Geochemistry

The Geochemistry program offers an undergraduate degree in Earth Science with Geochemistry Option. See page 75.

Master of Science in Geochemistry

The Master of Science degree in Geochemistry may be earned either with thesis or without thesis in accordance with the general requirements of the Graduate Program.

The master's candidate must demonstrate competence in chemistry, geology, mathematics, and physics comparable to the requirements for the Bachelor of Science degree in either chemistry, one of the engineering sciences, or one of the geological sciences.

A program of study for the master's degree must be approved by the student's advisory committee and must satisfy the general requirements for the degree, including GEOP 590 (at least three credit hours) or GEOC 591 (at least six credit hours). Students must complete two credit hours of GEOC 592, at least four credit hours of GEOC 593 (unless the degree is completed in a shorter time), 12 credit hours in geochemistry, and six credit hours in upper- division or graduate chemistry courses. As part of the degree requirements, students must have completed CHEM 331; ERTH 444; ERTH 380; or their equivalents.

Doctor of Philosophy in Earth and Environmental Science with Dissertation in Geochemistry

Students of exceptional ability as demonstrated in previous courses or in a master's degree program may pursue a program leading to the doctoral degree.

The prospective doctoral candidate in earth and environmental science with specialization in geochemistry should develop a good background in chemistry, geology, mathematics, and physics in addition to achieving a high level of competence in the field of specialization. Ph.D. students must include three credit hours of GEOC 592 and at least six credit hours of GEOC 593, unless the degree is completed in a shorter time. Additional information is found under the Graduate Program (page 28).

Fields of doctoral dissertation research include geochemistry of ore deposits, trace element and isotope geochemistry of igneous and metamorphic systems, fluid-inclusion geochemistry, geochronology, hydrogeochemistry, stable isotope geochemistry, and environmental geochemistry. Interdisciplinary programs in the earth science fields are encouraged.

Geochemistry Graduate Courses:

GEOC 500, Directed Research, cr to be arranged
This course may not be used to fulfill graduate degree requirements.
Research under the guidance of a faculty member.

GEOC 507, Hydrogeochemistry, 3 cr, 3 cl hrs
Prerequisite: CHEM 122
Pre- or Corequisite: ERTH 440
The thermodynamics and aqueous chemistry of natural waters, with emphasis on groundwater. Chemical equilibrium concepts, surface chemistry, redox reactions, and biochemistry. The interaction of water with the atmosphere and geologic materials. Basic concepts applied to problems of groundwater quality evolution, water use, and groundwater contamination. Shares lecture with ERTH 407. (Same as HYD 507 and CHEM 531)

GEOC 516, 40Ar/39Ar Geochronology, 4 cr, 3 cl hrs, 3 lab hrs
Prerequisite: ERTH 444
Offered spring semester, alternate years
Principles and applications of 40Ar/39Ar geochronology and thermochronology, including field and laboratory methods.

GEOC 517, Advanced 40Ar/39Ar Geochronology, 3 cr, 3 cl hrs
Advanced topics, specialized applications, and current research in 40Ar/39Ar geochronology.

GEOC 535, Crustal and Mantle Evolution, 3 cr, 3 cl hrs
Origin and evolution of continents and evolution of the mantle. (Same as GEOL 535)

GEOC 543, Mineral Equilibria, 3 cr, 2 cl hrs, 3 lab hrs
Offered spring semester, alternate years
Application of chemical thermodynamics to mineral stabilities in aqueous systems.

GEOC 552, X-ray Fluorescence Spectrometry, 1–2 cr, 3 lab hrs
Offered on demand
Theory and application of x-ray fluorescence to the analysis of geologic materials.

GEOC 554, Fluid Inclusions, 1–2 cr, 6 lab hrs
Offered on demand
Theory and application of thermometric analysis to fluid inclusions.

GEOC 555, Advanced Aqueous Geochemistry, 3 cr, 3 cl hrs
Prerequisite: HYD 507 or consent of instructor
Advanced topics in aqueous geochemistry, including chemical weathering, surface reactivity, colloidal phenomena, environmental organic chemistry, process-based reactive transport modeling, and other topics of interest to those enrolled. The course consists of introductory lectures on each topic followed by review and discussion of current papers from the literature. (Same as GEOL 555 and HYD 555).

GEOC 558, Environmental Tracers in Hydrology, 3 cr, 3 cl hrs
Prerequisites: ERTH 440; HYD 507
Offered in alternate years
Atomic structure and abundances of environmental isotopes. Stable isotope fractionation. Mass spectrometry. Applications of the stable isotopes of hydrogen, oxygen, and carbon to meteorology and hydrology. Radioactive decay and radionuclide production. Applications of tritium, 3He, 14C, 36Cl , and other radionuclides. Application of CL-, Br, chlorofluorocarbons and other environmental tracers to hydrologic problems. (Same as HYD 558)

GEOC 561, Ore Genesis, 3 cr, 3 cl hrs
Offered spring semester, alternate years
Principles of the geochemistry of ore deposits including stable isotopes, lead isotopes, solution geochemistry, and element partitioning. Review of recent tectonic and geochemical generic models of hydrothermal, magmatic, and sedimentary ore deposits. (Same as GEOL 561)

GEOC 562, Ore Genesis, 3 cr, 3 cl hrs
Offered fall semester, alterante years
Principles of the geochemistry of ore deposits including stable isotopes, solution geochemistry, and element partitioning. Review of recent tectonic and geochemical generic models of hydrothermal, magmatic, and sedimentary ore deposits. (Same as GEOL 562)

GEOC 565, Stable Isotope Geochemistry, 3 cr, 3 cl hrs
Offered spring semester
Principles of stable isotope geochemistry with applications to geologic systems.

GEOC 566, Practical Aspects of Mass Spectrometry, 3 cr, 1 cl hr, 6 lab hrs
Prerequisites: GEOC 565; consent of instructor
Offered fall semester
Theory and application of stable isotope mass spectrometry. Through lectures, problem sets, and laboratory exercises, students learn how to analyze geologic samples to determine stable isotope composition.

GEOC 571, 572, Advanced Topics in Geochemistry, 2 or 3 cr
Study of a special topic in geochemistry, normally one related to a field of research at Tech.

GEOC 575, Theory and Practice of Electron Microprobe Analysis, 1 cr
Prerequisites: ERTH 380; consent of instructor
Principles, techniques and applications of electron microprobe

analysis: X-ray theory, sample preparation techniques, hands-on analysis using the electron microprobe, techniques of instrument calibration and data reduction. Emphasis on analysis of geological samples. Class participation is required for students who plan to use the electron microprobe as part of their thesis research. Class time will be divided between lecture and hands-on sample preparation and analysis.

GEOC 581, Directed Study, cr to be arranged

Study under the guidance of a member of the geochemistry staff. In general, subject matter will supplement that available in the other graduate offerings in geochemistry.

GEOC 590, Independent Study, cr to be arranged

In this course, the student must clearly demonstrate the ability to organize and pursue research. A written final report is required. At the discretion of the instructor, other faculty members may be requested to review the final report.

GEOC 591, Thesis (master's program), cr to be arranged

GEOC 592, Graduate Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing
Offered spring semesters

Seminar presentations by graduate students on their current research topics. M.S. students must present at least one seminar; Ph.D. students must present at least one seminar in each of two different semesters. Graded on S/U basis; credits earned may not be applied towards the 30 credits required for the M.S. degree (same as GEOL 592, GEOP 592, HYD 592)

GEOC 593, Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing
Offered fall and spring semesters

Seminar presentations by faculty, students, and outside speakers. Graded on *S/U* basis. Satisfactory performance consists of regular attendance at approved seminars. Credit earned may not be applied towards the 30 credits required for the M.S. degree. (Same as GEOL 593, GEOP 593, HYD 593)

GEOC 595, Dissertation (doctoral degree program), cr to be arranged

Geophysics (Solid Earth)

The Geophysics program offers an undergraduate degree in Earth Science with Geophysics option. See page 76.

Graduate Program

Requirements for the Master of Science in Geophysics (Solid Earth)

The Master of Science degree in Geophysics (Solid Earth) may be earned under either of the plans outlined below:

With Thesis:

The student's course of study must be approved by the student's advisory committee and must fulfill the general requirements for the master's degree with thesis and must include (unless taken in undergraduate work): ERTH 325, 445, and 448, or their equivalents; upper-division geology, six credit hours; competence in mathematics corresponding to nine credit hours beyond calculus; at least six credit hours of GEOP 591, two credit hours of GEOP 592, and twelve additional credit hours in graduate geophysics (up to six credit hours of this requirement may be replaced with non-geophysics graduate courses with the advisor's approval).

Without Thesis:

Courses approved by the student's advisory committee must fulfill the general requirements for the master's degree without thesis and must include (unless taken in undergraduate work): ERTH 325, 445, and 448, or their equivalents; upper-division geology, six credit hours; competence in mathematics corresponding to nine credit hours beyond calculus; at least three credit hours of GEOP 590, two credit hours of GEOP 592, and twelve additional credit hours of graduate courses in geophysics (up to six credit hours of this requirement may be replaced with non-geophysics graduate courses with the advisor's approval).

Doctor of Philosophy in Earth and Environmental Science with Dissertation in Geophysics

Students of exceptional ability as demonstrated by previous academic achievement may pursue a program leading to the doctoral degree.

The prospective doctoral candidate in earth and environmental science with specialization in physics of the solid earth should develop a solid background in physics, mathematics, and geology in addition to achieving a high level of competence in the field of geophysics.

With the approval of the advisory committee, the student should select a program including a minimum of nine credit hours in graduate geophysics beyond the M.S. degree, three credit hours of GEOP 592, plus additional courses in related fields.

Research fields appropriate for the geophysics candidate include crustal exploration, earthquake seismology, tectonophysics, environmental, and hydrogeothermal studies. Interdisciplinary programs in the earth science fields are encouraged.