

Fall 2020 Course Descriptions as of 04/05/2020 08:11 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: http://rcs.registrar.arizona.edu/course_descriptions_key.

Geosciences (GEOS)

GEOS 170A1: Earth: From Birth to Death (3 units)

Description: Students will learn that a few universal laws describe the behavior of our physical surroundings, from the universe to every action in our daily lives. This interdisciplinary course will cover aspects of the scientific process, astronomy, physics, chemistry, and Earth sciences, with an emphasis on geosciences and society, including earthquakes, mass extinctions in geologic history, and global warming. It will give students the ability to read and appreciate popular accounts of major discoveries and important public issues in the physical sciences.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Equivalent to: ASTR 170A1, PTYS 170A1

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 101 "A Geological Perspective" (Topic 1) or "Planet Earth: Evolution of the Habitable World" (Topic 9) or PTYS 170A1 or ASTR 170A1.

General Education: NATS 101

GEOS 170C1: Life on Earth (3 units)

Description: Course examines the evolution of life, how ecosystems work, and aspects of the ecological role of humans in the global ecosystem. Emphasis on modern biological processes as well as the geologic history of those processes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Equivalent to: ANTH 170C1, ENTO 170C1, MCB 170C1

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 104 "Animal Sexual Behavior" (Top 1), "Human Var In Mod World" (Top 4), "Life on Earth" (Top 5) or "Views of Life" (Top 8) or ANTH 170C1, ENTO 170C1, or MCB 170C1.

General Education: NATS 104

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 195D: A Sense of Place (1 unit)

Description: Students are introduced to the geology and ecology of Tucson and surrounding mountain ranges, including interactions between past and present societies and our desert environment. Four Saturday field trips (one per month) are scheduled during the semester, each emphasizing a particular region with its unique geological and biological aspects. A Tuesday evening class meeting will take place prior to each Saturday field trip.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$33

Course Components: Colloquium Required

Freshman Colloquia: Freshman Colloquia

GEOS 199: Independent Study (1 - 4 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 212: Introduction to Oceanography (3 units)

Description: Introduces the oceans and their geological, physical, chemical and biological processes with emphasis on their history and formation and the interactions of humans with the marine environment.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Discussion May Be Offered
Lecture Required

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).

General Education: Tier 2 Natural Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 214: Astrobiology: A Planetary Perspective (3 units)

Description: We will explore questions about the origin, evolution, and future of life on Earth and the possibility of life arising independently elsewhere in the Universe. We will examine what it means for a planet to be habitable, both in terms of basic necessities for living organisms to function and environmental limits to their ability to survive. Finally, we will review different approaches for searching for life within the Solar System and beyond using direct and remote sensing techniques.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: ASTR 202, ASTR 214, GEOS 214

Also offered as: ASTR 214, PTYS 214

Course typically offered:

Main Campus: Fall, Spring

Home department: Planetary Sciences

Enrollment requirement: Enrollment not allowed if you have previously taken ASTR 202.

General Education: Tier 2 Natural Sciences

Honors Course: Honors Contract

Honors Course: Honors Contract

GEOS 216: Dinosaurs (3 units)

Description: Learn what happened in the real Jurassic Park. Big ideas from cosmology, geology, biology, and atmospheric science are combined to explain the existence of the marvelous Mesozoic monsters.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

General Education: Tier 2 Natural Sciences

Honors Course: Honors Contract

Honors Course: Honors Contract

GEOS 218: Geological Disasters and Society (3 units)

Description: Geological catastrophes (earthquakes, meteorite impacts, flooding) are important processes in shaping the Earth. This course will acquaint students with the scientific principles governing these catastrophes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).

General Education: Tier 2 Natural Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 220: Environmental History of the Southwest (3 units)

Description: Environmental and cultural history of the Southwest emphasizing discovery of the past using historical science techniques of tree-ring and packrat midden analyses and repeat photography.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).

Field trip: Field trip

General Education: Tier 2 Natural Sciences

GEOS 222: The Beauty of Landscapes (3 units)

Description: This course weaves together geosciences, mathematics, and art history to explore how landscapes evolve, the mathematics that describe them, and the ways in which landscapes have been portrayed and appreciated by American artists. Landscapes are formed by the force of gravity as well as the forces exerted by the flow of wind, liquid water, and ice. Landscape development involves self-organization, a principle in which ordered patterns develop at large scales due to interactions that occur at smaller scales. The results in many cases are of striking beauty. Quantifying the complex shape of landscapes required a new form of mathematics (fractals). This course will explore how landscapes develop, how to quantify their patterns, and of the history of how American artists have celebrated the beauty of landscapes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).

General Education: Tier 2 Natural Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: The National and Tribal Parks in the Western USA provide a natural laboratory in which students can learn how geological processes shaped the Earth's surface through time. This class will explore the geology of the National/Tribal Parks in the Western USA and will involve a one week field trip to some of the most iconic National Parks in Arizona. Students will learn how tectonics and erosion shaped the Earth's surface and formed the beautiful landscape we can enjoy today in our National Parks. They will be exposed directly in the field to the product of some fundamental processes in geology. Students will also learn about the more recent geological history (e.g., climate changes) and culture of the region including the history of the indigenous people inhabitant of these regions and their relationships with the environment. The goal of this class is to expose students to geological processes affecting Earth's surface and environmental changes affecting humans through the geological features preserved in the National Parks of the Western USA.

Career: Undergraduate

Recommendations and additional information: One science class with laboratory component, or permission of the instructor.

Field trip: A week-long field trip (5 days plus travel time) will be offered to all students attending this class. This field trip will visit some of the main National (Tribal) Parks and Monuments in Arizona.

Description: Introduction to Earth's materials; surface and internal geologic processes; plate tectonics; and geologic time. Includes practical experience in rock and mineral identification, topographic maps, and applied problems in geosciences.

Career: Undergraduate

Course Components:	Laboratory	Required
	Lecture	Required

Field trip: Two or more field trips.

Shared Unique Number: SUN# GLG 1101

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 255: Historical Geology (4 units)

Description: Evolution and history of continents, mechanism of plate tectonics and effects on climate change, and origin and evolution of life. Methods used for historical reconstruction, sequence of life recorded by the fossil record, and tectonic evolution of major continents through time.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$77

Course Components:	Laboratory	Required
	Lecture	Required

Recommendations and additional information: GEOS 251.

Field trip: Three day field trip to the Grand Canyon.

Enrollment requirement: GEOS 251 and freshman standing

GEOS 280: Programming and Data Analysis in the Earth Sciences (3 units)

Description: This course will provide students with a skill set relevant to processing, analyzing, visualizing, and interpreting data from a variety of Earth and environmental science disciplines. Programming methods and data analysis will be performed using MATLAB. Students will design and implement code to analyze data and will communicate results through technical reports and presentations. Topics covered include: conditional statements; loops; array operations; automated data analysis and visualization techniques; time-series analysis; working with geospatial data; data uncertainty; and curve fitting. No prior programming experience is required.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

GEOS 294: Practicum (1 - 4 units)

Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 299: Independent Study (1 - 4 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 299H: Honors Independent Study (1 - 3 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

Enrollment requirement: Student must be active in the Honors College.

Honors Course: Honors Course

Honors Course: Honors Course

GEOS 300: Earth Surface Processes (3 units)

Description: Introduction to landforms and sediment transport processes in hillslope, fluvial, aeolian, glacial, and coastal environments. Landform development in response to tectonics and climate. Natural hazards occurring on Earth's surface. Quantitative skills and techniques for working with and analyzing data will be emphasized.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Field trip: Students will be required to attend one day-long field trip in the Tucson area (multiple field trip opportunities will be available to accommodate the expected enrollment).

Enrollment requirement: GEOS 251.

Honors Course: Honors Contract

Honors Course: Honors Contract

GEOS 302: Principles of Stratigraphy and Sedimentation (4 units)

Description: Basic principles and methods of stratigraphic and sedimentologic analysis; sedimentation processes and depositional environments, facies relations, stratigraphic analysis and classification, correlation, and dynamics of basin fill.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$91

Course Components: Laboratory Required
Lecture Required

Recommendations and additional information: GEOS 251.

Field trip: Two or more field trips.

Enrollment requirement: GEOS 251 and (PHYS 102 or PHYS 141 or PHYS 161H).

Writing Emphasis: Writing Emphasis Course

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 304: Structural Geology (4 units)

Description: Description, analysis, and mechanisms of rock deformation. Weekly laboratory assignments focused on analysis and construction of geologic maps and cross sections, analysis of deformed rocks, and how rock deformation relates to tectonics.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$39

Course Components:	Laboratory	Required
	Lecture	Required

Field trip: Course includes 3 day-long field trips offered on weekends.

Enrollment requirement: GEOS 251 and (PHYS 102 or PHYS 141).

GEOS 306: Mineralogy (3 units)

Description: Principles of crystallography, crystal-chemistry, X-ray diffraction and optical mineralogy. Phase diagrams and phase transitions in the Earth's mantle. Systematic mineralogy. Atomic structure, and physical and optical properties of common rock forming minerals. Identification of minerals and determination of mineral compositions.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$48

Course Components:	Laboratory	Required
	Lecture	Required

Enrollment requirement: CHEM 151 and GEOS 251.

GEOS 308: Paleontology (3 units)

Description: Basic principles and concepts; morphology and classification of fossils; their occurrence, distribution, geologic and evolutionary significance.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$38

Course Components:	Laboratory	Required
	Lecture	Required

Equivalent to: ECOL 308

Recommendations and additional information: GEOS 251 or GEOS 212 or ECOL 182R and ECOL 182L.

Field trip: Field trip.

Enrollment requirement: GEOS 251 or GEOS 212 or ECOL 182R and ECOL 182L.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 322: Introduction to Geophysics (3 units)

Description: Physical principles applied to problems in earth science including seismology, gravity, magnetics, heat flow, plate tectonics.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Laboratory Required
 Lecture Required

Enrollment requirement: GEOS 251 and (MATH 122B or MATH 125).

Special Exam: Special Exam Grade & Credit

GEOS 330: Introduction to Remote Sensing (3 units)

Description: Introduction to remote sensing principles, techniques, and applications, designed principally for those with no background in the field.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$50

Course Components: Laboratory May Be Offered
 Lecture Required

Equivalent to: GEN 330, GEOS 330, SW 330, SWES 330, WSM 330

Also offered as: ENVS 330, GEN 330, GEOG 330, GIST 330, WSM 330

Course typically offered:

Main Campus: Fall

Online Campus: Fall, Spring, Summer

Home department: School of Geography and Development

Student Engagement Activity: Discovery

Student Engagement Competency: Interdisciplinarity

GEOS 340: Environmental Chemistry (3 units)

Description: An introduction to the chemistry of air, water and terrestrial environments. Application of general chemistry to understanding processes that affect the quality of Earth's near-surface air/water/land environments.

Grading basis: Student Option ABCDE/PF

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: GEOS 340, HWRS 340

Also offered as: ENVS 340, HWRS 340

Course typically offered:

Main Campus: Fall

Recommendations and additional information: CHEM 103A, CHEM 103B.

Home department: Environmental Science

Honors Course: Honors Contract

Honors Course: Honors Contract

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 342: The History of Earth's Climate (3 units)

Description: GEOS 342 offers a comprehensive introduction to Earth systems and climate science, including a full discussion of how Earth's geology and planetary aspects shape the climate system, and an overview of the history of Earth's climate throughout geologic time.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

GEOS 346: Mineral and Energy Resources (3 units)

Description: History of the impact of minerals and metals on development of society and civilization, uniqueness of resources, current situation and problems.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Recommendations and additional information: Junior standing.

GEOS 346H: Mineral and Energy Resources (3 units)

Description: History of the impact of minerals and metals on development of society and civilization, uniqueness of resources, current situation and problems.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:

Recommendations and additional information: Junior standing.

Enrollment requirement: Student must be active in the Honors College.

Honors Course: Honors Course

Honors Course: Honors Course

GEOS 356: Petrology (4 units)

Description: Principles of Igneous and Metamorphic petrology; introductory concepts of phase equilibrium, thermodynamics and diffusion kinetics. Emplacement of igneous rocks; distribution, and origins of igneous and metamorphic rocks; rocks in their tectonic settings and implications. Principles of thermometry and barometry. Examination of rocks in hand specimen and thin section; electron microprobe analysis and applications to P-T-t calculations.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$99

Course Components: Laboratory Required

Lecture	Required
---------	----------

Equivalent to: GEOS 345

Enrollment requirement: GEOS 251 and GEOS 306 and (MATH 122B or MATH 125).

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 392: Directed Research (1 - 6 units)

Description: Individual or small group research under the guidance of faculty.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

Recommendations and additional information: Instructor approval required.

GEOS 393: Internship (1 - 15 units)

Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 394: Practicum (1 - 4 units)

Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 396H: Geosciences Honors Special Topics Seminar (1 - 3 units)

Description: An Honors special topics seminar course for Honors Active Juniors and Seniors.

Course includes small group discussion, research, and presentations on a variety of geosciences related special topics of interest. Current research, relevant issues, historical perspectives and guest speakers may be included. Honors sophomores may enroll with consent of the department.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Seminar Required

Repeatable: Course can be repeated a maximum of 2 times.

Enrollment requirement: Honors active Junior or Senior status.

Honors Course: Honors Course

Honors Course: Honors Course

GEOS 397A: Teaching Geosciences (2 - 3 units)

Description: The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Workshop Required

Repeatable: Course can be repeated for a maximum of 12 units.

Recommendations and additional information: Consult department before enrolling.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 399: Independent Study (1 - 4 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 399H: Honors Independent Study (1 - 3 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

Enrollment requirement: Student must be active in the Honors College.

Honors Course: Honors Course

Honors Course: Honors Course

GEOS 400: Introduction to Geochemistry (3 units)

Description: Nuclear systematics and thermodynamics with applications to geologic processes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 500

Recommendations and additional information: CHEM 152.

GEOS 403: Physics of the Solar System (3 units)

Description: Survey of planetary physics, planetary motions, planetary interiors, geophysics, planetary atmospheres, asteroids, comets, origin of the solar system.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: ASTR 403, GEOS 403

Also offered as: ASTR 403, PHYS 403, PTYS 403

Course typically offered:

Main Campus: Spring (odd years only)

Home department: Planetary Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 404B: Lowell Program Topics in Ore Deposits Mapping (1 unit)

Description: This intensive course deals with methods in ore deposits mapping. It includes lectures and field trips, highlighting how geologic mapping is used to understand mineral zoning, time-space relations, and fundamental phase equilibria.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Laboratory	Required
	Lecture	May Be Offered

Repeatable: Course can be repeated for a maximum of 3 units.

Equivalent to: MNE 404B

Co-convened with: GEOS 504B

Field trip: Field trips.

GEOS 404C: Lowell Program Topics in Mineral Deposit Types (1 unit)

Description: This intensive course covers the geology of selected types of mineral deposits, including their lithologic, structural, and geochemical features and applications to mineral exploration. The course includes lectures, laboratory exercises, and field trips to selected ore systems.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Laboratory	May Be Offered
	Lecture	Required

Repeatable: Course can be repeated for a maximum of 3 units.

Equivalent to: MNE 404C

Co-convened with: GEOS 504C

Field trip: Field trips.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 405: Accessible Earth (Study Abroad in Italy) (6 units)

Description: The Accessible Earth Study Abroad Program targets senior level undergraduate and first/second year graduate students seeking to utilize modern Earth observation systems (e. g., satellite observation systems, ground-based Geophysical networks) and data science technologies in their Geoscience research. The Program is based in the beautiful Umbrian hilltop City of Orvieto, Italy, an exceptional location from which to reflect upon the history of science from the Renaissance to the Space Age, and gain an appreciation of the global scope of modern Earth observation systems, the societal relevance of Geoscience research, and the range of research topics that may be performed with a combination of instrumentation and data science technologies. From Orvieto, students will have ample opportunities to immerse themselves in Italian culture and history, as well as develop ideas for how to utilize 21st century technologies to further our understanding of the Earth system. A five-day field trip will touch on a wide range of Geoscience and related topics, including the tectonic history of the Mediterranean region, the Cretaceous-Paleogene boundary, the enigmatic geodynamics of the Northern Apennines orogen, past and modern coastal hazards along the Adriatic coast, present-day Geological processes in the Alps, Neolithic and Etruscan Archaeology, and other topics. From Orvieto, students will learn to use several software tools for acquiring, analyzing, and interpreting Earth observation data sets, including data transfer protocols, Bash and Python shell scripting, Generic Mapping Tools (GMT), iPython/Jupyter notebooks for interactive analysis and documentation, git and GitHub for version control, scientific collaboration, and social networking, and other software tools that are empowering modern scientific discovery.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 505

Recommendations and additional information: Limited to students in senior year of Geosciences or related 4-year degree program, or enrolled as graduate students in a Geoscience Masters or PhD program. Students expected to have at least 30 units of Geoscience coursework with minimum GPA of 2.75.

Field trip: A 5-day field trip will take place during early July. Points of interest on the field trip itinerary are as follows: Day 1- Frontale di Aprio. Day 2- City of Venice. Day 3- Vajont Dam. Day 4- Bolzano. Day 5- Return to Orvieto.

Student Engagement Activity: Intercultural Exploration

Student Engagement Competency: Diversity and Identity

GEOS 408: Tectonic Petrology (3 units)

Description: Applications of igneous and metamorphic petrology to the regional tectonic study of continents. Course will have a field trip.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 508

Recommendations and additional information: GEOS 356.

Field trip: Course will have a field trip.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 410: Microbial Biogeochemistry and Global Change (3 units)

Description: Microbes are the drivers of planetary biogeochemistry. They produce half the oxygen on the planet, and fix half the carbon. They introduce bioavailable forms of nitrogen into the biosphere. If human life ceased to exist, the central biogeochemical cycles would continue turning. However, while the planet's biogeochemistry can persist readily in the absence of human life, that does not mean that humankind's presence lacks impact. The Anthropocene (era of human impact) has seen significant changes to planetary stocks and fluxes of C, N, S, etc. Many of these changes involve or impact microbes, and have significant impacts on biogeochemical cycles. To understand microbial biogeochemistry in today's world, one must include the context of global change. And, conversely, one cannot understand the trajectory of global change without understanding microbial feedbacks via biogeochemical cycles. In this interdisciplinary undergraduate and graduate class we will cover major microbial biogeochemical cycles, and how these cycles are impacted by, and feedback to, global change. To understand the research in this area, we will discuss current methods in both microbial ecology and biogeochemistry, ranging from molecular meta-omics to the use of isotopes as biogeochemical tracers, with a particular emphasis on the challenges and opportunities of integrating these two disciplines. Lectures will be mixed with journal club-style readings and discussions, so active participation is essential. This course is designed for graduate students from diverse backgrounds and advanced undergraduates.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Also offered as: ECOL 410, ENVS 410, PLS 410

Co-convened with: GEOS 510

Course typically offered:

Main Campus: Spring

Recommendations and additional information: Background in biology or biogeochemistry, and openness to interdisciplinary learning.

Home department: Soil, Water, & Environmental Sciences

GEOS 411: Geology and Geophysics of the Solar System (3 units)

Description: Geologic processes and landforms on satellites and the terrestrial planets, their modification under various planetary environments, and methods of analysis. Required course for the undergraduate minor in Planetary Sciences.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Also offered as: HWRS 411, PTYS 411

Course typically offered:

Main Campus: Spring (even years only)

Home department: Planetary Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 412A: Ocean Sciences (3 units)

Description: This course offers an overview of the ocean sciences for undergraduate students with some scientific background. This course will broaden the exposure of UA undergraduates to marine science in a cross-disciplinary context. Students considering a career or graduate school in marine science will find this class a useful preview of the different areas of marine science, and students interested in natural or environmental sciences will gain a better understanding of the many linkages between the ocean and the broader natural world. We will cover the role of the ocean in diverse components of the Earth system, including geological, biological, climatic, and human aspects.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Also offered as: ATMO 412A, ECOL 412A, ENVS 412A

Recommendations and additional information: One year of science, or consent of instructor.

GEOS 412B: Ocean Sciences Field Course (1 unit)

Description: This course is a field trip component intended to complement GEOS 412A, Ocean Sciences. It offers an opportunity for students concurrently enrolled in GEOS 412A to gain hands-on experience with observational methods and data collection in Ocean Sciences. The 3-day trip, to southern California, will entail a half day of work aboard a working research vessel to learn oceanographic data collection techniques. Additionally, the class will make observational stops at several intertidal localities, at a marine geology locality and at other stops to consider marine environmental issues.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$156

Course Components: Laboratory Required

Also offered as: ECOL 412B

Recommendations and additional information: One year of science courses. Students in 412B must also be enrolled in 412A.

Field trip: Required 3 day field trip to California.

GEOS 414: Geology Field Camp (6 units)

Description: Field methods in geology; preparation of geologic reports; emphasis on geologic mapping.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$1970

Other Fee: The flat fee includes a non-refundable \$400 deposit

Course Components: Lecture Required

Recommendations and additional information: GEOS 251, GEOS 302, GEOS 304.

Student Engagement Activity: Discovery

Student Engagement Competency: Innovation and Creativity

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 415: Geologic Hazards (2 units)

Description: Physical aspects of floods, landslides, subsidence, earthquakes, volcanoes, and coastal storms. Role of geology in natural-hazard management.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Recommendations and additional information: GEOS 251.

GEOS 416: Field Studies in Geophysics (3 units)

Description: Seismic, magnetic, electrical, and gravity exploration techniques.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: GEOS 416

Also offered as: GEN 416

Co-convened with: GEOS 516

Course typically offered:

Main Campus: Spring

Recommendations and additional information: GEN 448.

Field trip: Field trips.

Home department: Mining & Geological Engineering

GEOS 417: Sedimentary Basin Analysis (3 units)

Description: Physical mechanisms of sedimentary basin formation, including flexure, thinning and thermal contraction of the lithosphere; isostasy; subsidence analysis; sequence stratigraphy; paleocurrents and sediment provenance; tectonics of sedimentary basins.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$50

Course Components: Lecture Required

Co-convened with: GEOS 517

Recommendations and additional information: GEOS 302.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 418: Geometallurgy (3 - 4 units)

Description: This course is designed to introduce students to the theory and practice of geometallurgy and the role of mineralogy in mine planning, ore processing, and mine development. Topics include spatial distribution and variability of minerals in ore deposits, mineral behavior and element deportment during ore processing, and industry practices in geometallurgical sampling, testing, materials characterization, and planning. The laboratory section introduces industrial methods of mineral characterization (including SEM, XRD, and MLA) and provides hands-on examination of mineral processing samples from various deposit types.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Laboratory	May Be Offered
	Lecture	Required

Also offered as: MNE 418

Co-convened with: GEOS 518

Course typically offered:

Main Campus: Spring

Field trip: Field trip to Freeport-McMoRan Process Technology Center (Valencia Road, Tucson).

Home department: Mining & Geological Engineering

Enrollment requirement: Adv Standing: Engineering. (CHEM 152 or MSE 110) and GEOS 251 and GEOS 306.

GEOS 419: Physics of the Earth (3 units)

Description: Fundamentals of the physics of the solid earth, including thermodynamics, rheology, geomagnetism, gravity, and plate tectonics.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: PTYS 419

Co-convened with: GEOS 519

Recommendations and additional information: MATH 254.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 421: Petroleum Geology and Geophysics (4 units)

Description: This course will explore the geology of petroleum systems, including the geologic conditions and processes that control the formation of the essential elements of a petroleum system and the technological tools and methods that are used in petroleum exploration, with an emphasis on case studies and exercises from a broad range of global tectonic settings.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Laboratory Required
 Lecture Required

Co-convened with: GEOS 521

Course typically offered:

Main Campus: Spring

Recommendations and additional information: GEOS 304 and GEOS 302, or permission of the instructor.

Honors Course: Honors Contract

Honors Course: Honors Contract

GEOS 422: Critical Zone Science & Management (3 units)

Description: This course targets undergraduate science majors and graduates interested in learning more about integrated and interdisciplinary team science while learning about the cross-cutting research and observational strategies employed across NSF's Critical Zone Observatory network. At least half of the course will focus on guided data analysis based on CZO data sets.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Also offered as: ENVS 422, HWRS 422

Co-convened with: GEOS 522

Recommendations and additional information: Class participants must have completed at least one university/college-level lab-based science course and mathematics through pre-calculus

Home department: Soil, Water, & Environmental Sciences

GEOS 423: Regional Structural Geology (3 units)

Description: [Taught alternate years beginning Fall 2004]. Geologic mapping in a variety of rock types and structural regimes, with emphasis on the recognition and solution of regionally significant structural problems.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$100

Course Components: Lecture Required

Repeatable: Course can be repeated for a maximum of 12 units.

Co-convened with: GEOS 523

Recommendations and additional information: GEOS 304.

Field trip: Field trip

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 424A: Space Geodesy (3 units)

Description: Introduction to space geodesy with application to the Earth Sciences. Course provides an overview of modern techniques (GPS, InSAR, etc.), with emphasis on the principles of the Global Positioning System. Applications include plate motions, earthquakes/volcano deformation, Earth orientation, and atmospheric studies.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 524A

Recommendations and additional information: MATH 215; PHYS 241 or PHYS 251; ability to program a computer to perform scientific calculations. Or, the student must prove knowledge of calculus, linear algebra and physics including mechanics and electromagnetic wave theory.

GEOS 425: Regional Tectonics (3 units)

Description: Survey of tectonic processes operating within continents, along continental margins, and on the ocean floor.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$100

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 525

Recommendations and additional information: GEOS 304.

Field trip: Optional field trip.

GEOS 427: Orogenic Systems (3 units)

Description: An analysis of the geology, geophysics, and geochemistry, and the tectonic evolution of selected world mountain systems ranging from currently active belts in both oceanic and continental settings back through Phanerozoic, Proterozoic, and into Archean time.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 527

Recommendations and additional information: At least one advanced undergraduate course in geology, geochemistry, or geophysics.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 430: The Chemical Evolution of Earth (3 units)

Description: [Taught alternate years beginning Fall 2004]. Chemical differentiation and evolution of Earth's mantle and crust according to major-element, trace-element and isotopic characteristics of neodymium, hafnium, strontium, lead and other isotopes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: PTYS 430

Co-convened with: GEOS 530

Recommendations and additional information: GEOS 356 or equivalent undergraduate petrology.

Field trip: Field trips.

GEOS 432: Introduction to Seismology (3 - 5 units)

Description: Fundamentals of the generation, propagation, and interpretation of seismic waves. Two sections: earthquake seismology and exploration seismology. Sections meet together for introduction then students choose one (3 units) or both (5 units) for the remainder of the semester.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 532

Recommendations and additional information: MATH 254; consult department before enrolling.

GEOS 434A: Introduction to Exploration Seismology (3 units)

Description: Fundamental theory of seismic wave propagation, and techniques of seismic reflection and refraction data acquisition and interpretation applied to exploration of the Earth's lithospheric structure and natural resources. Study of methods to image the crust in 2-D and 3-D.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 534A

Recommendations and additional information: MATH 124, MATH 129.

Honors Course: Honors Contract

Honors Course: Honors Contract

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: The course will focus on the processes and properties associated with earthquake sources and volcanic systems and how these properties affect the hazards associated with these events. Lectures will focus on derivations of common equations used to study these systems and discussions on recent publications related to the modeling of earthquake sources and volcanic eruptions. Students will lead discussions on relevant papers and final projects will involve writing summary papers and applying modeling techniques discussed in the class to carry out original analyses.

Main Campus: Fall

Honors Course: Honors Contract

Main Campus: Fall

Field trip: No

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: Survey of dendrochronological theory and methods. Applications to archaeological, geological, and biological dating problems and paleoenvironmental reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts.

Career: Undergraduate

Course Components:	Laboratory	Required
	Lecture	Required

Also offered as: ANTH 439A, GEOG 439A, WSM 439A

Field trip: Field trip.

Description: Large-scale tectonic problems approached by combined geophysical and geologic analysis in regional context.

Career: Undergraduate

Course Components:	Laboratory Lecture	May Be Offered Required
---------------------------	-----------------------	----------------------------

Repeatable: Course can be repeated a maximum of 2 times.

Co-convened with: GEOS 540

Recommendations and additional information: 20 units of geosciences, MATH 254.

Description: In-depth class about the planet Mars, including origin and evolution, geophysics, geology, atmospheric science, climate change, the search for life, and the history and future of Mars exploration. There will be guest lectures from professors and research scientists with expertise about aspects of Mars. The course may include visits to Mars exploration centers at the University of Arizona and Arizona State University. There will be lots of discussion of recent results and scientific controversies about Mars. All students are expected to have a knowledge of basic calculus.

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: ASTR 442, GEOS 442

Also offered as: ASTR 442, PTYS 442

Course typically offered:

Main Campus: Spring (odd years only)

Recommendations and additional information: PTYS 411 is strongly recommended but not required.

Home department: Planetary Sciences

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 446: Economic Mineral Deposits (3 units)

Description: Geology of metallic and nonmetallic ore deposits. Economic considerations, processes of formation, methods of study and exploration, and description of geologic aspects and settings of representative worldwide examples.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 546

Recommendations and additional information: GEOS 304, GEOS 306.

Field trip: Field trip

GEOS 447: Global and Regional Climatology (3 units)

Description: Description and analysis of the atmospheric circulation process that produces differences in climates throughout the world. Emphasis on the earth's problem climates and climatically sensitive zones most susceptible to floods, droughts, and other environmental stresses due to global change.

Grading basis: Regular Grades

Career: Undergraduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Also offered as: GEOG 447

Co-convened with: GEOS 547

Recommendations and additional information: ATMO 171 or GEOG 171.

Home department: School of Geography and Development

GEOS 448: Geophysical Exploration and Engineering (3 units)

Description: Principles of gravity, magnetic, seismic and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: GEOS 448

Also offered as: GEN 448

Co-convened with: GEOS 548

Course typically offered:

Main Campus: Fall

Recommendations and additional information: PHYS 141, PHYS 241, MATH 223.

Home department: Mining & Geological Engineering

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 450: Geomorphology (4 units)

Description: Processes, form, and dynamics of the fluvial system from source to mouth. Introduction to aeolian, glacial, and planetary geomorphology.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$25

Course Components: Laboratory May Be Offered
Lecture Required

Equivalent to: GEOG 450

Co-convened with: GEOS 550

Recommendations and additional information: GEOS 251.

Field trip: Field trip.

GEOS 453: Glacial and Quaternary Geology (3 units)

Description: [Taught alternate years beginning Spring 2005]. Glacial processes, landforms, and deposits. Physical aspects of Quaternary paleoenvironmental change and effects on fluvial, eolian, lacustrine, weathering, and mass movement processes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 553

Recommendations and additional information: GEOS 251.

GEOS 456: Thrust Belts and Synorogenic Sediments (3 units)

Description: Geometry and mechanics of thrust faults and thrust belts; tectonics of contractional orogenic belts; geomorphology of thrust belts and foreland basin system; depositional systems and provenance of foreland basin sediments; application of orogenic-wedge models.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$100

Course Components: Lecture Required

Repeatable: Course can be repeated a maximum of 5 times.

Co-convened with: GEOS 556

Recommendations and additional information: GEOS 302 and GEOS 304 or equivalent.

GEOS 460: Characterization and Identification of Minerals (3 units)

Description: This course will provide theoretical and practical training in the procedures of X-ray diffraction, Raman spectroscopy and electron microprobe techniques, used to characterize minerals and identify unknown samples. Students will learn to use the equipment and interpret results.

Grading basis: Student Option ABCDE/PF

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 560

Recommendations and additional information: Introductory Mineralogy course.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 466: Stable Isotope Geochemistry and Paleoclimate (3 units)

Description: An examination of stable isotopes in paleoenvironmental reconstruction, emphasizing O, C, H and N isotopes in the ocean, rivers, ice, lakes, soils, speleothems, and fossils. The class includes in-class presentations and a lab project.

Grading basis: Student Option ABCDE/PF

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 566

Recommendations and additional information: GEOS 251; CHEM 101A/B, CHEM 103A/B, or CHEM 105A/B.

GEOS 469: Seismic Data Processing (3 units)

Description: Fundamental theory and practical applications of time-series analysis and digital filtering. A problem-solving approach to seismic reflection data process.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 569

Recommendations and additional information: GEOS 434A or consent of instructor. Recommended, MATH 322 or MATH 422.

GEOS 470L: Volcanology: Laboratory and Field Methods (1 unit)

Description: Hand specimen and petrographic examination of volcanic rocks; geologic map exercises; field trips with geologic mapping exercises.

Grading basis: Student Option ABCDE/PF

Career: Undergraduate

Flat Fee: \$30

Course Components: Laboratory Required

Co-convened with: GEOS 570L

Recommendations and additional information: GEOS 251, GEOS 356. Concurrent registration, GEOS 470R.

Field trip: Field trips with geologic mapping exercises.

GEOS 470R: Volcanology: Physical Processes and Petrologic Applications (3 units)

Description: Physical and chemical properties of magmas; physical volcanology of silicic, intermediate, mafic, and ultramafic magmas, with applications to petrology, extraterrestrial volcanism, mineral deposits, and society.

Grading basis: Student Option ABCDE/PF

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 570R

Recommendations and additional information: GEOS 251, GEOS 356. Concurrent registration, GEOS 470L

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 474A: Geochronology and Thermochronology (3 units)

Description: This class will familiarize students with principles of geochronology and thermochronology and applications in Earth and planetary sciences. Topics will include radioactive decay and growth, long- and short-lived radioisotope systems, analytical methods, determining dates and rates of a wide variety of events and processes, and the use of radiogenic isotopes as tracers in Earth and planetary processes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 574A

Recommendations and additional information: GEOS 251, GEOS 306, GEOS 400.

Honors Course: Honors Contract

Honors Course: Honors Contract

GEOS 477: Active Tectonics (3 units)

Description: Regional and subregional examination of faulting, folding, uplift, subsidence, collapse, volcanism, and mass wasting associated with active contemporary deformations of the Earth's crust. Emphasis includes impact on human society.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 577

Field trip: Field trip

GEOS 478: Global Change (3 units)

Description: Analysis of the Earth system through an examination of its component parts (particularly climate and biogeochemistry) and their interactions with human activities, emphasizing information needed to understand modern and future environmental changes.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Equivalent to: ECOL 478, GEOG 478, HWRS 478, HYDR 478, RNR 478

Co-convened with: GEOS 578

Recommendations and additional information: Upper-division standing, introductory course work in biological and physical sciences.

GEOS 479: Introduction to Climate Dynamics (3 units)

Description: The course will cover the interactions between the different components of the climate system including the atmosphere, ocean, sea/land ice, etc., and the dominant feedbacks so that students can understand the working of the climate system and the mechanisms governing its variability and response to external perturbations.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 579

Recommendations and additional information: MATH 124.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 482: Paleoclimatology (3 units)

Description: Topics in paleoclimatology including prediction of paleoclimatic patterns, proxy paleoclimatic indicators, and paleoclimatic cycles.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 582

GEOS 484: The Coevolution of Earth and the Biosphere (3 units)

Description: This course examines the interplay of changes in earth environments and biological evolution from the earliest life to the present. The focus is geochemical and topics include the early earth and life, evolutionary jumps, mass extinctions, and the rise of hominids.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$31

Course Components: Lecture Required

Co-convened with: GEOS 584

Recommendations and additional information: Calculus II (MATH 129) or consent of the instructor

Field trip: 2-3 field trips to geologic localities near Tucson, Arizona.

GEOS 486: Organic Geochemistry (3 units)

Description: This course offers an introduction to and broad overview of the field of Organic Geochemistry - the structure and fate of organic molecules in the geosphere. This is a course for students with upper level standing who have completed basic undergraduate courses in chemistry, geoscience, and biology. Students interested in using organic geochemical techniques in an academic, environmental, or petroleum industry setting will find this course useful as a rigorous introduction to the discipline.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 586

Recommendations and additional information: Natural or physical sciences major with upper level standing who has completed basic courses in chemistry, biology, and geosciences. CHEM II (152) required. Organic Chemistry (241/242/243) strongly recommended.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 487: Physical and Dynamical Oceanography (3 units)

Description: The course will introduce the physical properties of seawater including the three-dimensional structures of ocean temperature, salinity and density, their mean states, seasonal and interannual variability and long-term change. The heat, salt and mass budgets of the world oceans will be discussed, with emphasis on the role of the ocean in the climate system. The course will introduce basic concepts and general principles of ocean dynamics to understand large-scale ocean circulation, including wind-drive and density-driven (thermohaline) circulation. Special topics focus on the formation of the western boundary currents (the Gulf Stream), ocean waves and tides, ENSO dynamics, and coastal ocean processes (sea level rise and storm surge).

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 587

Course typically offered:

Main Campus: Fall

Field trip: No

GEOS 489: Quaternary Geochronology (3 units)

Description: Review of quantitative dating techniques for Quaternary geologists, including ^{14}C , U-series, in situ cosmogenic radionuclides, TL, amino acids and others.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Lecture Required

Co-convened with: GEOS 589

Recommendations and additional information: CHEM 103B, CHEM 104B, GEOS 251.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 490: Remote Sensing for the Study of Planet Earth (3 units)

Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$50

Course Components: Lecture Required

Equivalent to: ARL 490, ATMO 490, GEN 490, GEOG 490, GEOS 490, HWRS 490, MNE 490, OPTI 490, RNR 490, SW 490, SWES 490

Also offered as: ATMO 490, ENVS 490, GEOG 490, HWRS 490, OPTI 490, REM 490, RNR 490

Co-convened with: GEOS 590

Course typically offered:

Main Campus: Fall

Home department: Committee on Remote Sensing and Spatial Analysis

Enrollment requirement: GEOG/GEN/GEOS/ENVS/WSM/GIST 330.

GEOS 492: Directed Research (1 - 6 units)

Description: Individual or small group research under the guidance of faculty.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

Equivalent to: ECOL 492, MCB 492

GEOS 493: Internship (3 units)

Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 494: Practicum (3 units)

Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 496E: Topics in Structure and Tectonics (1 - 4 units)

Description: This seminar series is being started to give undergraduate students the opportunity to be involved with the research being done using grant money. Seminar titles and course content will vary depending on the stage of the research being conducted.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Seminar Required

Repeatable: Course can be repeated a maximum of 5 times.

Recommendations and additional information: Registration by permission only.

Field trip: One or more required field trips.

GEOS 497C: Dendrochronology (2 - 3 units)

Description: Hands-on, quantitative construction and assessment of dendrochronologies using software of the Dendrochronological Program Library and other computer resources.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Workshop Required

Equivalent to: ANTH 497C, WSM 497C

Co-convened with: GEOS 597C

Field trip: Field trip.

GEOS 497I: Practical Dendroclimatology (3 units)

Description: An intensive introduction to the practical application of dendrochronology to paleoclimatology.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Workshop Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: ANTH 497I, WSM 497I

Co-convened with: GEOS 597I

Field trip: One day and weekend field trip.

GEOS 497J: Dendroarchaeology (3 units)

Description: An intensive introduction to the practical application of dendrochronology to a selected topic drawn from archaeology, ecology, forest science, or geoscience.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$48

Course Components: Workshop Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: ANTH 497J, WSM 497J

Co-convened with: GEOS 597J

Field trip: One day trip and an eight day trip.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 497K: Dendroecology (3 units)

Description: Dendroecology is the study of ecology through the use of the tree-ring record. Ecological variables in the tree-ring record, theory and techniques of dendrochronology, applications to forest ecology. Lectures, laboratory training, and a multi-day field trip including data collection.

Grading basis: Regular Grades

Career: Undergraduate

Flat Fee: \$50

Course Components:	Laboratory	May Be Offered
	Lecture	May Be Offered
	Workshop	Required

Repeatable: Course can be repeated a maximum of 3 times.

Equivalent to: ECOL 497K

Co-convened with: GEOS 597K

Recommendations and additional information: Two semesters of Introductory Biology (ECOL 181-182 or equivalent) and one semester of Ecology (ECOL 302 or equivalent). Applicants with field experience but lacking course prerequisites may request consent of instructor.

Field trip: One required 3-4 days to SW forested sites to collect data and specimens for analysis.

GEOS 498: Senior Capstone (1 - 3 units)

Description: A culminating experience for majors involving a substantive project that demonstrates a synthesis of learning accumulated in the major, including broadly comprehensive knowledge of the discipline and its methodologies. Senior standing required.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

GEOS 498H: Honors Thesis (3 units)

Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated for a maximum of 9 units.

Enrollment requirement: Student must be active in the Honors College.

Honors Course: Honors Course

Honors Course: Honors Course

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 499: Independent Study (1 - 4 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Alternative Grading: S, P, F

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 499H: Honors Independent Study (3 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

Grading basis: Regular Grades

Career: Undergraduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

Enrollment requirement: Student must be active in the Honors College.

Honors Course: Honors Course

Honors Course: Honors Course

GEOS 500: Introduction to Geochemistry (3 units)

Description: Nuclear systematics and thermodynamics with applications to geologic processes. Graduate-level requirements include an independent research report.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 400

GEOS 502: Analytical and Numerical Modeling in Geosciences (3 units)

Description: Analytical and numerical solutions to partial differential equations and other models widely used in disparate fields of geosciences

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: ECOL 502, MCB 502

Also offered as: PTYS 502

Recommendations and additional information: MATH 129. Open to advanced undergraduates with strong mathematical backgrounds and consent of instructor and Graduate College.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 503: Physics of the Solar System (3 units)

Description: Survey of planetary physics, planetary motions, planetary interiors, geophysics, planetary atmospheres, asteroids, comets, origin of the solar system. Graduate-level requirements include an in-depth research paper on a selected topic and an oral class presentation.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: ASTR 503, GEOS 503

Also offered as: ASTR 503, PHYS 503, PTYS 503

Course typically offered:

Main Campus: Spring (odd years only)

Home department: Planetary Sciences

GEOS 504B: Lowell Program Topics in Ore Deposits Mapping (1 unit)

Description: This intensive course deals with methods in ore deposits mapping. It includes lectures and field trips, highlighting how geologic mapping is used to understand mineral zoning, time-space relations, and fundamental phase equilibria. Graduate-level requirements include additional reading material worth 20% of grade.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Laboratory	Required
	Lecture	May Be Offered

Repeatable: Course can be repeated for a maximum of 3 units.

Equivalent to: MNE 504B

Also offered as: MNE 504B

Co-convened with: GEOS 404B

Field trip: Field trips.

GEOS 504C: Lowell Program Topics in Mineral Deposit Types (1 unit)

Description: This intensive course covers the geology of selected types of mineral deposits, including their lithologic, structural, and geochemical features and applications to mineral exploration. The course includes lectures, laboratory exercises, and field trips to selected ore systems. Graduate-level requirements include more extensive reading and discussions during the course for 20% of grade.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Laboratory Lecture	May Be Offered Required
---------------------------	-----------------------	----------------------------

Repeatable: Course can be repeated for a maximum of 3 units.

Equivalent to: MNE 504C

Also offered as: MNE 504C

Co-convened with: GEOS 404C

Field trip: Field trips.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 505: Accessible Earth (Study Abroad in Italy) (6 units)

Description: The Accessible Earth Study Abroad Program targets senior level undergraduate and first/second year graduate students seeking to utilize modern Earth observation systems (e.g., satellite observation systems, ground-based Geophysical networks) and data science technologies in their Geoscience research. The Program is based in the beautiful Umbrian hilltop City of Orvieto, Italy, an exceptional location from which to reflect upon the history of science from the Renaissance to the Space Age, and gain an appreciation of the global scope of modern Earth observation systems, the societal relevance of Geoscience research, and the range of research topics that may be performed with a combination of instrumentation and data science technologies. From Orvieto, students will have ample opportunities to immerse themselves in Italian culture and history, as well as develop ideas for how to utilize 21st century technologies to further our understanding of the Earth system. A five-day field trip will touch on a wide range of Geoscience and related topics, including the tectonic history of the Mediterranean region, the Cretaceous-Paleogene boundary, the enigmatic geodynamics of the Northern Apennines orogen, past and modern coastal hazards along the Adriatic coast, present-day Geological processes in the Alps, Neolithic and Etruscan Archaeology, and other topics. From Orvieto, students will learn to use several software tools for acquiring, analyzing, and interpreting Earth observation data sets, including data transfer protocols, Bash and Python shell scripting, Generic Mapping Tools (GMT), iPython/Jupyter notebooks for interactive analysis and documentation, git and GitHub for version control, scientific collaboration, and social networking, and other software tools that are empowering modern scientific discovery.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 405

Recommendations and additional information: Limited to students in senior year of Geosciences or related 4-year degree program, or enrolled as graduate students in a Geoscience Masters or PhD program. Students expected to have at least 30 units of Geoscience coursework with minimum GPA of 2.75.

Field trip: A 5-day field trip will take place during early July. Points of interest on the field trip itinerary are as follows: Day 1- Frontale di Aprio. Day 2- City of Venice. Day 3- Vajont Dam. Day 4- Bolzano. Day 5- Return to Orvieto.

GEOS 508: Tectonic Petrology (3 units)

Description: Applications of igneous and metamorphic petrology to the regional tectonic study of continents. Course will have field trip. Graduate-level requirements include application of learned concepts to projects and interpretation of newly acquired data.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convener with: GEOS 408

Field trip: Course will have a field trip.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 509: Advanced Petrology (3 units)

Description: [Taught alternate years beginning Fall 2005]. An advanced treatment of the topic based primarily on the principles of thermodynamics, diffusion-kinetics, and heat transfer. Applications to quantitative understanding of P-T-t evolution of metamorphic rocks, and chemical and dynamic evolution of igneous rocks

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Recommendations and additional information: GEOS 583 or consent of instructor.

GEOS 510: Microbial Biogeochemistry and Global Change (3 units)

Description: Microbes are the drivers of planetary biogeochemistry. They produce half the oxygen on the planet, and fix half the carbon. They introduce bioavailable forms of nitrogen into the biosphere. If human life ceased to exist, the central biogeochemical cycles would continue turning. However, while the planet's biogeochemistry can persist readily in the absence of human life, that does not mean that humankind's presence lacks impact. The Anthropocene (era of human impact) has seen significant changes to planetary stocks and fluxes of C, N, S, etc. Many of these changes involve or impact microbes, and have significant impacts on biogeochemical cycles. To understand microbial biogeochemistry in today's world, one must include the context of global change. And, conversely, one cannot understand the trajectory of global change without understanding microbial feedbacks via biogeochemical cycles. In this interdisciplinary undergraduate and graduate class we will cover major microbial biogeochemical cycles, and how these cycles are impacted by, and feedback to, global change. To understand the research in this area, we will discuss current methods in both microbial ecology and biogeochemistry, ranging from molecular meta-omics to the use of isotopes as biogeochemical tracers, with a particular emphasis on the challenges and opportunities of integrating these two disciplines. Lectures will be mixed with journal club-style readings and discussions, so active participation is essential. This course is designed for graduate students from diverse backgrounds and advanced undergraduates. Graduate-level requirements include (i) a twice-as-extensive background reading and synthesis component for their final presentation as the undergraduates, (ii) an active leadership role in group discussions.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Also offered as: ECOL 510, ENVS 510, PLS 510

Co-convened with: GEOS 410

Course typically offered:

Main Campus: Spring

Recommendations and additional information: Background in biology or biogeochemistry, and openness to interdisciplinary learning.

Home department: Soil, Water, & Environmental Sciences

Interdisciplinary Interest Area: ECOL - Ecology & Evolution Bio

Interdisciplinary Interest Area: GEOS - Geosciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 512A: Geoarchaeology (3 units)

Description: Applications of earth sciences in addressing archaeological questions, emphasizing past landscapes and environments, and site formation. The focus is on stratigraphy, sedimentology, soils, and geomorphology.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOS 512A

Also offered as: ANTH 512A

Course typically offered:

Main Campus: Spring

Recommendations and additional information: One course in archaeology, and one course in geology or physical geography, or consent of instructor.

Field trip: A one-day field trip, and a three-day field trip.

Home department: School of Anthropology

GEOS 514: Quaternary Geology (3 units)

Description: [Taught alternate years beginning Spring 2004]. Principles of Quaternary stratigraphy emphasizing geochronology, terrestrial processes, stratigraphic records, regional correlation, and comparisons with the deep ocean record and models of climate change.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: ANTH 514

Also offered as: ANTH 514

Recommendations and additional information: GEOS 251.

Field trip: Field trip.

GEOS 516: Field Studies in Geophysics (3 units)

Description: Seismic, magnetic, electrical, and gravity exploration techniques. Graduate-level requirements include additional project work requiring a more in-depth analysis.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: GEOS 516

Also offered as: GEN 516

Co-convened with: GEOS 416

Course typically offered:

Main Campus: Spring

Recommendations and additional information: GEN 548.

Field trip: Field trips.

Home department: Mining & Geological Engineering

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 517: Sedimentary Basin Analysis (3 units)

Description: Physical mechanisms of sedimentary basin formation, including flexure, thinning and thermal contraction of the lithosphere; isostasy; subsidence analysis; sequence stratigraphy; paleocurrents and sediment provenance; tectonics of sedimentary basins. Graduate-level requirements include an independent research project.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$50

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convended with: GEOS 417

Recommendations and additional information: GEOS 544.

GEOS 518: Geometallurgy (4 units)

Description: This course is designed to introduce students to the theory and practice of geometallurgy and the role of mineralogy in mine planning, ore processing, and mine development. Topics include spatial distribution and variability of minerals in ore deposits, mineral behavior and element deportment during ore processing, and industry practices in geometallurgical sampling, testing, materials characterization, and planning. The laboratory section introduces industrial methods of mineral characterization (including SEM, XRD, and MLA) and provides hands-on examination of mineral processing samples from various deposit types.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Laboratory	Required
	Lecture	Required

Also offered as: MNE 518

Co-convened with: GEOS 418

Course typically offered:

Main Campus: Spring

Online Campus: Spring

Field trip: Freeport-McMoRan Process Technology Center (Valencia Road, Tucson)

Home department: Mining & Geological Engineering

GEOS 519: Physics of the Earth (3 units)

Description: Fundamentals of the physics of the solid earth, including thermodynamics, rheology, geomagnetism, gravity, and plate tectonics. Graduate-level requirements include a term paper in publication format on some aspect of a major course topic.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: PTYS 519

Also offered as: PTYS 519

Co-convened with: GEOS 419

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 520: Meteorites (3 units)

Description: Classification; chemical, mineralogical and isotopic composition; cosmic abundances; ages; interaction with solar and cosmic radiation; relation to comets and asteroids.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOS 520

Also offered as: PTYS 520

Recommendations and additional information: PTYS 510.

Home department: Planetary Sciences

GEOS 521: Petroleum Geology and Geophysics (4 units)

Description: This course will explore the geology of petroleum systems, including the geologic conditions and processes that control the formation of the essential elements of a petroleum system and the technological tools and methods that are used in petroleum exploration, with an emphasis on case studies and exercises from a broad range of global tectonic settings.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Laboratory	Required
	Lecture	Required

Co-convened with: GEOS 421

GEOS 522: Critical Zone Science & Management (3 units)

Description: This course targets undergraduate science majors and graduates interested in learning more about integrated and interdisciplinary team science while learning about the cross-cutting research and observational strategies employed across NSF's Critical Zone Observatory network. At least half of the course will focus on guided data analysis based on CZO data sets. Graduate-level requirements include working with more complex data sets and a 10-page research paper. In general, most seasonal-annual or multi-site data sets will qualify. Please discuss with your instructor prior to turning in a research paper proposal.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Also offered as: ENVS 522, HWRS 522

Co-convened with:

Recommendations and additional information: Class participants must have completed at least one university/college-level lab-based science course and mathematics through pre-calculus

Home department: Soil, Water, & Environmental Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 523: Regional Structural Geology (3 units)

Description: [Taught alternate years beginning Fall 2004]. Geologic mapping in a variety of rock types and structural regimes, with emphasis on the recognition and solution of regionally significant structural problems. Graduate-level requirements include additional reading assignments on structural processes and regional geology.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$100

Course Components:	Lecture	Required
---------------------------	---------	----------

Repeatable: Course can be repeated a maximum of 4 times.

Co-convended with: GEOS 423

Field trip: field trip

GEOS 524A: Space Geodesy (3 units)

Description: Introduction to space geodesy with application to the Earth Sciences. Course provides an overview of modern techniques (GPS, InSAR, etc.), with emphasis on the principles of the Global Positioning System. Applications include plate motions, earthquakes/volcano deformation, Earth orientation, and atmospheric studies.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 424A

GEOS 525: Regional Tectonics (3 units)

Description: Survey of tectonic processes operating within continents, along continental margins, and on the ocean floor. Graduate requirements include writing a 10-page research paper that addresses a significant problem in regional tectonics.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$100

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 425

Field trip: Field Trip

GEOS 527: Orogenic Systems (3 units)

Description: An analysis of the geology, geophysics, and geochemistry, and the tectonic evolution of selected world mountain systems ranging from currently active belts in both oceanic and continental settings back through Phanerozoic, Proterozoic, and into Archean time. Graduate-level requirements include an oral presentation of the term project and additional content for home work and mid-term exam.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convended with: GEOS 427

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 528: Crustal Deformation (3 units)

Description: A detailed overview of the physics of earthquakes and faulting, and mechanical models of crustal deformation. This course will provide a review of the most commonly applied models for crustal deformation, developed from first principles. Topics may include the earthquake cycle, simple models for interseismic and coseismic deformation associated with infinite and finite length faults, the physics of earthquakes and faulting, heterogeneous elastic Earth models, time-dependent deformation associated with viscoelastic and poroelastic rheologies, volcano deformation, and similar topics.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Recommendations and additional information: MATH 129, PHYS 151. Basic familiarity with scientific computation.

GEOS 529: Objective Analysis in the Atmospheric and Related Sciences (3 units)

Description: This graduate course provides an overview of statistical methods used to interpret datasets in the atmospheric and related sciences. The objective is to provide a working knowledge of the statistical tools most commonly used. Topics include application of basic statistics (composite analysis; significance testing; curve fitting; regression analysis; correlation; and non-normal distributions), non-parametric statistical significance testing (e.g. Monte-Carlo methods and field significance), matrix methods (principal component analysis; SVD analysis; CCA), and time series analysis (harmonic analysis; power spectra; data filtering; cross-spectrum analysis; singular spectrum analysis; and wavelet analysis).

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOG 529. GEOS 529. HWRS 529

Also offered as: ATMO 529, GEOG 529, HWRS 529

Course typically offered:

Main Campus: Fall (odd years only)

Recommendations and additional information: Undergraduate level statistics course and linear algebra required. Computer programming skills (C, Fortran, Matlab) and knowledge of graphical display packages needed or consent of instructor.

Home department: Hydrology and Atmospheric Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 530: The Chemical Evolution of Earth (3 units)

Description: [Taught alternate years beginning Fall 2004]. Chemical differentiation and evolution of Earth's mantle and crust according to major-element, trace-element and isotopic characteristics of neodymium, hafnium, strontium, lead and other isotopes. Graduate-level requirements will include an additional paper.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: PTYS 530

Also offered as: PTYS 530

Co-convened with: GEOS 430

Field trip: Field trips.

GEOS 531: Hydrogeology (4 units)

Description: Hydrologic and geologic factors controlling the occurrence and dynamics of groundwater on regional and local scales. Graduate-level requirements include a research paper on a topic related to hydrogeology but not covered in lectures.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$20

Course Components:	Laboratory Lecture	May Be Offered Required
---------------------------	-----------------------	----------------------------

Equivalent to: GEOS 531

Also offered as: HWRS 531

Co-convened with:

Course typically offered:

Main Campus: Fall

Home department: Hydrology and Atmospheric Sciences

GEOS 532: Introduction to Seismology (3 - 5 units)

Description: Fundamentals of the generation, propagation, and interpretation of seismic waves. Two sections: earthquake seismology and exploration seismology. Sections meet together for introduction then students choose one (3 units) or both (5 units) for the remainder of the semester. Graduate-level requirements include a term paper.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convended with: GEOS 432

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 534A: Introduction to Exploration Seismology (3 units)

Description: Fundamental theory of seismic wave propagation, and techniques of seismic reflection and refraction data acquisition and interpretation applied to exploration of the Earth's lithospheric structure and natural resources. Study of methods to image the crust in 2-D and 3-D. Graduate-level requirements include development of an additional term project. Projects are more heavily weighted in determining the total grade.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convener with: GEOS 434A

GEOS 535: Advanced Subsurface Hydrology (3 units)

Description: Advanced aquifer and well hydraulics; heterogeneity, unsaturated flow; natural and artificial recharge; ground-water and surface-water interaction; mass and heat transport.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOS 535

Also offered as: HWRS 535

Course typically offered:

Main Campus: Spring

Recommendations and additional information: MATH 250B or MATH 254 or MATH 355.

Home department: Hydrology and Atmospheric Sciences

GEOS 536: Earthquakes and Volcanic Systems: Processes and Hazards (3 units)

Description: The course will focus on the processes and properties associated with earthquake sources and volcanic systems and how these properties affect the hazards associated with these events. Lectures will focus on derivations of common equations used to study these systems and discussions on recent publications related to the modeling of earthquake sources and volcanic eruptions. Students will lead discussions on relevant papers and final projects will involve writing summary papers and applying modeling techniques discussed in the class to carry out original analyses.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 436

Course typically offered:

Main Campus: Fall

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 537: Introduction to Earth-System Modeling (4 units)

Description: This course will introduce the basic concepts of numerical modeling of the climate system. The course material will cover: basic processes that shape Earth's climate; application of model hierarchies in climate science; how model predictions of both past and future climates are used to inform policy.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 437

Course typically offered:

Main Campus: Fall

Recommendations and additional information: GEOS 280 and (MATH 122B or MATH 125.)

Field trip: No

GEOS 538: Biogeography (3 units)

Description: The role of historical events and ecological processes in determining the past and present geographic distribution of plants and animals. Graduate-level requirements include a research paper.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: ECOL 538, GEOS 538

Also offered as: ECOL 538, GEOG 538

Co-convened with: GEOS 438

Course typically offered:

Main Campus: Fall

Home department: School of Geography and Development

GEOS 539A: Introduction to Dendrochronology (4 units)

Description: Survey of dendrochronological theory and methods. Applications to archaeological, geological, and biological dating problems and paleoenvironmental reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. Graduate-level requirements include a research paper reviewing critically some aspect of dendrochronology.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$85

Course Components: Laboratory Required

Lecture	Required
---------	----------

Equivalent to: ANTH 539A, GEOG 539A, WSM 539A

Also offered as: ANTH 539A, GEOG 539A, WSM 539A

Co-convened with: GEOS 439A

Field trip: Field trip.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 540: Geodynamics (3 units)

Description: Large-scale tectonic problems approached by combined geophysical and geologic analysis in regional context. Graduate-level requirements include a quantitative modeling project in some aspect of tectonics and a publication-format paper.

Grading basis: Regular Grades

Career: Graduate

Course Components: Laboratory May Be Offered
 Lecture Required

Repeatable: Course can be repeated a maximum of 2 times.

Co-convened with: GEOS 440

GEOS 541: Soils and Landscapes of Arizona (3 units)

Description: Physical and chemical processes and mineralogy of weathering and soil formation; quantitative pedology; the soil as part of the ecosystem.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOS 541, SW 541

Also offered as: ENVS 541

Course typically offered:

Main Campus: Spring (odd years only)

Recommendations and additional information: GEOS 251, CHEM 103B.

Home department: Environmental Science

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 542: Mars (3 units)

Description: In-depth class about the planet Mars, including origin and evolution, geophysics, geology, atmospheric science, climate change, the search for life, and the history and future of Mars exploration. There will be guest lectures from professors and research scientists with expertise about aspects of Mars. The course may include visits to Mars exploration centers at the University of Arizona and Arizona State University. There will be lots of discussion of recent results and scientific controversies about Mars. All students are expected to have a knowledge of basic calculus. Graduate-level requirements include the completion of a research project that will be presented in class as well as a report. The research project could be analysis of Mars datasets, a laboratory experiment, or new theoretical modeling.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: ASTR 542, GEOS 542

Also offered as: ASTR 542, PTYS 542

Co-convened with:

Course typically offered:

Main Campus: Spring (odd years only)

Recommendations and additional information: PTYS 511, Geology of the Solar System is strongly recommended but not required.

Home department: Planetary Sciences

GEOS 543C: Geologic Best Practices and Project Stages (3 units)

Description: This course introduces communication and leadership terminology as applied to project management in mineral exploration and mining, then examines the stages through which projects advance and how best practices in geology are achieved at the various stages.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: MNE 543C

Also offered as: MNE 543C

Field trip: Course includes field trips.

GEOS 543D: Sustainable Development and Mineral Resources (2 units)

Description: This survey course covers the breadth of mineral resources development from both mining and non-mining perspectives. The course is intended to provide a broad, interdisciplinary overview of topics for graduate students interested in mineral resources topics who wish to learn more about the scope, current issues and future challenges.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Repeatable: Course can be repeated a maximum of 3 times.

Also offered as: MNE 543D

Field trip: One or two day-long field trips to relevant areas in southern Arizona.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 544: Advanced Physical Sedimentology (3 units)

Description: First half of course deals with mechanics of flows and sediment transport, oscillatory and unidirectional flows, waves and wave theory, bedforms and flow regimes, sediment gravity flows, liquefaction and fluidization. Second half covers physical processes and facies in alluvial fan, fluvial, eolian, deltaic, nearshore, shelf, slope and turbidite fan systems. Emphasis is on clastic systems.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$47

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: GEN 544

Recommendations and additional information: GEOS 302 and MATH 254 or consent of instructor.

GEOS 546: Economic Mineral Deposits (3 units)

Description: Geology of metallic and nonmetallic ore deposits. Economic considerations, processes of formation, methods of study and exploration, and description of geologic aspects and settings of representative worldwide examples. Graduate-level requirements include an independent study project.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convended with: GEOS 446

Field trip: Field trip

GEOS 547: Global and Regional Climatology (3 units)

Description: Description and analysis of the atmospheric circulation process that produces differences in climates throughout the world. Emphasis on the earth's problem climates and climatically sensitive zones most susceptible to floods, droughts, and other environmental stresses due to global change. Graduate-level requirements include an additional term paper.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Also offered as: GEOG 547

Co-convened with: GEOS 447

Course typically offered:

Main Campus: Spring

Home department: School of Geography and Development

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: Principles of gravity, magnetic, seismic and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources. Graduate-level requirements include a special research project collecting and interpreting geophysical field data.

Career: Graduate

Equivalent to: GEOS 548

Also offered as: GEN 548

Co-convened with: GEOS 448

Course typically offered:

Main Campus: Fall

GEOS 549: Radar Remote Sensing of Planetary Surfaces (4 units)

Description: This graduate course will focus on the use of radar remote sensing for studies of planetary surfaces, including rocky and icy objects. It will cover the basics of how radar works including SAR and sounding (ground penetrating) radar, the use of different frequencies, an introduction to electromagnetic wave propagation including polarimetry, radar data processing, and the use of radar field equipment. The course will include a discussion of some of the past, current and future radars included on spacecraft and their design and science results. The course will be focused on geosciences; in particular, applications relevant to planetary processes such as regolith development, volcanism, cratering, fluvial deposits etc. This class includes 3 hours/week lecture plus a lab and fieldwork component.

Grading basis: Regular Grades

Career: Graduate

Also offered as: PTYS 549

Course typically offered:

Main Campus: Spring

Recommendations and additional information: Field work (trips of 1 or 2 days) will involve using ground penetrating radar and other instruments to investigate subsurface stratigraphy. Lab component may involve demonstrations, work on in-lab radar equipment, testing, field trip preparation.

Field trip: Yes

Home department: Planetary Sciences

-**CC** represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 550: Geomorphology (4 units)

Description: Processes, form, and dynamics of the fluvial system from source to mouth. Introduction to aeolian, glacial, and planetary geomorphology. Graduate-level requirements include additional discussion section once a week.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$25

Course Components:	Laboratory	May Be Offered
	Lecture	Required

Equivalent to: ARL 550, ARL 550

Also offered as: ARL 550, GEOG 550

Co-convened with: GEOS 450

Field trip: Field trip.

GEOS 551: Remote Sensing of Planetary Surfaces (4 units)

Description: This graduate course will focus on the use of remote sensing in the study of rocky and icy planetary surfaces. It is not a science course, but rather intended to provide technical knowledge of how instruments work and practical techniques to deal with their datasets. In this course, we will cover how different types of remote-sensing instruments work in theory and practice along with case studies (student-led) of specific planetary science instruments. We will discuss what datasets are generated by these instruments, their limitations and where they can be located. Lab sessions will provide experience in how these data are processed, visualized and intercompared. The class consists of two lectures and a 2.5-hour lab session each week.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Laboratory	Required
	Lecture	Required

Also offered as: PTYS 551

Course typically offered:

Main Campus: Fall (even years only)

Recommendations and additional information: Strong undergraduate background in math, physics, chemistry, and geoscience; introductory courses in remote sensing, GIS, planetary science, or astronomy.

Home department: Planetary Sciences

GEOS 553: Glacial and Quaternary Geology (3 units)

Description: [Taught alternate years beginning Spring 2005]. Glacial processes, landforms, and deposits. Physical aspects of Quaternary paleoenvironmental change and effects on fluvial, eolian, lacustrine, weathering, and mass movement processes. Graduate-level requirements include an independent research project or term paper in publication format.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 453

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 554: Evolution of Planetary Surfaces (3 units)

Description: The geologic processes and evolution of terrestrial planet and satellite surfaces including the Galilean and Saturnian and Uranian satellites. Course includes one or two field trips to Meteor Crater or other locales.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$195

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: GEOS 554

Also offered as: PTYS 554

Course typically offered:

Main Campus: Fall (odd years only)

Home department: Planetary Sciences

GEOS 555: Introduction to Atmospheric and Hydrology Remote Sensing (3 units)

Description: The purpose of this course is to introduce the basic remote sensing techniques and their applications to the atmosphere, hydrology and other fields. This includes understanding the basic concepts of radiation transfer, passive and active remote sensing, satellite and ground-based remote sensing and their retrieval techniques. Finally, inversion techniques in remote sensing will be briefly introduced and the uncertainties/errors of the retrieved cloud and precipitation properties will be estimated. Graduate students will do some homework, but primarily work on processing and analyzing the aircraft, ground-based and satellite remote sensing data collected from instructors research projects. Graduate students will get hands-on experience by doing these projects using IDL, MATLAB, FORTRAN, or other programs. For some projects, I may provide key codes as a reference.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Also offered as: ARL 555, ATMO 555, ENVS 555, HWRS 555, OPTI 555, REM 555

Course typically offered:

Main Campus: Spring

Home department: Hydrology and Atmospheric Sciences

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 556: Thrust Belts and Synorogenic Sediments (3 units)

Description: Geometry and mechanics of thrust faults and thrust belts; tectonics of contractional orogenic belts; geomorphology of thrust belts and foreland basin system; depositional systems and provenance of foreland basin sediments; application of orogenic-wedge models. Graduate-level requirements include an in-depth research paper on a single aspect of the course topic.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$100

Course Components:	Lecture	Required
---------------------------	---------	----------

Repeatable: Course can be repeated a maximum of 5 times.

Equivalent to: WSM 556

Co-convened with: GEOS 456

GEOS 560: Characterization and Identification of Minerals (3 units)

Description: This course will provide theoretical and practical training in the procedures of X-ray diffraction, Raman spectroscopy and electron microprobe techniques, used to characterize minerals and identify unknown samples. Students will learn to use the equipment and interpret results. Graduate-level requirements include demonstrating deeper understanding of the physics behind the experimental phenomena

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: GEN 560

Co-convened with: GEOS 460

GEOS 561: Paleoindian Origins (3 units)

Description: Chronological development of Paleo-Indian occupation of the New World in relation to environmental changes of the Quaternary Period; site discoveries, case studies, hypothesis on the peopling of the Americas.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Equivalent to: GEOS 561

Also offered as: ANTH 561

Course typically offered:

Main Campus: Fall, Spring

Field trip: Field trip.

Home department: School of Anthropology

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: An examination of stable isotopes in paleoenvironmental reconstruction, emphasizing O, C, H and N isotopes in the ocean, rivers, ice, lakes, soils, speleothems, and fossils. The class includes in-class presentations and a lab project. Graduate-level requirements include additional in-class presentations and a more rigorous grading scale.

Career: Graduate

Equivalent to: WSM 566

GEOS 567: Inverse Problems in Geophysics (3 units)

Grading basis: Regular Grades

Career: Graduate

Equivalent to: ATMO 567, PTYS 567

Also offered as: PTYS 567

Recommendations and additional information: Experience with linear algebra recommended.

Interdisciplinary Interest Area: ATMO - Atmospheric Sciences

Description: Fundamental theory and practical applications of time-series analysis and digital filtering. A problem-solving approach to seismic reflection data process. Graduate-level requirements include a special research project.

Grading basis: Regular Grades

Career: Graduate

Co-convened with: GEOS 469

Description: Hand specimen and petrographic examination of volcanic rocks; geologic map exercises; field trips with geologic mapping exercises. Graduate students requirement includes completing a group project with an oral presentation.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$30

Co-convener with: GEOS 470L

Recommendations and additional information: Concurrent registration, GEOS 570R.

Field trip: Field trips with geologic mapping exercises.

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 570R: Volcanology: Physical Processes and Petrologic Applications (3 units)

Description: Physical and chemical properties of magmas; physical volcanology of silicic, intermediate, mafic, and ultramafic magmas, with applications to petrology, extraterrestrial volcanism, mineral deposits, and society. Graduate-level requirements include writing a research paper in the middle of the course.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 470R

Recommendations and additional information: Concurrent registration, GEOS 570L.

GEOS 572: Global Biogeochemical Cycles (3 units)

Description: Study of processes affecting global chemical fluxes. Particular attention to current global concerns, i.e., ozone hole, carbon cycle, climate warming, atmospheric oxidation, hydrologic cycle.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: GEOS 572, HWRS 572

Also offered as: GC 572, HWRS 572

Home department: Committee on Global Change

GEOS 573: Earth System Modeling (3 units)

Description: This course will focus on use of numerical methods to solve partial differential equations of geophysical fluid dynamics; computational design and working of the Earth system model and its critical components; procedures to run and modify the Earth system model; model applications to important climate issues.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Also offered as: ATMO 573

Recommendations and additional information: ATMO 441A, computer programming skills (C, Fortran, Matlab)

GEOS 574A: Geochronology and Thermochronology (3 units)

Description: This class will familiarize students with principles of geochronology and thermochronology and applications in Earth and planetary sciences. Topics will include radioactive decay and growth, long- and short-lived radioisotope systems, analytical methods, determining dates and rates of a wide variety of events and processes, and the use of radiogenic isotopes as tracers in Earth and planetary processes. Graduate-level requirements include an additional problem set and final project presentation.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 577: Active Tectonics (3 units)

Description: Regional and subregional examination of faulting, folding, uplift, subsidence, collapse, volcanism, and mass wasting associated with active contemporary deformations of the Earth's crust. Emphasis includes impact on human society. Graduate-level requirements include leadership role on field trips and a special presentation.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 477

Field trip: Field trip

GEOS 578: Global Change (3 units)

Description: Analysis of the Earth system through an examination of its component parts (particularly climate and biogeochemistry) and their interactions with human activities, emphasizing information needed to understand modern and future environmental changes. Graduate-level requirements include an in-depth written exercise and additional activities as described in the syllabus.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Equivalent to: ECOL 578, GC 578, GEOG 578, HWRS 578, HYDR 578, RNR 578, SW 578

Also offered as: ECOL 578, GC 578, GEOG 578, HWRS 578, RNR 578

Co-convened with: GEOS 478

Course typically offered:

Main Campus: Fall

Interdisciplinary Interest Area: ECOL - Ecology & Evolution Bio

GEOS 579: Introduction to Climate Dynamics (3 units)

Description: The course will cover the interactions between the different components of the climate system including the atmosphere, ocean, sea/land ice, etc., and the dominant feedbacks so that students can understand the working of the climate system and the mechanisms governing its variability and response to external perturbations. Graduate-level requirements include a final paper and presentation. The students choose the topics with the help of instructors, which maybe related to their dissertation research.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 479

Recommendations and additional information: MATH 124.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

Description: Fundamental principles of stable, radiogenic, and cosmogenic isotope chemistry of natural waters; geochemical processes affecting isotopic compositions of surface waters, soil waters, and groundwaters; and case studies of isotope hydrogeology. Mandatory field trip: Sampling surface- and ground-waters in Tucson Basin, field methods in isotope hydrogeology. Graduate-level requirements include a facsimile research grant proposal (i.e., as if writing proposal to a government grant agency), including abstract, of not less than 10 pages; the grade will be based on both the written paper as well as oral presentation of the research proposal to the class.

Career: Graduate

Equivalent to: GEOS 580

Also offered as: HWRS 580

Co-convened with:

Course typically offered:

Main Campus: Spring

Field trip: Sampling surface- and ground-waters in Tucson Basin, field methods in isotope hydrogeology.

Home department: Hydrology and Atmospheric Sciences

Description: Topics in paleoclimatology including prediction of paleoclimatic patterns, proxy paleoclimatic indicators, and paleoclimatic cycles. Graduate-level requirements include an additional research project.

Career: Graduate

Co-convened with: GEOS 482

Description: This course examines the interplay of changes in earth environments and biological evolution from the earliest life to the present. The focus is geochemical and topics include the early earth and life, evolutionary jumps, mass extinctions, and the rise of hominids. Graduate level requirements include multiple in-class presentations/reviews on journal articles.

Career: Graduate

Flat Fee: \$31

Also offered as: ASTR 584, PTYS 584

Co-convener with: GEOS 484

Recommendations and additional information: Calculus II (MATH 129) or consent of the instructor.

Field trip: 2-3 field trips to geologic localities near Tucson, Arizona.

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 585A: Applied Time Series Analysis (1 - 3 units)

Description: [Taught alternate years beginning Spring 2005]. Analysis tools in the time and frequency domains are introduced in the context of sample data sets drawn from ecology, hydrology, climatology and paleoclimatology. Students optionally use their own data in assignments applying methods.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
	Workshop	May Be Offered

Recommendations and additional information: An undergraduate statistics course.

GEOS 586: Organic Geochemistry (3 units)

Description: This course offers an introduction to, and broad overview of, the field of Organic Geochemistry - the structure and fate of organic molecules in the geosphere. Students interested in using organic geochemical techniques in an academic, environmental, or petroleum industry setting will find this course useful as a rigorous introduction to the discipline. Graduate level requirements include the completion of an additional laboratory-based research project, the writing a research paper that summarizes the results of this project, and a brief presentation to the class summarizing the project and outcomes.

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 486

GEOS 587: Physical and Dynamical Oceanography (3 units)

Description: The course will introduce the physical properties of seawater including the three-dimensional structures of ocean temperature, salinity and density, their mean states, seasonal and interannual variability and long-term change. The heat, salt and mass budgets of the world oceans will be discussed, with emphasis on the role of the ocean in the climate system. The course will introduce basic concepts and general principles of ocean dynamics to understand large-scale ocean circulation, including wind-drive and density-driven (thermohaline) circulation. Special topics focus on the formation of the western boundary currents (the Gulf Stream), ocean waves and tides, ENSO dynamics, and coastal ocean processes (sea level rise and storm surge).

Grading basis: Regular Grades

Career: Graduate

Course Components:	Lecture	Required
---------------------------	---------	----------

Co-convened with: GEOS 487

Course typically offered:

Main Campus: Fall

Field trip: No

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 589: Quaternary Geochronology (3 units)

Description: Review of quantitative dating techniques for Quaternary geologists, including ¹⁴C, U-series, in situ cosmogenic radionuclides, TL, amino acids and others. Graduate-level requirements include an in-depth research paper project on a single aspect of the course topic.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Co-convened with: GEOS 489

GEOS 590: Remote Sensing for the Study of Planet Earth (3 units)

Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$50

Course Components: Lecture Required

Equivalent to: ARL 590, ARL 590, ATMO 590, GEN 590, GEOG 590, GEOS 590, HWRS 590, MNE 590, OPTI 590, RNR 590, SW 590, SWES 590

Also offered as: ARL 590, ATMO 590, ENVS 590, GEOG 590, HWRS 590, MNE 590, OPTI 590, REM 590, RNR 590

Co-convened with: GEOS 490

Course typically offered:

Main Campus: Fall

Home department: GIDP on Remote Sensing and Spatial Analysis

GEOS 594: Practicum (1 - 4 units)

Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 595A: Topics in Geosciences (1 unit)

Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Colloquium Required

Repeatable: Course can be repeated a maximum of 2 times.

GEOS 595E: Topics in Dendrochronology (1 - 4 units)

Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

Grading basis: Regular Grades

Career: Graduate

Course Components: Colloquium Required

Repeatable: Course can be repeated for a maximum of 9 units.

Equivalent to: WSM 595E

Also offered as: WSM 595E

GEOS 596A: Mineralogy-Petrology-Geochemistry (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

GEOS 596B: Economic Geology (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

GEOS 596C: Geomorphology-Quaternary Geology (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 596D: Paleontology-Sedimentary Geology (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

Equivalent to: ANTH 596D

Also offered as: ANTH 596D

GEOS 596E: Structure-Tectonics (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

Field trip: Field trip

GEOS 596F: Geophysics (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 596G: Water-Rock-Microbial Interactions (3 units)

Description: Advanced topics in aqueous geochemistry and geomicrobiology will be discussed from current literature. Students will gain an understanding of how waters evolve through, and are influenced by, the hydrologic cycle via reactions with minerals, organic matter, and biologic processes. Strong emphasis on field and laboratory analyses, coupled with geochemical modeling. Course will greatly expand on topics from HWRS 517 and be tailored to students' research interests.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Equivalent to: AREC 696G, GEOS 696G, SIE 696G

Also offered as: HWRS 596G

Course typically offered:

Main Campus: Fall (odd years only)

Recommendations and additional information: Consent of instructor.

Home department: Hydrology and Atmospheric Sciences

GEOS 596H: Geosciences (1 - 4 units)

Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

Grading basis: Regular Grades

Career: Graduate

Course Components: Seminar Required

Repeatable: Course can be repeated for a maximum of 6 units.

Equivalent to: CLAS 596H

GEOS 597B: Field School in Egyptian Archaeology (1 - 6 units)

Description: Archaeological excavation training program that provides an opportunity to engage in all phases of fieldwork. Field techniques include: mapping, remote sensing, trench supervision, and artifact drawing and analysis. Offered on archaeological sites in Egypt or in museums.

Grading basis: Regular Grades

Career: Graduate

Course Components: Workshop Required

Also offered as: ANTH 597B, ARH 597B, MENA 597B

Recommendations and additional information: Application to instructor not later than December 1st. Permission of instructor required. Knowledge of archaeological methods and ancient Egyptian history and culture would be helpful.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 597C: Dendochronology (2 - 3 units)

Description: Hands-on, quantitative construction and assessment of dendrochronologies using software of the Dendrochronological Program Library and other computer resources.

Grading basis: Regular Grades

Career: Graduate

Course Components: Workshop Required

Equivalent to: ANTH 597C, WSM 597C

Also offered as: ANTH 597C, WSM 597C

Co-convened with: GEOS 497C

GEOS 597I: Practical Dendroclimatology (3 units)

Description: An intensive introduction to the practical application of dendrochronology to paleoclimatology. Graduate-level requirements include synthesis and presentation of analytical results.

Grading basis: Regular Grades

Career: Graduate

Course Components: Workshop Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: ANTH 597I, WSM 597I

Also offered as: ANTH 597I, WSM 597I

Co-convened with: GEOS 497I

Field trip: One day and weekend field trip.

GEOS 597J: Dendroarchaeology (3 units)

Description: An intensive introduction to the practical application of dendrochronology to a selected topic drawn from archaeology, ecology, forest science, or geoscience. Graduate-level requirements include synthesis and presentation of analytical results.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$48

Course Components: Workshop Required

Repeatable: Course can be repeated a maximum of 2 times.

Equivalent to: ANTH 597J, WSM 597J

Also offered as: ANTH 597J, WSM 597J

Co-convened with: GEOS 497J

Field trip: One day trip and an eight day trip.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 597K: Dendroecology (3 units)

Description: Dendroecology is the study of ecology through the use of the tree-ring record. Ecological variables in the tree-ring record, theory and techniques of dendrochronology, applications to forest ecology. Lectures, laboratory training, and a multi-day field trip including data collection. Graduate-level requirements include a brief paper on an applied problem in dendroecology and make a presentation to the class.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$50

Course Components:	Laboratory	May Be Offered
	Lecture	May Be Offered
	Workshop	Required

Repeatable: Course can be repeated a maximum of 3 times.

Equivalent to: ECOL 597K

Co-convened with: GEOS 497K

Field trip: One required 3-4 days to SW forested sites to collect data and specimens for analysis.

Interdisciplinary Interest Area: ECOL - Ecology & Evolution Bio

GEOS 599: Independent Study (1 - 4 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 646A: Advanced Ore Deposit Geology (4 units)

Description: Geology, characteristics and origins of ore deposits in igneous, sedimentary, and metamorphic rocks. Laboratories include field trips, analytical techniques, problem solving.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Recommendations and additional information: GEOS 446 or GEOS 546.

Field trip: Field trip

GEOS 646B: Advanced Ore Deposits II (4 units)

Description: Geology, characteristics and origins of ore deposits in igneous, sedimentary, and metamorphic rocks. Laboratories include field trips, analytical techniques, problem solving.

Grading basis: Regular Grades

Career: Graduate

Course Components: Lecture Required

Repeatable: Course can be repeated a maximum of 2 times.

Recommendations and additional information: GEOS 546.

Field trip: Field trip

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 650: Field Studies in Geomorphology (3 units)

Description: Field mapping exercises in geomorphology.

Grading basis: Regular Grades

Career: Graduate

Flat Fee: \$44

Course Components: Lecture Required

Recommendations and additional information: GEOS 450.

Field trip: Field trip.

GEOS 695G: Global Change Toolkit (1 unit)

Description: Course will provide student with a foundational background, vocabulary, and communication skills necessary for successful engagement in advanced interdisciplinary scholarly research on global change issues.

Grading basis: Regular Grades

Career: Graduate

Course Components: Colloquium Required

Also offered as: GC 695G

Recommendations and additional information: Student must be enrolled at the graduate-level in a global-change related discipline.

GEOS 900: Research (1 - 6 units)

Description: Individual research, not related to thesis or dissertation preparation, by graduate students.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 909: Master's Report (1 - 9 units)

Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

GEOS 910: Thesis (1 - 6 units)

Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

GEOS 920: Dissertation (1 - 9 units)

Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).

Grading basis: Alternative Grading: S, P, F

Career: Graduate

Course Components: Independent Study Required

Repeatable: Course can be repeated a maximum of 99 times.

-SA represents a Student Abroad & Student Exchange offering

-CC represents a Correspondence Course offering

May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.