

Earth Sciences

Bradford Clement, *Professor and Chairperson*
William Anderson, *Associate Professor*
Laurel Collins, *Associate Professor*
Grenville Draper, *Professor*
Michael Gross, *Associate Professor*
Stephen Haggerty, *Distinguished Research Professor*
Rosemary Hickey-Vargas, *Professor*
Jose Longoria, *Professor*
Andrew Macfarlane, *Associate Professor*
Florentin Maurrasse, *Professor*
René Price, *Assistant Professor*
Edward Robinson, *Research Associate*
Gautam Sen, *Professor*
Neptune Srimal, *Lecturer*
Michael Sukop, *Assistant Professor*
Dean Whitman, *Associate Professor*
Hugh Willoughby, *Distinguished Research Professor*
Ping Zhu, *Assistant Professor*

The department offers the Master of Science Degree and Doctor of Philosophy Degree in Geosciences with opportunities for concentrated studies in structural geology/tectonics, igneous petrology/geochemistry/economic geology, hydrogeology and environmental geology, stratigraphy/sedimentology, paleobiology, paleoecology and geophysics/paleomagnetism. In addition, students may select a concentration in the regional geology of Southern Florida, the Caribbean, and Latin America, including problems related to the above-mentioned fields. Overall, the graduate program emphasizes a multidisciplinary approach to solving geologic and environmental problems, and stresses the importance of field observation complemented by laboratory analysis.

The department is well-equipped with advanced and basic geological instrumentation. Major on-site analytical facilities are an electron microprobe and scanning electron microscope housed in the Florida Center for Analytical Electron Microscopy (FCAEM), two thermal ionization mass spectrometers (VG-354), inductively coupled plasma emission spectro-analyzer, and a paleomagnetism laboratory with cryogenic magnetometer. In addition the department owns a complete array of instruments for field geophysics and for field hydrologic studies, and two vehicles for transportation to local field sites. The department has facilities for micropaleontological studies, research in high pressure experimental petrology and experimental structural geology, a class 100 clean laboratory for processing isotopic samples, and a microscopy lab with heating/freezing stage for fluid inclusion studies. Excellent facilities for chemical analysis such as the stable isotope mass spectrometry lab, are available through formal connections with the Southeast Environmental Research Center.

Application Procedures

Admission decisions to the Program will be made by the Department's Graduate Admission Committee.

To be considered for admission, applicants must submit the following documents prior to the admission deadlines.

1. FIU On-line Graduate Application Form (available at <http://gradschool.fiu.edu>).

2. Official transcripts of all college level work. When applicable, a certified English translation must accompany the original.

3. Graduate Record Examination and English proficiency (TOEFL and TSE) exam scores taken within the previous three years, sent from the Education Testing Service.

4. A resume with pertinent information regarding applicant's previous experience and achievements.

5. A statement of intent, including a brief discussion (not to exceed 2000 words) of educational goals and career projections. The applicant may also include a copy of previous written scientific work.

6. Three letters of recommendation from former professors or academic advisors.

Official transcripts and test scores should be sent directly to the Office of Graduate Admissions, Florida International University, P.O. Box 659004, Miami, FL 33265, with the application fee. A cover letter, photocopies of transcripts and test score reports, resume, statement of intent and letters of recommendation should be sent to the Graduate Coordinator, Department of Earth Sciences, Florida International University, Miami, FL 33199.

Admission

To be admitted to the Graduate Programs in Geosciences, a student must meet the following minimum requirements:

1. Hold a Bachelor's or Master's degree from an accredited college or university in a relevant discipline of science, engineering or mathematics.

2. Have a grade point average (GPA) of 3.0 or higher (or equivalent) during the last two years of undergraduate program, and 3.0 or higher during the Master's degree program.

3. Have a minimum combined score on the verbal and quantitative sections of the Graduate Record Examination (GRE) of 1000 for the M.S. program or 1120 for the PhD program.

4. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.3 overall on the IELTS is required. A score of at least 50 on the Test of Spoken English (TSE) is required in order to be eligible for a teaching assistantship.

5. Meet the University's general requirements for admission to graduate programs.

All application materials should be submitted by February 15 in order to be considered for Fall term admission and by September 1 for Spring term admission.

Financial Aid

The Earth Sciences Department offers a number of graduate teaching and research assistantships which are awarded each semester on a competitive basis. The assistantships provide a stipend and waiver of tuition, and are usually not awarded to students pursuing the Non-Thesis Track M.S. degree. Applicants interested in an assistantship should indicate this in the FIU Graduate Application form and their cover letter. Applicants seeking assistantships should contact individual faculty members in their area of research interest.

Master of Science in Geosciences

The Master of Science degree is conferred upon successful completion of the requirements (listed below) of either the Thesis Track or Non-Thesis Track option of the degree program.

Thesis Track: Course Requirements: 30 credits, including:

GLY 5931/GLY 6931, Graduate Seminars	2
Courses in field of specialization	18
Electives	4
GLY 6971, Thesis	6

Courses in the field of specialization and electives are chosen by the student in close consultation with a faculty advisor. These courses are selected to fit the student's particular professional goals and to ensure sufficient depth and breadth of geological knowledge.

Thesis Track: Graduation Requirements

1. A minimum GPA of 3.0 in all coursework counted toward the 30 credits required for the Master's degree.
2. Satisfactory completion and defense of a thesis proposal and an original research thesis.

Non-Thesis Track: Course Requirements:

30 credits, including:

Courses in field of specialization	18
Electives	12

Electives may include at most 3 credits of Supervised Research (GLY 6910) leading to a research paper.

Non-Thesis Track: Graduation Requirements:

A minimum GPA of 3.0 in all course work counted toward the 30 credits required for the Master's degree.

Doctor of Philosophy in Geosciences

The Doctor of Philosophy in Geosciences is conferred based on satisfactory completion of required course work, a demonstrated mastery of a broad field of knowledge, and the ability to conduct original and independent research. A minimum of 75 credit hours beyond the Bachelor's degree is required for the Ph.D. A minimum of 24 credit hours is devoted to research toward the Ph.D. Dissertation. A maximum of 36 graduate credit hours of formal lecture courses earned as part of a graduate degree from another accredited program may be transferred with the approval of the major advisor and Graduate Program Director.

Course Requirements

GLY 5931/GLY 6931, Graduate Seminars	2
Formal graduate level courses (non-research courses chosen in consultation with the major advisor)	30
GLY 7980, Ph.D. Dissertation	24

The remaining credits may be either formal graduate level courses or independent study and special projects, selected in consultation with the major advisor.

Graduation Requirements

1. A minimum GPA of 3.0 in all course work required for the Ph.D. degree.
2. Satisfactory performance on qualifying examinations on general geologic knowledge and the field of subspecialization.
3. Successful presentation of a research proposal and oral examination before the dissertation committee in the candidacy examination.

4. Completion and successful defense of a dissertation.

Fields of Concentration

Geophysics/Paleomagnetism/Remote Sensing

Geophysical investigative techniques using remote sensing, gravity, magnetism, seismic reflection and refraction, earthquake seismology, and thermal properties. Land-based geophysical studies of the Caribbean and South American seismicity and crustal structure.

Hydrogeology/Environmental Geology

Field and modeling approaches to groundwater flow and solute fluxes in subsurface and near subsurface environments. Interaction of surface water and groundwater, solute transport, chemical and isotopic tracing techniques, watershed hydrology in south Florida, other U.S. locations, and Central America.

Igneous Petrology/Geochemistry/Economic Geology

Research problems in petrology/geochemistry of igneous and metamorphic rocks with reference to their origin, and relationships in time and space. Origin of hydrothermal and other economic deposits. Field occurrence, geochemistry and petrogenesis of crystalline rocks, especially those of the Caribbean region and South America. Generation of associated (often, economically significant) hydrothermal deposits. Application of trace element and isotope geochemistry to the study of these petrogenetic associations.

Paleobiology/Paleoecology

Research applied to taxonomy, phylogeny, evolutionary processes, paleoecology, taphonomy, and biostratigraphy as applied to select fossil groups. Zonal distribution, facies analysis, and paleoecology of different groups of fossils. Specialization may be in microfossils or microfossils, applied to several aspects of the paleobiology of particular fossil groups, including biodiversity, paleoecology, response to global climatic changes, oceanographic or environmental and time relationships of selected organisms.

Regional Geology

Multidisciplinary geologic research applied to a specific geographic area.

Stratigraphy/Sedimentology

Sedimentary petrology, sedimentary environments, paleo-oceanography, sequence stratigraphy, cyclic stratigraphy, microfacies analysis, and basin analysis. Field and laboratory techniques applied to solution of problems in these topics, especially as applied to sedimentary rock sequences of south Florida, the Caribbean, and Meso-America. Evolution of the sedimentary basins of these regions and their relationships to global and regional tectonics.

Structural Geology – Tectonics

Field oriented research on methods of structural analysis. Analysis of geologic deformations based upon the principles of mechanics and utilizing research data from laboratory and field investigations of folding, fabrics, fracture, and faulting. Structural geology of the Caribbean and South America.

Course Descriptions

Note: Laboratories may not be taken prior to the corresponding lecture course. Laboratories must be taken concurrently where noted, but students must register for the laboratory separately.

Definition of Prefixes

EVS-Environmental Science; GEO-Geography/Systematic; GLY-Geology; MET-Meteorology; OCE- Oceanography; OCG-Oceanography-Geological; OCP-Oceanography/Physical.
F-Fall semester offering; S-Spring semester offering; SS-Summer semester offering.

ESC 5005 Earth Science Enrichment Activities for Teachers (1-2). Workshop presenting Earth Science enrichment activities to high school and middle school science teachers.

ESC 5162 Workshop: Microfossil Paleoenvironments (2). Recent foraminifera and diatoms are sampled, prepared and identified from marine to freshwater facies. Taxon distributions are used to interpret paleoenvironments. Prerequisite: Permission of the instructor.

GLY 5021 Earth Sciences for Teachers (3). Study of geological materials and processes, as covered in Physical Geology, but at a higher level and with additional assignments. Prerequisite: Permission of the instructor. Corequisite: GLY 5021L. (F,S,SS)

GLY 5021L Earth Sciences for Teachers Laboratory (1). Study of the properties of minerals and rocks; interpretation of topographic and geologic maps; study of the geology of Florida, including field trips. Prerequisite: Permission of the instructor. Corequisite: GLY 5021. (F,S,SS)

GLY 5060 Planet Earth: Dynamic Earth (1). Essentials of metamorphism, rock rheology, seismology, plate tectonics, plate boundaries, plate movement, continental rifting and evolution of mountain belts.

GLY 5106 Paleocology and Paleoenvironments (3). Paleocology of fossils, paleobiodiversity, sedimentary facies, and environments, skeletal mineralogy, paleoecological gradients, chronologic scales and paleobiogeography and global patterns. Prerequisite: Permission of the instructor.

GLY 5107 Planet Earth: Evolving Earth (1). Essentials of lithostratigraphy, biostratigraphy, geologic time scale, modern sedimentological processes, sedimentary rocks, evolution and extinction events, paleoenvironments and paleoclimates.

GLY 5158 Florida Geology (3). Detailed lithostratigraphic and biostratigraphic analyses of Southeast Florida and their relationship to tectonics, paleoclimates. Prerequisites: GLY 4511 and GLY 4511L. (S in alternate years)

GLY 5159 Planet Earth: South Florida (1). Geology, water resources and geologic environments of South Florida.

GLY 5195 Topics in Paleoclimatology (3). Broad concepts in paleoclimatology are reviewed and discussed. Topics include climate models, Quaternary climates, dating and pre-Quaternary climates. Prerequisite: Permission of the instructor.

GLY 5245 Water-Rock Interaction (3). Survey of geochemical processes at the water-rock interface. Topics include absorption of inorganic and organic ions, colloid stability in groundwater, mineral dissolution and precipitation. Prerequisites: CHM 1046, MAC 3312, GLY 4822 or permission of the instructor.

GLY 5246 Geochemistry (3). **GLY 5246L Geochemistry Lab (1).** Origin of chemical elements and principles affecting their distribution in the solar system, solid earth and hydrosphere. Use of chemical data to solve geologic problems. Prerequisites: Physical Geology and General Chemistry. (S in alternate years)

GLY 5266 Stable Isotope Biogeochemistry (3). Application and theory of stable isotope approaches to biogeochemistry. Topics: Introduction to IRMS machines, C/N/O/H/S (biogeochem. processes), sampling/lab. prep., and recent advances. Prerequisites: One year of chemistry or permission of the instructor.

GLY 5283C Application of ICPES in Geochemistry (3). Determination of elemental abundances in rocks, soils, natural water using inductively coupled plasma emission spectroscopy (ICPES). Instrumental principles, sample selection and preparation methods and application of results to research. Prerequisites: CHM 1045, CHM 1046 or permission of the instructor. (S or SS)

GLY 5286 Research Instrumentation and Techniques in Geology (3). Survey of techniques and instrumentation used in geological research, including computing and data handling. Prerequisites: Graduate standing or permission of the instructor. Corequisite: GLY 5286L. (F)

GLY 5286L Research Instrumentation and Techniques in Geology Lab (1). Introduction to advanced instrumentation and analytical techniques in Geology, including computing and data processing. Prerequisites: Graduate standing or permission of the instructor. Corequisite: GLY 5286. (F)

GLY 5287C Scanning Electron Microscopy with EDS Analysis (3). Imaging and microanalysis of materials using SEM including EDS. Prerequisite: Permission of the instructor.

GLY 5288C Electron Microprobe Microanalysis with EDS Analysis (3). Imaging and analysis of geological and other materials using electron microprobe with EDS analysis. Prerequisite: Permission of the instructor.

GLY 5298 Topics in Geochemistry (3). Seminar covering current research in selected areas of low-temperature geochemistry: oceans and oceanic sediments; continental waters and sediments; hydrothermal systems. Prerequisites: GLY 5246 or permission of the instructor. (F)

GLY 5322 Igneous Petrology and Geochemistry (3). Presentation and discussion of current topics in igneous petrology and geochemistry in a seminar format. Prerequisite: Permission of the instructor. (S)

GLY 5329 Planet Earth: Solid Earth (1). Essentials of the formation and evolution of the crust mantle and core of the earth. Composition and physical properties. Generation of magmas, their geochemistry.

GLY 5335 Metamorphic Geology (3). Metamorphic mineralogy; characteristics of low, medium and high pressure metamorphic rocks; pressure-temperature determinations; metamorphic textures; modeling and determination of P-T-t paths. (F)

GLY 5335L Metamorphic Geology Lab (1). Petrographic examination of metamorphic rocks. (F)

GLY 5346 Sedimentary Petrology (3). Systematic study of sedimentary rocks. Special emphasis on genetical aspects, geochemistry, paleontology, mineralogy, and microfacies. Emphasizes microscopic study. Prerequisite: GLY 4551. Corequisite: GLY 5346L. (F in alternate years)

GLY 5346L Sedimentary Petrology Lab (1). Laboratory studies of sediments and sedimentary rocks with emphasis on microscopic analyses and geochemical techniques. Prerequisites: GLY 4551 and GLY 4551L. Corequisite: GLY 5346. (F in alternate years)

GLY 5408 Advanced Structural Geology (3). Advanced treatment of the theory of rock mechanics to solve problems of natural rock deformation. Prerequisites: GLY 4400, MAC 3413, or permission of the instructor. Corequisite: GLY 5408L. (S)

GLY 5408L Advanced Structural Geology Lab (1). Problem solving in theory of rock deformation. Experimental procedures in rock mechanics. Corequisite: GLY 5408. (S)

GLY 5415 Caribbean Geology and Tectonics (3). Integration of geologic and geophysical data to understand the evolution and present tectonic configuration of the Caribbean area. Prerequisite: Permission of the instructor.

GLY 5425 Tectonics (3). Properties of the lithosphere; plate kinematics and continental drift; characteristics of plate boundaries; mountain belts; formation of sedimentary basins. Prerequisites: GLY 1010, 1100, 4400, 4300, 3202 or permission of the instructor. (S)

GLY 5455 Physical Volcanology (3). Description of volcanoes and their products, geophysical and tectonic constraints on volcanic processes, and modeling and forecasting of volcanic eruptions. Prerequisites: GLY 4450, GLY 4300 or permission of the instructor. (F in alternate years)

GLY 5457 Geophysical Data Analysis (3). Computer analysis and modeling of geophysical data and digital images. Statistical description of data, linear inverse theory, digital signal and image processing. Computer exercises with MATLAB. Prerequisites: GLY 4450, MAP 2302, MAS 3105, PHY 2048, PHY 2049 or permission of the instructor. Corequisite: GLY 5457L. (F)

GLY 5457L Analysis of Geophysical Data Lab (1). Field and laboratory applications of geophysical techniques. Computer aided analysis and three-dimensional modeling of gravity and magnetic data. Prerequisites: GLY 4450, PHY 2048, PHY 2049, MAC 2311, MAC 2312, MAP 2302. Corequisite: GLY 5457. (F)

GLY 5495 Seminar in Geophysics (3). Detailed investigation of current geophysical techniques, including topics on instrument design. Prerequisites: GLY 5457 or permission of the instructor. (S)

GLY 5497 Topics in Structural Geology and Tectonics (3). Selected advanced topics in structural geology and rock deformation. Latest advances in crustal tectonics. Prerequisite: GLY 5408. (S)

GLY 5599 Seminar in Stratigraphy (3). Discussion of research projects and/or current literature in stratigraphic correlation as derived from sedimentologic principles and biozonation. Prerequisite: GLY 5346. (F,S)

GLY 5608 Advanced Paleontology I (3). Discussion of current literature and research projects on evolution, systematics functional morphology, with reports by members of the seminar. Prerequisites: GLY 4650 or permission of the instructor. (F)

GLY 5621 Caribbean Stratigraphic Micropaleontology (3). Microscopic study of biostratigraphic type sections from the Caribbean area. Emphasis on planktonic foraminifera and radiolaria, paleoecologic and paleoclimatic interpretations. Prerequisites: GLY 4650 or permission of the instructor. (F)

GLY 5628 Radiogenic Isotope Methods (3). Theory and practice of radiogenic isotope ratio measuring techniques. Use of class-100 clean room facilities, and introduction to thermal ionization mass spectrometry. Prerequisite: General Chemistry.

GLY 5655 Topics in Paleobiology (1-3). Various concepts in paleobiology are reviewed and discussed, based on readings of the literature, including journal articles and books. Prerequisite: Permission of the instructor.

GLY 5710 Watershed Hydrology (3). Hydrologic processes on watershed, water budgets, effects on water quality, field investigative methods using tracers and hydrometric measurements, hydrologic and hydrochemical models.

GLY 5754 Applied Remote Sensing in the Earth Sciences (3). Application of remote sensing and image analysis in the earth sciences; qualitative and quantitative satellite image and air photo interpretation. Emphasis is on use of computer processing packages. Prerequisites: GLY 1010 or permission of the instructor.

GLY 5758 GIS and Spatial Analysis for Earth Scientists (3). Application of GIS technology to spatial problems in the Earth Sciences. Topics include: spatial statistics, sampling theory, surface estimation, map algebra, and suitability modeling.

GLY 5785 Caribbean Shallow-Marine Environments (3). Field study of multiple tropical environments in the Caribbean area. Dynamic processes and coastal evolution in response to natural and human-induced changes.

GLY 5786 Advanced Field Excursion (3). A study of the geology of a selected region of the world followed by 10-12 day field trip in order to study the field relationships of the geologic features. Special emphasis is given to stratigraphic, structural and tectonic relationships of lithic package. Prerequisite: Permission of the instructor. (SS)

GLY 5808 Mining Geology (3). Application of theoretical models of ore formation to exploration and the use of geochemical and geophysical techniques in the search for ore deposits. Prerequisites: GLY 4300 and CHM 1046. (F)

GLY 5816 Economic Geology (3). Economically important metal deposits of sedimentary, igneous and hydrothermal origins and their geologic settings and characteristics. Prerequisites: GLY 1010, GLY 4300, CHM 1045, CHM 1046. (S)

GLY 5826 Hydrogeologic Modeling (3). Techniques used in modeling groundwater flow and solute transport in geologic systems. Case studies of significant aquifers. Prerequisites: GLY 5827, MAP 2302, or permission of the instructor. (S,SS)

GLY 5827 Hydrogeology (3). Physics of flow in geological media. Saturated and unsaturated flow, groundwater and the hydrologic cycle, estimating hydraulic parameters of aquifers, introduction to chemical transport. Prerequisites: GLY 1010, MAC 2312, and PHY 2053, or permission of the instructor. (F)

GLY 5827L Hydrogeology Lab (1). Laboratory, field, and computer exercises to complement GLY 5827. (F)

GLY 5828 Chemical Hydrogeology and Solute Transport (3). Quantitative analysis of hydrologic, geologic, and chemical factors controlling water quality and the transport and fate of organic and inorganic solutes in the subsurface. Prerequisite: GLY 5827. (S)

GLY 5834 Field Hydrogeology (3). Field methods in hydrogeology. Drilling, logging, wells, data loggers, hydraulic conductivity/transmissivity measurements, purging, field chemistry parameter measurements, sampling methods. Prerequisites: GLY 4822 or permission of the instructor.

GLY 5835 Introduction to Lattice Boltzmann Methods (3). The course will provide an introduction to Lattice Boltzmann methods for fluid dynamics simulation. Emphasis on multiphase fluids. Prerequisites: Programming skills, graduate standing, permission of the instructor.

GLY 5889 Geology for Environmental Scientists and Engineers (3). Characterization of rocks and rock masses; geological maps; seismic hazards; weathering of rocks; hydrologic cycle; slope stability; coastal processes; geophysical techniques. Course includes field trips in the South Florida region. Prerequisites: CHM 1045, GLY 1010 or permission of the instructor.(S)

GLY 5931 Graduate Seminar (1). Presentation or critical examination of current research problems in geology. A selection of topics is considered each term. Topics may also include individual research in the student's field of investigation. Prerequisites: Graduate standing or permission of the instructor. (F,S,SS)

GLY 6159 Stratigraphy of the Circum Caribbean Region (4). Detailed lithostratigraphic and biostratigraphic analyses of Caribbean islands, Central America, northern South America and Caribbean basin. Prerequisites: GLY 5621 or permission of the instructor. (SS)

GLY 6247 Trace Element and Isotope Geochemistry (3). Principles of trace element and isotope fractionation and radioactive decay, and their application to the interpretation of igneous rocks and the chemical evolution of the earth. Prerequisites: GLY 5246 or permission of the instructor. Corequisite: GLY 6247L. (S)

GLY 6328 Advanced Igneous Petrology (3). Interpretation of igneous rocks; chemistry and physics of magma generation and crystallization; origin of major igneous rock series with emphasis on tectonic controls. Prerequisite: Permission of the instructor. Corequisite: GLY 6328L. (S)

GLY 6328L Advanced Igneous Petrology Lab (1). Identification of rocks using microscopic and microprobe techniques. Prerequisite: Permission of the instructor. Corequisite: GLY 6328. (S)

GLY 6337 Metamorphic Phase Equilibria (3). Theory and methods of calculation of metamorphic phase equilibria and P-T paths using appropriate analysis of composition space, activity models, geothermometry, geobarometry. Origin and interpretation of zoning in metamorphic minerals. Prerequisites: GLY 5335 or permission of the instructor. (F)

GLY 6345 Sedimentary Petrography (3). Comparative study and fundamental observations of sedimentary rocks in hand specimens and under the petrographic microscope; their classification, theoretical and practical implications. Prerequisites: GLY 4551 or permission of the instructor. (F)

GLY 6345L Sedimentary Petrography Laboratory (1). Laboratory studies of sedimentary rocks in thin section. Prerequisites: GLY 4551 or permission of the instructor. Corequisite: GLY 6345. (F)

GLY 6353 Microfacies Analysis (3) GLY 6353L Microfacies Analysis Laboratory (1). Identification and interpretation of the fossil and mineralogical constituents of sedimentary rocks in thin section. Emphasis is placed on the paleoecological significance of fossil remains in carbonates. Prerequisites: GLY 4551 or permission of the instructor. (S)

GLY 6392 Topics in Igneous Petrology and Geochemistry (3). Research seminar in contemporary petrology and geochemistry. Student presentation on thesis research. Prerequisites: GLY 5322 or permission of the instructor. (F,S)

GLY 6427 Quantitative Geotectonics (3). Application of continuum mechanics and heat transfer to problems in geology. Observational constraints on earth properties. Emphasis is on problems relating to the earth's lithosphere. Prerequisites: GLY 4450, GLY 4400, GLY 5425 and MAP 2302 or permission of the instructor. (F in alternate years)

GLY 6444 Quantitative Analysis of Joints and Faults (3). Application of fracture mechanics to geologic problems, including the analysis of local and regional stress fields, bedrock fracture systems, estimation of fracture related strain, and the influence of mechanical properties on rock failure. Prerequisites: GLY 4400, GLY 4450, GLY 5425 or permission of the instructor. (F in alternate years)

GLY 6447 Advanced Topics in Structural Geology and Tectonics (3). Detailed exploration of selected research topics in structural geology and tectonics. Prerequisites: GLY 5408 or permission of the instructor. (F,S)

GLY 6448 Stress in the Earth's Crust (3). The distribution and magnitude of stress in the earth's crust,

laboratory derived values for earth stress, in situ stress measurements, regional stress patterns and sources of stress in the lithosphere. Prerequisites: GLY 4400, GLY 4450, GLY 5425 or permission of the instructor. (S)

GLY 6468 Paleomagnetism (3). Physics of rock and mineral magnetism, geomagnetism and paleomagnetism; field and laboratory methods, geomagnetic field behavior, magnetostratigraphy, apparent polar wander. Prerequisites: GLY 4400, GLY 3202 or permission of the instructor. Corequisite: GLY 6468L. (F)

GLY 6468L Paleomagnetism Laboratory (1). Physics of rock and minerals magnetism, geomagnetism and paleomagnetism; field and laboratory methods, geomagnetic field behavior, magnetostratigraphy, apparent polar wander. Prerequisites: GLY 4400, GLY 3202 or permission of the instructor. Corequisite: GLY 6468. (F)

GLY 6485 Physics of the Earth (3). Properties and dynamics of the Earth's interior studied from a physical perspective. Topics include heat flow, fluid flow, earthquake seismology. Prerequisites: GLY 4450 and MAC 2313. (F)

GLY 6496 Advanced Topics in Geophysics (3). Discussion of research projects and current literature in geophysics. Prerequisite: GLY 5495. (S)

GLY 6517 Basin Analysis (3). Analysis of sedimentary basins based on their origin, paleogeographic evolution and tectonic setting. Emphasis is placed on the tectonic evolution and economic potential of sedimentary basins. (S in alternate years)

GLY 6517L Basin Analysis Lab (1). Analysis of different types of sedimentary basins using a case history approach. Corequisite: GLY 6517. (S in alternate years)

GLY 6595 Topics in Sedimentology (3). Oral presentation by students of research projects and survey of relevant literature with reports by members of the seminar. Prerequisite: GLY 5346. (S in alternate years)

GLY 6626 Stratigraphic Micropaleontology: Foraminifera (3). Nomenclature, taxonomy, and biostratigraphy of Cretaceous and Cenozoic planktonic foraminifera. Studies of stratigraphically important taxa from Caribbean land sections, piston cores, and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (F in alternate years)

GLY 6627 Stratigraphic Micropaleontology: Radiolaria (3). Nomenclature, taxonomy and biostratigraphy of Cretaceous and Cenozoic radiolaria. Studies of stratigraphically important taxa using Caribbean land sections, piston cores, and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (S in alternate years)

GLY 6628 Stratigraphic Micropaleontology: Calcareous Nannofossils (3). Nomenclature, taxonomy, and biostratigraphy of triassic to recent nannofossils. Intensive training of identification of marker taxa using land and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (S in alternate years)

GLY 6690 Topics in Paleontology (3). Oral presentation and discussion of current research projects and relevant literature, with reports by members of the seminar.

Prerequisites: GLY 5608 or permission of the instructor. (F)

GLY 6809 Hydrothermal Geochemistry (3). The mineralogy, thermodynamics, chemistry and isotope chemistry of hydrothermal and geothermal systems, with an emphasis on the transport of solutes in hydrothermal solutions and ore-forming processes. Prerequisites: GLY 5246, CHM 3400 or permission of the instructor. (S in alternate years)

GLY 6817 Topics in Economic Geology (3). Current research directions in Economic Geology and Geochemistry, including ore formation processes, exploration and remediation.

GLY 6862 Numerical Methods in the Earth Sciences (3). Numerical techniques used by geoscientists, with emphasis on finite-difference and finite-element techniques to solve equations governing fluid flow and mass transport in geological systems. Prerequisites: MAP 2302, GLY 5827 and knowledge of one programming language or permission of the instructor.

GLY 6896 Advanced Topics in Hydrology (1-3). Research-oriented seminar course involving analysis of several contemporary topics chosen from the current literature in hydrology. Specific topics vary. May be repeated. Prerequisites: GLY 5827 and one other graduate level hydrology/hydrogeology course, or permission of the instructor. (S in alternate years)

GLY 6910 Supervised Research (1-12). Research apprenticeship under the direction of a professor or a thesis advisor. Prerequisites: Full graduate admission and permission of the instructor.

GLY 6931 Advanced Graduate Seminar (1). Oral presentation and discussion by students of an assigned literature survey, with reports by members of the seminar. Prerequisites: GLY 5931 or permission of the instructor. (F,S)

GLY 6941 Supervised Teaching in the Geosciences (1). Teaching a geological discipline under the supervision of departmental faculty. Prerequisite: Graduate standing.

GLY 6945 Proposal Writing (1). A graduate course aimed at introducing students to grant proposal writing.

GLY 6949 Professional Internship in Earth Science (1-3). Semester or summer term of supervised work at an approved government or industry laboratory or field station. Prerequisite: Graduate standing.

GLY 6966 Master's Comprehensive Examination (0). Oral and written examinations on knowledge in general geology and the student's field of concentration. Schedule to be selected in consultation with the Graduate Committee. Prerequisite: Advanced graduate standing. (F,S,SS)

GLY 6971 Master's Thesis (1-12). Field and/or laboratory research project toward thesis. Selected in consultation with major professor. Prerequisite: Permission of the major professor. (F,S,SS)

GLY 7980 Ph.D. Dissertation (1-12). Field and/or laboratory research directed towards completion of the doctoral dissertation. Selected in consultation with major

professor. Prerequisite: Permission of the Major Professor and Doctoral Candidacy. (F,S,SS)

OCG 6105 Advanced Marine Geology (3). OCG 6105L Advanced Marine Geology Lab (1). Application of geophysical and geological data to the interpretation of the earth's crust under the oceans, including the data provided by the Deep-Sea Drilling Project, dredging, piston-coring, gravity magnetism, and seismicity. Special emphasis will be given to the genesis and evolution of the Atlantic and Caribbean margins, and their potential for oil resources. Prerequisites: GLY 4730 or permission of the instructor. (F in alternate years)

OCG 6664 Paleoceanography (3). Mesozoic/Cenozoic development of the major ocean basins, their circulation and sedimentation history. Use of micropaleontologic and stable isotopic techniques in paleoceanographic analysis. Prerequisites: GLY 4730 or permission of the instructor. (F in alternate years)