# Department of Chemistry, Geoscience, and Physics

Dr. Daniel Marble, Interim Department Head
Department of Chemistry, Geosciences, and Physics
Science Building, Room 117
Box T-0540
Stephenville, TX 76402
254-968-9894
marble@tarleton.edu

Mrs. Eva Moody, Administrative Associate
Department of Chemistry, Geoscience, and Physics
Science 117
Box T-0540
Stephenville, TX 76402
254-968-9143
emoody@tarleton.edu

## Master of Science in Environmental Science

The Master of Science degree in Environmental Science offers built-in #exibility to best suit the needs of our students and their desired career paths. With both thesis and non-thesis options available and online offerings for coursework, this degree works for students in any stage of their careers.

With af#liations with the Texas Institute for Applied Environmental Research (https://www.tarleton.edu/tiaer/) (TIAER), Texas A&M AgriLife (https://agriliferesearch.tamu.edu/), the Center for Agribusiness Excellence (https://www.tarleton.edu/cae/) (CAE), and others, the interdisciplinary Environmental Science master's program is focused on addressing issues both locally and globally. With af#liated faculty spanning from engineering to policy, natural resources, chemistry, geography, and biology. This diverse program with concentrations in science and social policy is customizable and #exible to meet the needs of professionals and students alike. Hands-on experience in both the #eld and laboratory is emphasized in this program. Our students are driven to seek answers to the problems of today's ever-diversifying society.

A highly sought-after program, the M.S. in Environmental Science offers many career options:

- Environmental consultant
- Environmental education of#cer
- Environmental manager
- Nature conservation of#cer
- Sustainability consultant
- Waste management of#cer
- Water quality scientist
- Environmental chemist

## Special Requirements

Students pursuing the thesis option will be expected to prepare a thesis based on original research. A thesis proposal will be prepared for approval by the student's advisory committee and the College of Graduate Studies before the initiation of research. The thesis proposal and the thesis will be in conformance with the guidelines and deadlines established by the College of Graduate Studies. The thesis must demonstrate the capability of the student to perform original research and to present the results obtained from such research in a clear, concise, and well-organized manner. Students pursuing the non-thesis option will take six hours of additional coursework instead of the thesis as approved by their committee.

Students pursuing the non-thesis option will be expected to undertake a comprehensive examination in the final semester of their coursework. Comprehensive exams are administered by a committee of three or more faculty whose courses have made up a significant proportion of the graduate student's studies while at Tarleton and is chaired by the adviser for their chosen concentration. These examinations are comprehensive and intensive, with an expectation of demonstration of mastery of the coursework and program.

Further information on thesis and comprehensive exam requirements can be found in the department's graduate handbook.

## Master of Science degree in Environmental Science Program Requirements

| | | |
|---|---|---|
| ENVS 5185 | Graduate Seminar [1] | 1 |
| ENVS 5185 | Graduate Seminar [1] | 1 |
| ENVS 5185 | Graduate Seminar [1] | 1 |
| ENVS 5185 | Graduate Seminar [1] | 1 |
| ENVS 5460 | Applied Remote Sensing | 4 |
| Select one of the following: | | 3 |
| ENVS 5370 | Research & Analytical Methods | |
| WSES 5380 | Research Writing for Agricultural and Environmental Science | |
| Select one of the following: | | 3 |
| ENVS 5362 | Environmental Policy | |
| SOCI 5306 | Water Policy | |
| Select one of the following: | | 3 |
| ENVS 5345 | Advanced Oceanography | |
| ENVS 5310 | Environmental Geology | |
| Take 6 credits of qualifying graduate electives as approved by advisor and department (BIOL, CHEM, GEOL, GEOG, ENVS, POLI, SOCI, WSES) | | 6 |
| **Total Hours** | | **23** |

### Environmental Science - Non-thesis option

| | | |
|---|---|---|
| ENVS 5331 | Advanced Meteorology | 3 |
| Select one of the following | | 3 |
| ENVS 5311 | Environmental Chemistry | |
| ENVS 5314 | Environmental and Restoration Biology | |

| | |
|---|---|
| Take 7 credits of qualifying graduate electives as approved by advisor and department (BIOL, CHEM, GEOL, GEOG, ENVS, POLI, SOCI, WSES) | 7 |
| **Total Hours** | **13** |

### Environmental Science - Thesis Option

| | | |
|---|---|---|
| ENVS 5331 | Advanced Meteorology | 3 |
| ENVS 5088 | Thesis (Thesis proposal must be accepted before registering for this course) | 6 |
| **Total Hours** | | **9** |

### Environmental Social - Policy - Non-thesis option

| | | |
|---|---|---|
| Select two of the following | | 6 |
| ENVS 5301 | International Environmental Issues | |
| ENVS 5312 | Environmental Law | |
| SOCI 5386 | Problems in Sociology | |
| Take 7 credits of qualifying graduate electives as approved by advisor and department (BIOL, CHEM, GEOL, GEOG, ENVS, POLI, SOCI, WSES) | | 7 |
| **Total Hours** | | **13** |

### Environmental Social-Policy - Thesis option

| | | |
|---|---|---|
| Select one of the following | | 3 |
| ENVS 5301 | International Environmental Issues | |
| ENVS 5312 | Environmental Law | |
| SOCI 5312 | Environmental Sociology | |
| ENVS 5088 | Thesis (Thesis proposal must be accepted before registering for this course.) | 6 |
| **Total Hours** | | **9** |

## Chemistry Courses

**CHEM 5086. Chemical Problems. 1-6 Credit Hours (Lecture: 0 Hours, Lab: 1-6 Hours).**
Independent research in the laboratory or in the library under the guidance of a member of the graduate faculty. Up to 6 hours may be taken.

**CHEM 5310. Environmental Chemistry. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Study of the impact of chemistry on the environment to include topics on air, water, and soil pollution, with special emphasis on water. Beneficial chemical modification of the environment will be covered.

## Environmental Science Courses

**ENVS 5086. Environmental Problems. 1-3 Credit Hours (Lecture: 0 Hours, Lab: 1-3 Hours).**
Independent research under the supervision of an instructor. A formal report will be submitted to the instructor. A student may not count more than 6 hours of Environmental Science problems toward a degree. Lab fee $2.

**ENVS 5088. Thesis. 1-6 Credit Hours (Lecture: 1-6 Hours, Lab: 0 Hours).**
Scheduled when the student is ready to begin the thesis. No credit until the thesis is completed.

**ENVS 5185. Graduate Seminar. 1 Credit Hour (Lecture: 1 Hour, Lab: 0 Hours).**
A graduate seminar with content varying according to the needs and experiences of students and the instructor of record. May be repeated for up to four hours credit as content varies.

**ENVS 5300. The Regulatory Environment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
A survey of local, state, national, and international regulatory agencies to include their organization and authority. Case studies of environmental problems and legislated regulations are covered.

**ENVS 5301. International Environmental Issues. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
A seminar on environmental politics and policy on the international level. The focus of this course is upon international environmental policy with particular attention paid to the agreements and treaties made by nations to shape and implement environmental policy, plus a comparative study of how other nations and states address the environment.

**ENVS 5305. Environmental Ethics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
This class provides a broad overview of environmental ethics with a focus on practical solutions to ethical problems. Special consideration will be given to the ethical concerns that emerge from the changing relationships between humankind and the natural and built environment. Credit will not be awarded for PHIL 6305 or ENVS 6305 if either one of the PHIL 5305 or ENVS 5305 has already been taken.

**ENVS 5310. Environmental Geology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Explores the physical controls geology imparts to the global ecosystem through systems analysis of geologic processes. Focus on the interaction between major geologic and environmental systems, including the rock cycle, weathering and erosion, soil, structures, mass wasting, plate structure and kinematics, mapping, engineering geology, hydrogeology, energy resources, hazards, waste management, and the effects of changing climate. Prerequisites: At least 4 contact hours of Geology, and 4 contact hours of Chemistry.

**ENVS 5311. Environmental Chemistry. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Study of the impact of chemistry on the environment to include topics on air, water, and soil pollution, with special emphasis on water. Beneficial chemical modification of the environment will be covered.

**ENVS 5312. Environmental Law. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Focuses on the role of the American judiciary with respect to environmental policy and law, with particular emphasis on judicial review of environmental legislation and regulations, state-versus-federal environmental matters, and judicial review and interpretation of environmental treaties to which the United States is a party.

**ENVS 5313. Sustainability Policy. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
This class focuses on the world movement towards sustainability, urban sustainability, rural sustainability, and the use of sustainability benchmarks. This class will also focus on rationales for creating sustainability reports, public policy analysis using sustainability reports, and the creation of sustainability reports. Credit will only be awarded for one of ENVS 5313 and ENVS 6313.

**ENVS 5314. Environmental and Restoration Biology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Study of human interactions with plants and animals within ecosystems with an emphasis on conservation and restoration ecology. Outdoor laboratories and restoration of plant communities are required.

**ENVS 5320. Issues in Water Resources. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
This course will provide a broad introduction to the critical issues relating to the world's freshwater resources. Students will examine the occurrence, use, management, and conservation of water and water resources in the U.S. and the world. Students will develop an understanding of the history and current issues in water resources and the environmental problems and political response to these issues.

**ENVS 5325. Environmental Hydrology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
An examination of the processes that govern the earth's hydrologic cycle such as precipitation, evaporation and transpiration, runoff, infiltration and ground water and an exploration of anthropogenic effects on the hydrologic cycle. Topics include land-atmosphere interactions, movement of water in subsurface environments, contaminant transport in groundwater systems, streamflow generation, surface-water flow dynamics, urban runoff and flood control.

**ENVS 5329. Applications of Geographic Information Systems in Environmental Science. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**
Environmental and natural resource applications of Geographic Information Systems. Introduction to spatial analysis and 3-D analysis. The availability and uses of digital resources. Prerequisite: EASC 2320. Lab fee $2.

**ENVS 5331. Advanced Meteorology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
The study of the Earth’s atmosphere and processes within it. Topics include weather, climate, heating, adiabatic processes, precipitation types and formation, wind currents, geostrophic effects, prediction, and warnings. Historical events will be discussed in context of modern understanding.

**ENVS 5335. Watershed Modeling. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**
The course will explore commonly used watershed models that can be used in linking sources of pollutants to receiving waterbodies. The course will explore large watershed, streamflow, water quality, urban watershed, and agricultural watershed models. Information will include model calibration and evaluation techniques.

**ENVS 5341. Environmental Site Assessment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Introduction to Phase I and Phase II investigations, principles of siting and installation of monitoring wells, a review of sampling methods and sample design, and the use of water quality data to characterize subsurface contamination. Prerequisite Course(s): Hydrogeology or consent of Department Head.

**ENVS 5345. Advanced Oceanography. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
An integrated study of our oceans from the physical, chemical, biological, and geological aspects. Theory reinforced by practical field experience. Include analysis of seawater components, the effects of pollutants, and the impacts of chemical processes on marine organisms, as well as studying the physical conditions and physical processes within the ocean such as waves, currents, eddies, gyres and tides; the transport of sand on and off beaches; coastal erosion; and the interactions of the atmosphere and the ocean.

**ENVS 5362. Environmental Policy. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
The study of the politics of the natural environment with emphasis on the role of government in environmental protection.

**ENVS 5370. Research & Analytical Methods. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Research and analytical methods for Environmental Scientists. Explores the various approaches, methodologies, and philosophies behind research techniques.

**ENVS 5380. Research and Writing in Agriculture and Environmental Science. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Preparation of writing samples, technical reviews, and/or professional manuscripts related to various topics in agriculture or environmental science. Prerequisite: Approved research methodology course. Cross-listed with AGRI 5380.

**ENVS 5390. Topics in Environmental Science. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Scientific aspects of varied environmental topics, which may include waste disposal, wetlands, air pollution, energy, bioremediation, or watershed analysis. May be repeated for credit as topics vary. Prerequisites: 12 hours of science (including six hours of chemistry) or approval of department head.

**ENVS 5460. Applied Remote Sensing. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
An introduction to the features and interpretation of remotely sensed images from airborne and satellite platforms. Formats of imagery will include radar, thermal, and multispectral. Focus on interpretation of images for various usages, including agriculture, forestry, geology, urban landscapes, and geography. Factors affecting acquisition of a variety of features will be discussed. Introduction to the theory of color sensing and interpretation is included. Lab fee: $2.

**ENVS 6305. Environmental Ethics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
This class provides a broad overview of environmental ethics with a focus on practical solutions to ethical problems. Special consideration will be given to the ethical concerns that emerge from the changing relationships between humankind and the natural and built environment. Credit will not be awarded for PHIL 6305 or ENVS 6305 if either one of the PHIL 5305 or ENVS 5305 has already been taken.

**ENVS 6313. Sustainability Policy. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
This class focuses on the world movement towards sustainability, urban sustainability, rural sustainability, and the use of sustainability benchmarks. This class will also focus on rationales for creating sustainability reports, public policy analysis using sustainability reports, and the creation of sustainability reports. Credit will only be awarded for one of ENVS 5313 and ENVS 6313.

## Geology Courses

**GEOL 5086. Problems. 1-6 Credit Hours (Lecture: 0 Hours, Lab: 1-6 Hours).**
Independent research under the supervision of an instructor. A formal report will be submitted to the instructor. A student may not count more than 6 hours of problems toward a degree.

**GEOL 5088. Thesis. 1-6 Credit Hours (Lecture: 6 Hours, Lab: 6 Hours).**
Scheduled when the student is ready to begin the thesis. No credit until thesis is completed. Student must have submitted approved thesis proposal before taking for credit.

**GEOL 5100. Geology Seminar. 1 Credit Hour (Lecture: 1 Hour, Lab: 0 Hours).**
A graduate seminar course providing the opportunity for students to lead discussions on a current topic in Geology. Topics vary according to interests of faculty and/or students. May be repeated for credit as topics vary.

**GEOL 5300. History of Geology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
A study of the development of geological concepts and their impact upon science and society. Biographical as well as contemporary readings will be involved, investigating the confluence of geological science development with historical and societal factors.

**GEOL 5400. History of Geology. 4 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
A study of the development of geological concepts and their impact upon science and society. Biographical as well as contemporary readings will be involved, investigating the confluence of geological science development with historical and societal factors.

**GEOL 5401. Crystal Chemistry. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
An advanced study of the atomic or molecular arrangement of minerals. Topics covered would include, crystal structure, P-T phase diagrams, solid solution, exsolution, diffusion, atomic site occupancy, mineral chemical bonding, and the relationship of crystal structure to optical and physical properties. Lab fee: $2.

**GEOL 5402. Igneous Petrology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
An advanced study of the origin of igneous rocks. The course would focus on geochemical aspects of igneous rocks, with a special emphasis on process such as fractionation, assimilation and liquid immiscibility. The course would involve an in-depth study of phase diagrams. Lab fee: $2.

**GEOL 5403. Metamorphic Petrology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
An advanced study of the origin of metamorphic rocks. The course would focus on mineral chemical reactions occurring during metamorphism. Topics in the course would include thermodynamics, and in-depth study of phase diagrams. Lab fee: $2.

**GEOL 5404. High Temperature Geochemistry. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
A study of the chemistry involved in igneous and metamorphic processes. The course would emphasize trace elements, stable isotope systematics, and radioactive isotopic systems. Lab fee: $2.

**GEOL 5405. Low Temperature Geochemistry. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
A study of surface chemical systems. This course is sometimes called the geochemistry of natural waters. The course would focus on the chemistry of weathering and sediment deposition. Topics could include acidity and oxidation (EH-pH), stable isotopes, evaporate chemistry, clay chemistry, and aqueous system chemistry. Lab fee: $2.

**GEOL 5410. Field Paleoecology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
The ecology of ancient life. The course will focus on defining and identifying community structures through time, exploring the rise and fall of communities and the changing populations within them based on field identification, utilizing sediments and life habit. Lab fee: $2.

**GEOL 5420. Ichnology. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
Study of Trace Fossils. Course will focus on identification and description of ichnotaxa, ichnofacies, and ethological classifications. Field application of course content will be a major component. Lab fee: $2.

**GEOL 5430. Paleontological Data Analysis. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
Study and application of statistical and multivariate techniques used in classifying and differentiating organisms, taphonomics, orientations, and ecologies. Methods covered will include DCA, PCA, PCO, NMDS, and Parsimony Analysis, as well as basic statistical methods. Lab fee: $2.

**GEOL 5450. Geomechanics and Fracture System Analysis. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Mechanical analysis of stress and strain within the Earth's brittle crust. Major topics include analysis of present day stresses, Anderson stress classification, overpressure, mechanical properties of rock, Mohr failure envelopes, and critical stresses on faults. Characterization and quantification of natural fracture systems will be a major component of the course. Lab fee: $2.

**GEOL 5451. Geometric and Kinematic Analysis of Structures. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Analysis of concentric folds of layered sedimentary rocks and fault-related folds with emphasis on geometric relationships. Introduction to quantitative models based upon geometric relationships between fault geometry, rheology, and fault slip rate. Techniques will be presented to incorporate surface and subsurface data to construct viable, admissible structural cross sections while minimizing artificial distortion. Modern structural software will be used. Techniques will be presented for reconstructions and restorations of cross sections. Use of growth strata to constrain the kinematic pathway of both compressional and extension folds and fault-related folds. Lab fee: $2.

**GEOL 5452. Seal and Trap Analysis. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Examination of the geological and physical processes that trap hydrocarbons in the subsurface and techniques for the evaluation of seal competency. Lab fee: $2.

**GEOL 5453. Structural Systems. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Examination of extensional, compressional, and strike-slip systems from a tectonic and regional scale. The course will examine both kinematic and dynamic analysis of systems of associated structures. Emphasis will be on understanding key components and architectural elements of structural styles. Investigation of the mechanical and rheological controls on formation of structural regimes. Lab fee: $2.

**GEOL 5460. Sequence Stratigraphy. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**
Fundamental concepts of sequence stratigraphy applied to both carbonate and clastic systems. Integration of surface and subsurface data with an emphasis on petroleum exploration. Field trips required. Prerequisite: GEOL 3413 or equivalent with a grade of "C" or better Lab fee: $2.

**GEOL 5461. Carbonate Petrology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Introduction to the physical, chemical, and biologic properties of carbonate rocks, as revealed by petrographic microscopy, geochemical techniques, and field study. Emphasis is placed on the mineralogy, chemistry, textures, and sedimentary structures that characterize carbonate rocks, and the relation of these features to their depositional origin and subsequent diagenesis. Prerequisite: GEOL 3413 or equivalent with a grade of "C" or higher Lab fee: $2.

**GEOL 5462. Clastic Petrology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Introduction to the physical, chemical, and biologic properties of clastic rocks, as revealed by petrographic microscopy, geochemical techniques, and field study. Emphasis is placed on the mineralogy, chemistry, textures, and sedimentary structures that characterize carbonate rocks, and the relation of these features to their depositional origin and subsequent diagenesis. Prerequisite: GEOL 3413 or equivalent with a grade of "C" or higher Lab fee: $2.

**GEOL 5463. Clastic Depositional Systems. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Clastic facies analysis and depositional environments: modern and ancient alluvial, lacustrine, desert, deltaic, estuarine, shoreline, shallow marine shelf and deep marine environments. Field trips required. Prerequisite: GEOL 3413 or equivalent with a grade of "C" or better Lab fee: $2.

**GEOL 5464. Carbonate Depositional Systems. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Carbonate facies analysis and depositional environments; examination of both modern and ancient carbonate environments. Field trips required. Prerequisite: GEOL 3413 or equivalent with a grade of "C" or better Lab fee: $2.

**GEOL 5465. Basin Analysis. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**
Analysis of sedimentary basins, including their structural development, subsidence histories, thermal maturation, stratigraphy and depositional systems, and petroleum systems. Prerequisites: GEOL 3413 and GEOL 3312 (or equivalents) with a grade of "C" or better Lab fee: $2.

## Physics Courses

**PHYS 5303. Astronomy. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**
Selected topics in astronomy appropriate for public school teachers. Course may be repeated when topic changes.