GEOLGY AND GEOPHYSICS

Kline Geology Laboratory, 203.432.3124
http://earth.yale.edu
M.S., M.Phil., Ph.D.

Chair
David Bercovici

Director of Graduate Studies
Maureen Long

Professors Jay Ague, David Bercovici, Ruth Blake, Mark Brandon, Derek Briggs, David Evans, Alexey Fedorov, Debra Fischer, Jacques Gauthier, Shun-ichiro Karato, Jun Korenaga, Maureen Long, Jeffrey Park, Peter Raymond, Danny Rye, James Saiers, Ronald Smith, Mary-Louise Timmermans, John Wettlaufer

Associate Professor Kanani Lee

Assistant Professors Bhart-Anjan Bhullar, Pincelli Hull, Juan Lora, Noah Planavsky, Alan Rooney

FIELDS OF STUDY

Fields include geochemistry and petrology, geophysics, ice physics, mineral physics, seismology and geodynamics, structural geology and tectonics, paleontology and paleoecology, oceanography, meteorology, cryospheric dynamics, and climatology.

SPECIAL ADMISSIONS REQUIREMENTS

The department welcomes applicants oriented toward the earth sciences who have a bachelor’s or master’s degree in such fields as biology, chemistry, engineering, mathematics, meteorology, or physics, as well as those trained in geological, geophysical, and geochemical sciences. All applicants must submit scores from the General Test of the GRE. Scores from a pertinent GRE Subject Test are desirable but not required. The TOEFL or IELTS exam is required of all applicants for whom English is a second language.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

There is no formal language requirement and no required curriculum. Students plan their course of study in consultation with their adviser to meet individual interests and needs and to lay the foundations for dissertation research. At the end of the first year the faculty reviews the standing of each student. A student recommended for continuation in the Ph.D. program will be so notified. Some students may be encouraged at that time to pursue only the M.S. degree. At the end of the second year the faculty reviews each student’s overall performance to determine whether the student is qualified to continue for the Ph.D. degree. In order to qualify, a student must have met the Graduate School Honors requirement and maintained a better than passing record in the areas of concentration. Also, a student must have satisfied the requirements of the Qualifying Exam by having completed two Research Discourses termed (according to their degree of development) the Minor and the Major Discourses. The Major Discourse will be presented at the Qualifying Presentation, followed by an extended question period wherein the student must successfully defend both Discourses. Remaining degree requirements include a dissertation review in the third year; the preparation and defense of the dissertation; and the submission of the dissertation to the Graduate School.

Teaching experience is regarded as an integral part of the graduate training program in Geology and Geophysics. For this reason, all students are required to serve as teaching fellows for two terms during the course of their predoctoral training. Students whose advisers experience disruption in funding may require additional support from the Graduate School. In such cases, students will be required to teach additional terms, if needed, after they have fulfilled the academic teaching requirement.

In addition to all other requirements, students must successfully complete G&G 710, Responsible and Ethical Conduct of Research, prior to the end of their first year of study.

MASTER’S DEGREES

M.Phil. See Degree Requirements under Policies and Regulations.

M.S. Awarded only to students who are not continuing for the Ph.D. Students are not admitted for this degree. Minimum requirements include satisfactory performance in a course of study (typically six or more courses with at least one Honors grade in a graduate-level class) that is approved by the director of graduate studies (DGS), and a research project with the approval of the DGS and the student’s thesis committee.

Program materials are available at http://earth.yale.edu or upon request to the Director of Graduate Studies, Department of Geology and Geophysics, Yale University, PO Box 208109, New Haven CT 06520-8109; e-mail, dgs@geology.yale.edu.
COURSES

G&G 513a, Vertebrate Paleontology: Evolving Form and Function  Derek Briggs
Exploration of the basic constraints and potentials that controlled adaptive radiation in the evolution of the invertebrate skeleton.

G&G 519a, Introduction to the Physics and Chemistry of Earth Materials  Shun-ichiro Karato
Basic principles that control the physical and chemical properties of Earth materials. Equation of state, phase transformations, chemical reactions, elastic properties, diffusion, kinetics of reaction, and mass/energy transport.

G&G 521b, Geophysical Fluid Dynamics  Mary-Louise Timmermans
A survey of fluid dynamics, with applications to planetary atmospheres and oceans. Mathematical models illustrate the fundamental dynamical principles of geophysical fluid phenomena such as waves, boundary layers, flow stability, turbulence, and large-scale flows. Concepts are investigated through laboratory experiments in a rotating water tank. Prerequisite: differential equations or mathematical physics or equivalent.

G&G 522b, Physics of Weather and Climate  Staff
The climatic system; survey of atmospheric behavior on time scales from days (i.e., weather) to decades (i.e., climate); formulation of mathematical equations describing weather and climate with selected applications to small- and large-scale phenomena.

G&G 524a, Vertebrate Paleontology  Jacques Gauthier
Phylogeny and evolution of the major clades of vertebrates from Cambrian to Recent, as inferred mainly from the fossilized remains of the musculoskeletal system (cranial, axial, and appendicular skeletons). Special attention given to the evolution of vertebrate feeding, locomotor, and sensory systems.

G&G 526b, Introduction to Earth and Planetary Physics  Shun-ichiro Karato
An introduction to the structure and dynamics of Earth and other planets in the context of cosmic evolution. Review of basic physical principles and their applications to geophysics and planetary physics. Star formation and nucleosynthesis; planetary accretion and the birth of the solar system; heat flow, plate tectonics, and mantle dynamics; seismology and geodesy; core dynamics, geomagnetism, and planetary magnetism. Prerequisites: PHYS 181 and MATH 120 or equivalents.

G&G 528a, Science of Complex Systems  Jun Korenaga
Introduction to the quantitative analysis of systems with many degrees of freedom. Fundamental components in the science of complex systems, including how to simulate complex systems, how to analyze model behaviors, and how to validate models using observations. Topics include cellular automata, bifurcation theory, deterministic chaos, self-organized criticality, renormalization, and inverse theory.

G&G 529b, Introduction to Geodynamics  Jun Korenaga
An introduction to the structure and dynamics of Earth and other planets in the context of cosmic evolution. Review of basic physical principles and their applications to geophysics and planetary physics. Star formation and nucleosynthesis; planetary accretion and the birth of the solar system; heat flow, plate tectonics, and mantle dynamics; seismology and geodesy; core dynamics, geomagnetism, and planetary magnetism. Prerequisites: PHYS 181 and MATH 120 or equivalents.

G&G 530b, Introduction to Thermodynamics, Kinetics, and Fluid Flow  Jay Ague
This introductory course starts with the basics of continuum mechanics and covers a range of topics in geodynamics and relevant fields including the structure and dynamics of lithosphere, thermal convection and magmatism, Rayleigh-Taylor instability and plume dynamics, geoid and dynamic topography, and the thermal history of the core and geodynamics.

G&G 535a, Physical Oceanography  Alexey Fedorov
An introduction to ocean dynamics and physical processes controlling the large-scale ocean circulation, ocean stratification, the Gulf Stream, wind-driven waves, tides, tsunamis, coastal upwelling, and other oceanic phenomena. Equations of motion. Modern observational, theoretical, and numerous other techniques used to study the ocean. The ocean role in climate and global climate change.

G&G 538b / ASTR 520b, Computational Methods in Astrophysics and Geophysics  Paolo Coppi
The analytic and numerical/computational tools necessary for effective research in astronomy, geophysics, and related disciplines. Topics include numerical solutions to differential equations, spectral methods, and Monte Carlo simulations. Applications are made to common astrophysical and geophysical problems including fluids and N-body simulations.

G&G 540b, Invertebrate Paleontology: Evolving Form and Function  Derek Briggs
A study of the dynamic evolution of Earth's climate. Topics include warm (the Cretaceous, the Eocene, the PETM, the Pliocene) and cold (the "snowball Earth") climates of the past, glacial cycles, abrupt climate changes, the climate of the past thousand years, and the climate of the twentieth century.

G&G 544a, Global Biogeochemical Cycles  Noah Planavsky
In this course we explore the role that biological innovation and changes in tectonic process have played in shaping global biogeochemical cycles through time. The course focuses on extensively investigated elements (C, S), nutrients (N, P), and redox-sensitive metals (e.g., Fe, Mo, Cr, Zn, Cd). We survey key historical papers that provide the foundation for our understanding of geochmical cycles, basic modeling approaches, and widely utilized geochemical tracers; and we explore recent literature with the goal of discussing major uncertainties and key unanswered questions concerning the co-evolution of life and Earth surface processes. Students are expected to actively participate and help steer discussions, as well as to individually explore a specific aspect of the evolution of global biogeochemical cycling in detail over the course of the term.

G&G 545a, Thermodynamics, Kinetics, and Fluid Flow  Jay Ague
This course examines the fundamental principles of heat transfer, chemical mass transfer, and fluid-rock interaction in geologic systems.

G&G 645b, Paleocology  Pinelli Hull
This course in paleocology reviews basic ecological concepts in the context of classic and recent papers.
G&G 659a, Time Series Analysis with Geoscience Applications  Jeffrey Park
Introductory course in geoscience data analysis and time series methods, with emphasis on multiple-taper time series techniques. Examples drawn from seismological, paleoclimate, and historical climate data. Weekly computer assignments. Python proficiency helpful.

G&G 703a / E&EB 930a, Seminar in Systematics  Jacques Gauthier
Topics and class time are chosen by the participants, and have included reading books and/or a series of papers on particular topics (e.g., homology; morphological phylogenetics; evolution of egg colors and exposed nesting in dinosaurs/birds; origin of snake ecology; conflicts between morphology and molecules; role of fossils in phylogenetic inference).

G&G 710a, Responsible and Ethical Conduct of Research  Staff
A 5-to-6-week lecture course (1 hour) that is required of all graduate students and must be completed within the first year. Course topics include record keeping and data management/retention; plagiarism and fraud; collaboration, coauthorship, and ownership of research materials and intellectual property; laboratory dynamics and sexual harassment. G&G 710 is in addition to the existing online ethics module, The Yale Guide to Professional Ethics, that must be completed by all GSAS students within the first term of study, regardless of source of financial support.

G&G 744a or b, Seminar in Mantle and Core Processes  Staff
The seminar covers advanced topics concerning physical and chemical processes in the mantle and core of the Earth and planets. Specific topic and hour are arranged in consultation with enrolled graduate students.

G&G 757b, Studies in Global Geoscience  Staff
Reading seminar devoted to a specific geographic region of the Earth, selected as the destination of the departmental field trip for the current year. Topics of discussion include a broad range of geoscience disciplines, to be determined in part by the interests of participating students.

G&G 775a or b, Seminar in Lithosphere and Surface Processes  Staff
The seminar focuses on advanced topics in the evolution and structure of the lithosphere. The theme for the seminar changes each term, covering topics such as the restoration of continents in deep time, true polar wander, lithospheric instabilities, orogenesis at convergent plate boundaries, interactions between climate and tectonics. Meetings are for 1.5 hours, once a week, and are organized around readings from the primary research literature.

G&G 789b, Current Topics in Metamorphic Processes  Jay Ague
This seminar is based mostly on readings from the literature and focuses on emerging issues in metamorphic petrology, including deep element cycling, non-lithostatic pressure, and ultrahigh-temperature and ultrahigh-pressure metamorphism.

G&G 800a or b, Tutorial in Paleobiology  Staff

G&G 810a or b, Tutorial in Structural Geology and Tectonics or Solid Earth Geophysics  Staff

G&G 820a or b, Tutorial in Meteorology, Oceanography, or Fluid Dynamics  Staff

G&G 830a or b, The Geochemistry of Earth’s Past Climates  Staff
This seminar focuses on advanced topics in climate science from a geochemical perspective. We cover intervals from Deep Time to the Anthropocene. Meetings are for two hours, once a week, and are organized around readings from the primary research literature. Undergraduates require permission from the instructor. Enrollment limited to twelve.

G&G 840a or b, Tutorial in Sedimentology  Staff

G&G 860a or b, Tutorial in Remote Sensing  Staff