v. 111, F04003, doi:10.1029/2005JF000451

- Wobus, C.W., Whipple, K.X, Kirby, E., Snyder, N.P., Johnson, J., Spyropolou, K., Crosby, B., and Sheehan, D. (2006) Tectonics from topography: Procedures, promise, and pitfalls, in Willett, S.D., Hovius, N., Brandon, M.T., and Fisher, D.M., editors, *Tectonics, Climate, and Landscape Evolution*, Geological Society of America Special Paper 398, p. 55-74, doi: 10.1130/2006.2398(04).

- **Schultz, L.L**. (2005) Investigation of the transient response of Gower Gulch to forced diversion, Death Valley, California, M.S. Thesis, Boston College, Chestnut Hill, MA, 57 p.

- Snyder, N.P., Rubin, D.M., Alpers, C.N., Childs, J.R., Curtis, J.A., Flint, L.E., and Wright, S.A. (2004) Estimating rates and properties of sediment accumulation behind a dam: Englebright Lake, Yuba River, northern California, *Water Resources Research*, v. 40, W11301, doi:10.1029/2004WR003279.

- Snyder, N.P., Whipple, K.X., Tucker, G.E., and Merritts, D.J. (2003) Importance of a stochastic distribution of floods and erosion thresholds in the bedrock river incision problem, *Journal of Geophysical Research*, v. 108 (B2), 2117, doi: 10.1029/2001JB001655.

- Snyder, N.P., Whipple, K.X., Tucker, G.E., and Merritts, D.J. (2003) Channel response to tectonic forcing: analysis of stream morphology and hydrology in the Mendocino triple junction region, northern California, *Geomorphology*, v. 53, p. 97-127.

Paleontology

Research Professor Paul K. Strother

PALEOBOTANY AND PALYNOLOGY

The primary focus of our research group is terrestrialization and the fossil evidence of early life on land. We are investigating the biology of billion-year-old lake deposits that contain the earliest evidence of eukaryotes from terrestrial environments. Our study of the earliest plant spores (called cryptospores) provides the morphological and taxonomic basis for the evolution of the first land plants. A second line of research, concerns large-scale evolutionary patterns in Paleozoic phytoplankton and their relations to secular changes in ocean chemistry. We are presently working with scientists from Sheffield and Oxford universities (UK), University of Lille (France), U Conn and the University of Wisconsin. Students are involved in all phases of research from sample collection in the field to laboratory processing and microscopic examination. Digital imaging, database processing and morphometric analysis techniques are encouraged in the laboratory. Ongoing projects include field investigations in the Grand Canyon, the northwest Scottish Highlands, northern Michigan and beyond.

SELECTED PUBLICATIONS

Students' names in bold

- Strother, P., **L. Battison**, M. Brasier & C. Wellman. 2011. Earth's earliest non-marine eukaryotes. *Nature,* DOI: 10.1038/nature09943.

- Strother, P., T. Servais & M. Vecoli. 2010. The effects of terrestrialization on marine ecosystems: the fall of CO_2. In Vecoli, M., Clément, G. & Meyer-Berthaud, B. (eds) *The Terrestrialization Process: Modelling Complex Interactions at the Biosphere–Geosphere Interface*. Geological Society, London, Special Publications 339: 37–48.

- **Schaff, N.**, J. Beck & P. Strother. 2010. Integrated petrographic and palynological study of a middle Silurian section at Bluegrass, Highland County, Virginia. Joint meeting of the northeastern and southeastern sections of the Geological Society of America, Baltimore, March 13-16. [student poster]

- Taylor, W. & P. Strother. 2009. Ultrastructure, morphology, and topology of Cambrian palynomorphs from the Lone Rock Formation, Wisconsin, USA. *Review of Palæobotany and Palynology* 153: 296-309.

- Strother, P. 2008. A speculative review of factors controlling the evolution of phytoplankton during Paleozoic time. *Revue de micropaléontology* 51: 9-21.

- **Michaud, J.** and P. Strother. 2006. Studies on the Devonian/Carboniferous acritarch decline. Palaeozoic Palynology in Space and Time. CIMP General Meeting 2006, September 2-6, 2006- Prague, Czech Republic. Book of Abstracts: 37.

- Baldwin, C., P. Strother, J. Beck & **E. Rose**. 2004. Palaeoecology of the Bright Angel Shale in the eastern Grand Canyon, Arizona, U.S.A. Incorporating sedimentological, ichnological and palynological data, 213-236. *In: The Application of Ichnology to Palaeoenvironmental and Stratigraphic Analysis*. McIlroy, D. (ed.). Geological Society of London, Special Publications, 228.

Regional Geology and Tectonics of the Central Alpine-Himalayan Belt

Professors E.G. Bombolakis, Randolph J. Martin III

THE CAUSIN AND CASRI PROJECTS

The Caucasus Seismic Information Network (CauSIN) and the new Central Asia Seismic Risk Initiative (CASRI) are international research projects on the seismicity, structure, and tectonics of the Caucasus region and Central Asia. CauSIN encompasses the Caucasus from the Black Sea to the Caspian Sea (Georgia, Armenia, and Azerbaijan) and is being extended southward to the Turkish-Iranian Plateau. CASRI extends from the Caspian Sea to China, through Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan. Both CauSIN and CASRI are being guided by principal investigators from Boston College, MIT, Lawrence Livermore National Laboratory, and New England Research, Inc. We are collaborating closely with geoscience colleagues in these countries and in France and Greece on the neotectonic and active deformation in this part of the Alpine-Himalayan Belt. New GPS measurements are providing us and our students with tectonic deformation rates important for analyses of tectonics, seismicity, and seismic hazards. For additional information, visit www.causin.org.

SELECTED PUBLICATIONS

Students' names in bold

- **Martin, G.J.** (1997) An Experimental Investigation to Determine the Mechanism for Anelastic Strain Recovery, M.S. Thesis.

- **Szymanski, E.** (2005) Structure and Timing of Thrust and Nappe Development within the Mtkavari River Basin, Republic of Georgia, M.S. Thesis.

- **O'Connor, T., Szymanski, E.,** Krasovec, M., and Adamia, Sh. (2005) Rethinking the Tectonic Model of the Caucasus: An Investigation of the Southern Section of the Proposed Borjomi-Kazbegi Fault. EOS Transactions, American Geophysical Union, vol. 87, p. 200, San Francisco

Also presented at the Annual Meeting of the American Association of Petroleum Geologists in Houston, Texas (2005), and at the General Assembly of the European Geosciences Union in Vienna (2006).

- Bombolakis, E.G. (1994) Applicability of Critical-wedge Theories to Foreland Belts, Geology, vol. 22, pp. 535-538.

- Martin, R.J. III, and Haupt, R.W. (1994) Static and Dynamic Elastic Moduli, in Nelson and Lauback, eds., Granite: The Effects of Strain Amplitude, Proceedings 1st North American Rock Mechanics Symposium, The University of Texas at Austin.

❖ Adamia, Sh. A., Alania, V.M., Ananiashvili, G.D., Bombolakis, E.G., Chichua, G.K., Girsiashvili, D., Martin, R.J., and Tatarasvili, L. (2002), "Late Mesozoic-Cenozoic Geodynamic Evolution of the Eastern Georgian Oil-Gaz Bearing Basin (Trans Caucasus)," Proceedings of XVII Congress of Carpathian-Balkan Geological Association, vol. 53, Special Issue, edited by J. Michalik, L. Imon, and J. Vozar, VEDA-Publishing House of the Slovak Academy of Sciences, ISSN 1335-0552.

❖ Adamia, Sh., Bombolakis, E.G., Chabukiani, A., Kuloshvili, S., Martin, R.J., Tatarashvili, L. (2002), "Deep Structure and Seismotectonics of the Oil-and-Gas Bearing Regions of Georgia," International Conference on Assessment of Seismic Hazard and Risk in the Oil-Gas Bearing Areas, Azerbaijan National Academy of Sciences and United Institute of Earth Physics of Russian Academy of Sciences, Abstract, Baku.

Aqueous Geochemistry, Watershed Studies and Geochemistry of Soils

Professor Rudolph Hon

ARSENIC AND OTHER METALS IN GROUNDWATERS AND SOILS OF NEW ENGLAND

Recent worldwide attention to health concerns due to natural arsenic contaminated ground waters creates a need for scientific studies of arsenic sources, mechanisms of mobilization, attenuation and transport. Our project includes a study of elevated arsenic in soils within a zone in Central Massachusetts and the study of geochemical equilibria that could promote arsenicmobilization by a groundwater system. Our focus is on both the natural processes and the anthropogenically induced changes (release of landfill leachates) in the ground water system.

WATER QUALITY STUDIES OF AQUIFERS IN NEW ENGLAND

These studies follow chemical changes of water within the watershed systems from the time of precipitation, as the liquid water interacts with the biosphere, then with the underlying rock system and chemical weathering, changes brought by evapotranspiration and nutrient cycling and discharge into a surface drainage system. Within this context additional hydrochemical changes are caused by a multitude of anthropogenic activities and past and current land use such as waste water discharge, use of fertilizers, and chemical loading from runoffs.

STUDIES OF IMPACT OF DEICING CHEMICALS ON THE HEALTH OF WATERSHEDS

Liberal applications of vast amounts of deicing chemicals on road surfaces during the winter seasons in recent years has caused a progressive deterioration of water quality in aquifers and has a negative impact on vegetation and the ecosystems at large. In cooperation with local health and water municipal offices we monitor and study water quality in a few selected aquifer systems with the objective to assess the present and the future.

ROLD OF REDOX PROCESSES ON WATER QUALITY IN NEW ENGLAND

Changes in oxidation-reduction potential in the subsurface can lead to corresponding changes of water quality in ground water and can further affect the balances in the surface water - ground water coupled systems. Our research includes a study of the impact of landfill leachate plumes on water quality, on aqueous equilibria, and on mobilization of iron and manganese compared to an impact by a decay of organic materials in the wetland environments.

GEOGRAPHICAL INFORMATION SYSTEM

Geographical Information System provides a unique and a powerful environment for geologic, environmental, and geochemical data development such as geological maps, precipitation maps, and other similar databases. Furthermore, these datasets along with the existing maps and available aerial orthophotography create an environment for an environmental audit and analysis of watersheds, bedrock lithochemistry, past and present land use, and quality of water. Examples of some of the projects include a study of acidity of waters and their relation to the underlying bedrock, road density and composition of surface runoff, and analysis of nitrogen loading in areas of different household densities.

Facilities for Research

Our laboratory is equipped with modern analytical instrumentations for a complete chemical characterization of waters following well established analytical protocols. For major element analysis of waters we have Varian ICP-AES (Inductively Coupled Plasma Spectroscopy with optical detection system), anion analyses are done on DIONEX IC (Ion Chromatography), inorganic and organic carbons are analyzed by TOC-V Shimadzu instrument, low levels (in ng/g range) arsenic is analyzed by HG-AFS Excalibur (Hydride Generation - Atomic Fluorescence Spectroscopy), and alkalinity by an automatic titrator from Metrohm. Other laboratory instrumentation includes ultrafiltration by flow filtration from Millipore, conductance, pH, ORP, DO and ion selective electrochemical probes. For field studies students use peristaltic and bladder pumps for well sampling, multiprobes (HYDROLAB and GEOTECH) for field instrumental water quality characterization as well as water quality field kits. GIS (Geographical Information System) laboratory is supported by advanced workstations running ArcGIS software from ESRI. Our well-equipped computer laboratory includes scanners, color printers and a high resolution wide format (42 inches) color plotter for poster presentation quality outputs.

SELECTED THESES AND PRESENTATIONS AT SCIENTIFIC CONFERENCES

Students' names in bold

- **Xian, Qing** (2009) Statistical Assessment of Hydrochemical Characteristics of Stream Waters in Eastern New England, M.S. Thesis.

- **Mayo, Matthew** (2006) Arsenic Pathways at Landfills: A Case study of the Shepleys Hill Landfill, M.S. Thesis.

- **Kammer, David** (2006) Hydrochemical Characterization of Old Pond Meadows Aquifer, Norwell, Massachusetts, M.S. Thesis.

- Doherty, K. and Hon, R. (2002) Naturally Occuring Arsenic in Oberburden in Central Massachusetts: The 18th Annual International Conference on Contaminated Soils, Sediments and Water, Amherst, Massachusetts.

- Hon, R., Brandon, W., Stein. C., McTigue, D., and **Davidson, T.** (2002) Arsenic in Landfill Environments: The 18th Annual International Conference on Contaminated Soils, Sediments and Water, Amherst, Massachusetts.

- Hon, R., Ford, R.G., and Brandon, W.C. (2003) Role of Dissoved Inorganic Carbon on Arsenic Mobilization at Landfill Sites in Central Massachusetts, USA: Northeast Meeting of Geological Society of America, Halifax, Nova Scotia, Canada.

- **Mayo, M.J.**, Hon, R., Brandon, W.C., and Germansderfer, I. (2003) Elevated Arsenic in Ground Water at a Landfill Site in Ayer, Massachusetts: Northeast Meeting of Geological Society of America, Halifax, Nova Scotia, Canada.

- Doherty, K.A. and Hon, R. (2003) Migration Pathways of Arsenic in High Arsenic Zones in Central Massachusetts; Northeast Meeting of Geological Society of America, Halifax, Nova Scotia, Canada.

- Hon, R., Brandon, W.C., and Ford, R.G. (2003) Roles of Dissolved Inorganic Carbon on Arsenic Mobilization at Landfill Sites in Central Massachusetts, USA;Sixth International Symposium & Exhibition on Environmental Contamination in Central & Eastern Europe and the Commonwealth of Independent States, Prague, Czech Republic.

- **Mayo, M.J.**, Hon, R., Brandon, W.C., and Ford, R. (2003) Arsenic in Groundwater at Landfill Sites In Northern Central Massachusetts; 226th ACS National Meeting, New York, NY.

- Doherty, K.A. and Hon, R. (2003) Redistribution of Arsenic in Soils by Natural Hydrogeologic Processes: 226th ACS National Meeting, New York, NY.

- Hon, R., **Mayo, M.J.**, and Brandon, W.C. (2003) Arsenic Equilibria in Group Water at Landfills, Central Massachusetts; Annual Meeting of Geological Society of America, GSA Abstracts with Programs Vol. 35, No. 6.

- **Smith, L.G.**, and Hon, R. (2003) Anthropogenic Influences on Water Qualify in Small Coastal Catchment Basis in the Northeastern USA; Annual Meeting of Geological Society of America, GSA Abstracts with Programs Vol. 35, No. 6.

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Sedimentology

Assistant Professor Douglas A. Edmonds

SEDIMENTOLOGY AND STRATIGRAPHY, NUMERICAL MODELING, GEOMORPHOLOGY, DEPOSITIONAL ENVIRONMENTS

In certain locations on the earth's surface sediments are actively accumulating in depositional environments. These environments provide a host of natural resources, from biodiversity to energy, and are typically densely populated with humans. My research focuses on understanding these modern and ancient depositional environments. In modern environments, my goal is to understand what processes construct these environments, and also to predict how environments will evolve in response to perturbations, like climate change. In ancient environments, I am interested in using the process-based understanding derived from the modern to understand how stratigraphy is constructed. Using numerical modeling and field research, I create realistic models of these environments and then tease out cause and effect by performing well-designed experiments. Examples include, predicting what will happen to river deltas as discharge changes as predicted by climate change scenarios, and using physics-based morphodynamic models to predict sedimentology and stratigraphy.

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Biogeochemistry

Assistant Professor Dominic Papineau

PRECAMBRIAN GIOGEOCHEMISTRY, STABLE ISOTOPE GEOCHEMISTRY, IN SITU MICRO-ANALYSES, EXO/ASTSROBIOLOGY

The recent introduction of new state-of-the-art micro-analytical techniques in Earth sciences has stimulated exciting developments in the field of early Earth evolution and these new opportunities have the potential to build new bridges between the geological and biological sciences and to solve long-standing problems. Using combined in situ micro-analytical instruments, Papineau aims at understanding the basic principles that drive the evolution of Precambrian biogeochemical cycles (C, N, S, and P cycles in the Proterozoic and Archean) and at developing approaches to characterize potential biosignatures in Precmabrian sedimentary rocks and eventually in sediments returned from Mars. This is accomplished with a combination of field geology, isotope geochemistry, and the analysis of petrographic thin sections with electron beam instruments (EPMA, SEM, and TEM), ion beam techniques (nanoSIMS, ims1280, and FIB) and spectroscopy (Raman, FTIR, and STXM).

SELECTED PUBLICATIONS

- Papineau, D., DeGregorio, B.T., Cody, C.D., O'Neil, J., Steele, A., Stroud, R.M., and Fogel, M.L. (2011) Young poorly crystalline graphite in the >3.8 Gyr old Nuvvuagittuq banded iron formation, *Nature Geoscience*.

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