GEOS 4013 Data Analysis for the Geological Sciences

This course focuses on using univariate and multivariate statistics to address geologic problems, and interpreting and understanding data as presented in the scientific literature. Basic concepts in elementary statistics (p-values, distributions, hypothesis testing) will be reviewed with a geologic viewpoint. Advanced topics will be applied to geologic examples, and include matrix algebra, eigenvectors, regression, non-parametric resampling, spatial analysis, ordination methods, and multidimensional scaling. Examples will be taken from various geoscience subfields, and students will apply their understanding to both original projects and previously published work. Analyses will be performed in the “R” software environment, designed for statistical applications.

Prerequisites: STATS 3573 or the approval of the instructor

3 (3-0)

GEOS 4153 Natural Hazards and Disasters

This course will enable the student to 1) understand the scope and impact of natural hazards and disasters 2) recognize the difference between hazards and disasters and 3) understand how the expanding human footprint is leading to an increase in natural disasters. The laboratory sessions utilize geospatial technologies (Geographic information systems/GIS and remote sensing software) enabling students to develop mapping and modeling expertise and apply it to the study of diverse geological and atmospheric hazards including earthquakes, volcanoes, landslides, floods, storms, wildfires, and climate change.

4 (2-3)

GEOS 4143 Volcanology

This class covers the nature of volcanic processes and products, including eruptive styles, edifices, and structures, modern and ancient. The course includes analysis of the products of igneous, volcanoclastic, and hydrothermal activity. In addition to the general nature of volcanism, the class examines the evolution of specific eruptive centers and volcanic fields, with an emphasis on modern techniques of evaluation, assessment, and eruption risk.

3 (3-0)

Prerequisites: GEOS 3234 or the approval of the instructor
GEOS 4243 Geochemistry

This course covers thermodynamics and kinetics as applied to earth systems, over a range of conditions relevant to the Earth’s interior and its surface, with emphasis on the hydrosphere and lithosphere. The course examines speciation and phase stability in aqueous solutions, and pressure-temperature-composition relationships as applied to diagenesis, hydrothermal systems, metamorphism, and magmatism. Students will learn to use the software package Geochemist’s Workbench (GWB) to assist in constructing and understanding phase diagrams and reaction modeling.

Prerequisites: CHEM 1243 or CHEM1253, GEOS 3534 and STATS 3573 or the approval of the instructor
3 (3-1)

GEOS 4253 Isotope Geochemistry

This course is an overview of the geologic use of isotopic systems. It covers geochronology using radioactive decay series, including U-Th-Pb, Sm-Nd, K-Ar, Re-Os, and Lu-Hf, U-series disequilibrium, fallout isotopes such as 137Cs, and cosmogenic isotopes such as 10Be, 26Al, 14C and 36Cl. The course covers radiogenic and stable isotopes as applied to the evolution of the crust and mantle, stable isotopes (e.g. sulfur, carbon, hydrogen, oxygen) as applied to geothermometry, ore petrogenesis, paleontology, and the global climate system.

3 (3-0)

Prerequisites: CHEM 1243 or CHEM1253 or approval of the instructor

GEOS 4413 Regional/North American Geology

This course is an examination of the assembly of Texas and North America over time, beginning with the developments of the Granite-Rhyolite Terrane and Texas Cratons, Grenville deformation and the formation of Rodinia, formation of the southern Iapetus ocean and associated rifting, early Paleozoic marine deposition and sequential western (Antler, Nevadan, Klamath, Sonoma) and eastern (Taconic, Acadian), closure of the Iapetus ocean and associated orogenies (Alleghenian, Ouchita-Marathon, Ancestral Rocky), late Paleozoic sedimentation, Mesozoic epeiric marine incursion, Paleogene orogenic and gulf sedimentation, magmatic, and hydrothermal, and Neogene lithospheric tension, subduction, and hot-spot magmatism and deformation. The course will examine regional and narrow datasets and literature covering the events that shaped the modern continent.

3 (3-0)

Prerequisites: GEOS 3234 and 3434 or the approval of the instructor
GEOS 5033 GIS for Geosciences

This course focuses on developing spatial analysis skills using ArcGIS software and online analysis tools. Students will learn to access and download data, integrate, analyze, and model data, create new data sets, and make maps and presentations. The course will comprise case studies and laboratory activities with diverse applications including delineation of watershed boundaries; assessing susceptibility of ground water to point- and nonpoint-source pollution; investigating global patterns and trends in natural hazard/disaster; monitoring land cover change and its potential impacts; applying topographic maps to study geomorphology; exploring patterns and types of plate boundaries; and working with geological, structural, and geophysical data with applications for geologic mapping and resource exploration.

3 (2-2)

GEOS 5082 Special Topics in Geosciences

Review and discussion of current scientific literature and research related to a topic in the geosciences. Student will synthesize knowledge on the subject and present their findings. Discussions focus on the hypotheses, methodology, and approach of previous work, and how to apply that to the student’s current thesis research.

2  (May be repeated once with consent of graduate coordinator)

GEOS 5113 Geostatistics and Petroleum Reservoir Modeling

This course focuses on the theory and application of geostatistics and closely allied methodologies (e.g. Multiple Point Statistics or MPS) used to interpret and model oil and gas reservoirs, aquifers, and metallic ore deposits. Specific topics include kriging, sequential Gaussian simulation, sequential indicator simulation, object-based methods such as multiple point statistics, uncertainty assessment, and the use of experimental design-based workflows to build low, mid, and high case reservoir models for probabilistic assessment of recovery. The course will cover theory as well as case history examples. Students will also learn to build sophisticated reservoir models using spreadsheet and industry standard software with synthetic and actual reservoir data for both small and large petroleum reservoirs.

Prerequisites: GEOS 4534 and GEOS 4034 or the approval of the instructor

3 (3-1)
GEOS 5123 Advanced Formation Evaluation

This course will focus on petroleum and natural gas reservoir formation evaluation. The course topics include coring, “regular” core analysis, “special” core (SCAL) analysis, integrated core and well log-based analysis of formation resistivity, saturation, porosity, and lithology, advanced well logging and interpretation including the use of nuclear magnetic resonance (NMR) for fluid and permeability characterization, formation micro-imaging (FMI) for thin bed, stratigraphic, and structural (e.g. fracture) analysis, and spectral gamma ray logging for lithology and stratigraphy. Other topics include cased-hole logging, “dynamic” reservoir data acquisition and interpretation (e.g. via spinner/flowmeter logs, temperature logs), mercury injection capillary pressure (MICP) data acquisition and interpretation, the emerging field of CT image-based characterization of reservoir rocks and pore networks particularly for carbonate and shale reservoirs. Numerous case histories from a variety of reservoirs and reservoir development stages will be used throughout the course.

Prerequisites: GEOS 4534 and GEOS 4034 or the approval of the instructor

3 (3-1)

GEOS 5133 Petroleum Play Analysis

This course concerns petroleum and natural gas play analysis, with a focus on how an organic-rich source rock can combine, over time, with a series of other elements to produce an economic accumulation of petroleum. The course topics include the definition of play elements, which include source, maturation, reservoir, migration, seal, trap, and timing. Additional foci include structural styles and their controls on plays, basin classification and depositional systems and their relationship to play controls, and play analysis methods. Readings will focus on case histories of global play analyses. Laboratory exercises will include seismic and well log interpretation, stratigraphic and structural analysis, and integration of data sets to develop and present an integrated play analysis. Reservoir modeling, risk analysis and forecasting will be introduced by experienced speakers from the petroleum industry.

Prerequisites: GEOS 4534 and GEOS 4034 or the approval of the instructor

3 (2-2)
GEOS 5213 Techniques of Analytical Geochemistry

An overview of modern analytical techniques for assessing earth materials, underscoring energy and mass spectrometric and diffraction methods used in bulk and micro-volume characterization. The course will utilize field tools for aqueous geochemistry, laser-ablation and electron beam microanalysis, and/or dissolution absorption spectrometry. It will cover principles of dissolution electrochemistry, energy and particle sources, X-ray, electron, and neutron diffraction, ion-, electron-, X-ray-, and laser-sample interactions, accelerator techniques including XANES, Rutherford back-scattering, cathodoluminescence and fluorescence detection and spectrometry, and particle mass discrimination. The course will examine and construct analyses based on datasets from prominent techniques.

3 (1-4)

Prerequisites: Geochemistry (GEOS 4243) or the approval of the instructor

GEOS 5233 Advanced Igneous/Metamorphic Petrology

The course examines modern petrological techniques for evaluating igneous and metamorphic systems and delves into a nuanced understanding of their products. The course reviews prominent geothermobarometric and other mineralogical assemblages, and it explores modeling techniques for evaluating phase stability and mass transfer during alteration, metamorphism, and magmatism. The course will also review laboratory and field techniques for evaluating high-temperature earth systems. The course will cover readings on current igneous and metamorphic investigations, and evaluate in each in light of plate tectonic theory and a global geochemical framework. The course will utilize computer modeling and petrographic analysis of sample sets.

3 (2-2)

Prerequisites: Geochemistry (GEOS 4243) or the approval of the instructor

GEOS 5313 Carbonate Depositional Systems and Stratigraphy

This course covers all aspects of marine carbonate depositional systems and stratigraphy. The course will discuss characteristics of geologic and modern systems across a range of environments (shorelines, tidal flats, reefs, open shelf, deep basin etc.). Students will develop an understanding of sequence stratigraphy, identifying cycles, and the various features of the carbonate factory. Other topics include: diagenetic fabrics, ramp profiles, bioherm and reef formation, and carbonate petrology. Lecture will be supplemented by applied learning with thin sections, core, and hand samples. Concepts will be reinforced with advanced readings and discussion of carbonate-related topics including major carbonate petroleum reservoirs.

Prerequisites: GEOS 4534 or the approval of the instructor
GEOS 5323 Clastic Depositional Systems and Stratigraphy

This course covers all aspects of terrestrial and marine siliciclastic depositional systems and stratigraphy. The course will discuss characteristics of geologic and modern systems across a range of environments (deltas, lakes, shorelines, barrier islands, alluvial and submarine fans, turbidite systems etc.). Students will develop an understanding of clastic sequence stratigraphy, identifying cycles, and the mechanisms responsible for deep-water sedimentation. Other topics include: paleoclimate reconstruction, gravity flow processes, water-rock interactions, subsurface applications, and siliciclastic petrology. Lecture will be supplemented by applied learning with thin sections, core, and hand samples. Concepts will be reinforced with advanced readings and discussion of topics related to siliciclastic depositional systems including major siliciclastic petroleum reservoirs.

Prerequisites: GEOS 4534 or the approval of the instructor

GEOS 5433 Advanced Structural Geology and Geodynamics

The course will evaluate deformation processes and features in the crust and mantle, with an emphasis on structural regimes in the upper lithosphere. The course will evaluate stress regimes in reference to plate tectonic theory, and provides an overview of the application of continuum physics to deformation and related processes. These will be applied to lithospheric and asthenospheric deformation driven by geologic tension, compression, and shearing as exampled by modern and ancient rifts, tectonic basins, orogenies, subduction arcs, transforms, and crustal slumps. Students will explore examples through collection and analysis of structural measurements, geospatial and geophysical data, and computer modeling.

Prerequisites: GEOS 3234 and 3434 or the approval of the instructor

GEOS 5533 Metallic Ore Deposits

This course focuses on the formation and evaluation of the major classes of metallic ore deposits (e.g. gold, silver, copper, zinc, lead, uranium, and iron) as well as the tools used to interpret the depositional processes and conditions. Specific modules will focus on metal transport and depositional processes that produce ore deposits in igneous, metamorphic, hydrothermal, and non-hydrothermal settings. The use of fluid inclusion studies, stable and radiogenic isotope studies, and geochemical studies to interpret primary deposits and secondary/supergene deposits will be integrated throughout this case history-based course in metallic ore deposits. The course will also cover the impact of changes over time to the
composition of the mantle, crust, atmosphere, and oceans of the Earth on metallic ore deposition from
the Precambrian to the present.

Prerequisites: GEOS 4533 or the approval of the instructor

3 (3-1)

GEOS 5613 Evolutionary Paleobiology

This course applies quantitative statistical methods to the study of evolutionary biology in the fossil
record. The acquisition, processing, and analysis of paleontological data will be stressed throughout,
demonstrating the types of problems that can be addressed with information from fossils. Topics
include the quantitative study of shape (geometric morphometrics), phylogenetic analysis, diversity
analysis, survivorship curves, biogeographic models, time-series analysis, and biostratigraphy (graphic
correlation). Laboratory work will use the “PAST” statistical package.

Prerequisites: GEOS 3534 and STATS 3573 or the approval of the instructor

3 (2-2)

GEOS 6001 Graduate Seminar in Geosciences

The Graduate Seminar in the geosciences will cover selected topics within the field of geosciences.

1 (May be repeated for credit; see below)

Graduate Seminar each semester; must be taken at least four times prior to awarding either the
combined Bachelor of Science/ Master of Science Degree with Major in Geosciences or the two-year
Master of Science Degree with a Major in Geosciences.

GEOS 6983 Thesis I

3

Prerequisite: Graduate Advisory Committee Approval of student’s thesis proposal.

GEOS 6993 Thesis II

3

Prerequisite: GEOS 6983