Geology

Degrees Offered
- Master of Science
- Doctor of Philosophy

Nature of the Program
The graduate program in geology at WVU provides study opportunities in the following areas:

- Hydrogeology and environmental geology with strengths in flow and contaminant-transport modeling, mine reclamation, shallow geophysics, floods, and debris flows
- Basin analysis and sedimentary geology with strengths in seismic modeling, basin structures, depo-system analysis, sequence stratigraphy, biostratigraphy, paleoecology, diagenesis, and plate tectonics
- Energy geology and geophysics with strengths in the exploration and development of oil, gas, and coal; the computational analysis of hydrocarbon systems; and environmental impacts of fossil fuel usages

Research Linkages Around Morgantown
The WV Geological and Economic Survey (WVGES), located five miles from Morgantown, makes available laboratory equipment, fossil collections, cataloged drill cuttings and core, and subsurface logs from deep wells in the region. WVGES also offers students work and thesis opportunities in coal resources and petroleum geology. Several survey geologists are adjunct faculty.

The National Energy Technology Laboratory (NETL) of the U.S. Department of Energy laboratory located in Morgantown carries out and funds research on fossil-fuel resources and environmental problems. NETL projects support geology faculty and graduate-student research.

Extensive mining in the Appalachian region provides an excellent opportunity for students to study the environmental effects of coal extraction. The WVU geology faculty collaborates with the National Mine Land Reclamation Center (NMLRC) based on the WVU Evansdale campus. The NMLRC is the main center for coordination of acid-mine drainage research in the United States. WVU Geology has instrumented groundwater research sites in the region for both training and research.

The department houses the Statewide GIS Technical Center, the central source for GIS resources in West Virginia. The tech center is responsible for scanning and digitization of USGS, DLGs, DOQs, and a host of other data products. The center provides technical-support services for the development and operation of GIS in West Virginia. A limited number of RA opportunities are available related to center activities.

Facilities

COMPUTER FACILITIES AND NETWORK
Research and teaching computing facilities in the department are outstanding and are centered around a Windows client-server network. The research cluster has access to more than ten terabytes of redundant networked storage based on a series of RAID servers as well as diverse networked printers, large-format plotters, large-format digitizers, and scanners. The teaching cluster provides interactive computing resources for 125 students on networked computers. Classroom demonstration facilities are available in every teaching lab. The research cluster includes many workstations with dual-format displays. All resources are regularly upgraded with a replacement period of one to two years. Clusters for the GEO workgroup are linked to the WVGIS center and have gateway access to the university backbone. The entire building is networked. The department houses the GeoVirtual Lab which is centered around a four-walled immersive CAVE environment.

SOFTWARE RESOURCES
The department maintains software for instructional and research usage. A full range of common applications software is available on all network machines. In addition, statistical packages allow students to undertake detailed statistical analysis, whereas graphical analysis packages (TruFlite, Surfer, Geographix, RockWorks) enable users to render both 2-D and 3-D surfaces. GIS licenses include ARCGIS which is accessible to students for integration of complex geological and geophysical data. ERDAS IMAGINE provides a suite of image-processing tools for analyzing remotely sensed data. Dynamic Graphics EarthVision provides an interactive 3-D visualization environment. AutoCAD, Adobe Illustrator, and other graphics design packages allow accurate rendering of technical diagrams.

State-of-the-art geological and geophysical modeling and processing software are available for instructional and research use. Landmark Inc. GeoGraphix Discovery Suite, Seismic Micro Technology’s Kingdom Suite, and Schlumberger’s Petral software provide state-of-the-art tools for analysis of seismic reflection data and geophysical logs. Seismic processing capability is provided through Landmark’s ProMax 2-D, 3-D, and VSP. We use Sensors and Software’s EKKO View Deluxe software for processing and display of ground penetrating radar data. Interpex’s IXID software is available for forward and inverse modeling of resistivity and terrain conductivity data. Northwest Geophysical Associates’ GM-SYS software is used in the forward and inverse modeling of gravity and magnetic data. A host of Landmark products including Discovery Suite, Seisworks, Strat-works, and seismic modeling packages enhance geophysical and subsurface studies. We have recently improved our capability in integrated subsurface analysis
through the addition of IHS Petra, Schlumberger’s Interactive Petrophysics for reservoir property analysis, and Petrel. The focus of these products is on collaborative work-flows that unite geophysics, geology, and reservoir engineering domains.

Software for groundwater simulation includes aquifer characterization packages (AQTESOLV), finite-difference flow and particle-tracking codes (MODFLOW2000, MODPATH3), solute-transport codes (MT3-D, MODFLOWT), and preprocessors (Groundwater Vistas). Streamflow-modeling capabilities include HEC-2 step-backwater and peak value flood frequency software.

For structural geology studies we use 2-D and 3-D move (Midland Valley) and TriShear (created by R. Almendinger) in addition to standard structural analysis software. Basin modeling and evaluation of the generation of hydrocarbons are carried out with the GENEX (Baisip-Franlab) software.

**Laboratory And Field Instrumentation**

**GEOLOGICAL**
The department has a rock-crushing room equipped with jaw crusher and disk grinder as well as laboratories devoted to geological sample preparation which include standard mineral separation equipment (Frantz magnetic separator, Gemeni table, and heavy liquids set-up).

**GEOPHYSICAL**
The department owns a Geonics very low frequency sensor, an EM34 terrain conductivity meter, a Bison Instruments 12 Channel Seismograph, and a Geometrics magnetometer. The geophysics facility also offers large format plotting on twenty-four to forty-two inch HP plotters. Additional survey equipment includes a Leitz Model 2100 Total Station Survey System and a two-station GPS Traveler. Wide spectrums of software resources (see above) enhance geophysical research.

**GEOCHEMICAL**
Department laboratories own a Philips PW1800 X-ray diffraction unit for solid-state mineral analyses and a Philips PW9550 energy dispersion spectrometer for elemental analyses. A complete suite of equipment is available for the analysis of organic-rich materials including a Leco sulfur analyzer, a Leco proximate analyzer for moisture, carbon, and ash content, a Leco CHN analyzer for coal and shale, a Leco calorimeter, and a Biorad FTIR with microscope attachment to do FTIR analysis of microscopic entities in rocks. Water analytical facilities include a Dionex 100 Ion Chromatograph and a Beckmen Autotitrator. Outside White Hall, Varian sequential ICP and Finnemat ICP-MS units for water analysis are available to geology faculty in the WV Water Research Institute.

**HYDROGEOLOGICAL**
Groundwater field equipment includes an array of Global Water vented pressure transducer/datalogger instruments, Grundfos 4” and Redi-Flo 2 pumps, Geotech peristaltic pumps and flow-through sampling cells, and analog well recorders as well as a variety of generators, sampling pumps, flumes, pH and conductivity meters, bailers, and current meters.

**QUATERNARY GEOLOGY AND GEOMORPHOLOGY**
Quaternary geology and geomorphology research is served by a particle-size analysis laboratory as well as field instrumentation such as Garmin and Trimble GPS units, laser levels, and a Leica TC400 electronic distance meter.

**REMOTE SENSING**
The Remote Sensing Laboratory has a comprehensive suite of computing and field equipment. The laboratory operates two portable full-range (0.4 to 2.5 micrometer) field spectroradiometers and an aerial small format photography system based on two Nikon cameras. The laboratory shares a digital ADAR infra-red aerial acquisition system with biology and resource management. The ADAR system can be deployed in both helicopters and fixed wing aircraft. Remote sensing software includes site licenses for ERDAS Imagine, ENVI/IDL, and ARC/INFO image analysis and GIS software.

**FACULTY**

**CHAIR**
- Timothy Carr - PhD. Univ. of Wisconsin-Madison

**ASSOCIATE CHAIR FOR GEOLOGY**
- Shikha Sharma - Ph.D. (Univ. of Lucknow, India)

**PROFESSORS**
- Timothy Carr - Ph.D. (University of Wisconsin-Madison)
- Sedimentary and Petroleum Geology
- Joseph J. Donovan - Ph.D. (Pennsylvania State University)
- Hydrogeology, Quaternary Paleochemistry
- Gregory A. Elmes - Ph.D. (Pennsylvania State University)
- Geographic Information Science
• Dengliang Gao - Ph.D. Duke Univ.
• Trevor M. Harris - Ph.D. (University of Hull)
  Eberly Professor, Geographic Information Science
• Jaime Toro - Ph.D. Stanford Univ.
• Timothy A. Warner - Ph.D. (Purdue University)
  Remote Sensing

ASSOCIATE PROFESSORS
• Amy Hessl - Ph.D. (University of Arizona)
  Biogeography, Forest Ecosystems
• J. Steven Kite - Ph.D. (University of Wisconsin-Madison)
  Geomorphology, Quaternary Studies, Geoarchaeology
• Shikha Sharma - Ph.D. Univ. of Lucknow, India
• Dorothy J. Vesper - Ph.D. (Pennsylvania State University)
  Aqueous Geochemistry and Hydrogeology
• Amy Weislogel - Ph.D. Stanford Univ.

PROFESSORS EMERITI
• Robert E Behling - Ph.D. Ohio State Univ.
• Alan C. Donaldson - Ph.D. (Pennsylvania State University)
  Past Chair, Stratigraphy, Clastic Sedimentation
• Thomas W Kammer - Ph.D. Indiana Univ.
• Helen M Lang - Ph.D. Univ. of Oregon
• Henry W Rauch - Ph.D. Penn State Univ
• John J Renton - Ph.D. West Virginia Univ.
• Robert C. Shumaker - Ph.D. (Cornell University)
  Structural Geology, Tectonics
• Richard A. Smosna - Ph.D. (University of Illinois)
  Sedimentation, Stratigraphy, Carbonate Petrology
• Thomas Wilson - Ph.D. West Virginia Univ.

ASSISTANT PROFESSORS
• Graham Andrews - Ph.D. Univ. of Leicester
• Kenneth Brown - Ph.D. Miami Univ., Ohio
• James Lamdsell - Ph.D. Univ. of Kansas
• Joseph Lebold - Ph.D. (West Virginia University)
  Earth Science Education, Stratigraphy, Paleocology
• Eungul Lee - Ph.D. (University of Colorado)
  Climate, Regional Climate Modeling
• Brenden McNeil - Ph.D. (Syracuse University)
  GIScience and Environmental Modeling

CLINICAL ASSISTANT PROFESSOR
• Rick Landenberger - Ph.D. (West Virginia University)
  Remote Sensing, Geoscience Education

POST DOCTORAL RESEARCHER
• Maria Perez - Ph.D. (University of Michigan)
  Karst and Cavers, Science and Society

Admission Procedures and Prerequisites

Applicants for graduate studies in geology must have as a minimum requirement a bachelor’s degree and an overall grade point average of at least 3.0. Acceptance by the Department of Geology and Geography is necessary before admission of any prospective student to the program. All candidates for a graduate degree in geology must submit scores in the general aptitude tests of the Graduate Record Examination. Applicants seeking admission and financial support for the fall semester should apply by February 1. For spring semester, apply by October 1. Write to the department for an application package or download it from the website (see above).
Students seeking admission to the master’s program or the Ph.D. program must complete the equivalents of all allied science and mathematics courses required for the B.S. in geology at WVU, plus the following geology courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 101</td>
<td>Planet Earth</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 102</td>
<td>Planet Earth Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>GEOL 103</td>
<td>Earth Through Time</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 104</td>
<td>Earth Through Time Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>GEOL 284</td>
<td>Mineralogy</td>
<td>3</td>
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<tr>
<td>GEOL 285</td>
<td>Introductory Petrology</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 311</td>
<td>Stratigraphy and Sedimentation</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 341</td>
<td>Structural Geology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 404</td>
<td>Geology Field Camp</td>
<td>6</td>
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</tbody>
</table>

Similar courses from other universities or relevant experiences may be substituted if approved during admission review. A requirement may be waived by the committee if the student can demonstrate competence in that subject area.

**GPA Requirements**

During graduate study a minimum grade point average of 3.0 must be maintained in required formal courses in geology and cognate fields for the master’s degree and 3.3 for the Ph.D. A student who fails to maintain the required average at the completion of any semester will be placed on probationary status and allowed one academic year (two semesters) to attain the required average. If this is unsuccessful, the student will be dropped from enrollment in the graduate program.

**Master of Science**

The M.S. in Geology offers two options: research and professional studies. Students are required to take courses specified by their advisory committee, with whom they meet at the beginning of each semester. Students must take approved graduate courses from at least five different faculty from any department in the university.

**MAJOR REQUIREMENTS**

Select an Area of Emphasis: 30-39

<table>
<thead>
<tr>
<th>Professional Studies (39 credits)</th>
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<tbody>
<tr>
<td>Research (30 credits)</td>
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<tr>
<td>GEOL 699</td>
<td>Graduate Colloquium</td>
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<tr>
<td>Total Hours</td>
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**RESEARCH AREA OF EMPHASIS**

This has been the traditional option for the master of science in geology. Students considering continued studies (doctor of philosophy) or seeking employment in an area of geological research should choose this option. A minimum of twenty-four formal course hours, six research hours (GEOL 697), and two hours of GEOL 699 are required for graduation. A thesis based on original research under direction of a research committee is also required. With consent of the candidate’s research committee, the field work need not be done while in residence at WVU.

| Geology Courses | 24 |
| GEOL 697       | Research | 6 |
| Total Hours    | 30 |

* Approved graduate courses in biology, chemistry, physics, computer science, mathematics, engineering, soil sciences, business, or law may be taken as outside courses by geology graduate students. Students are free to take as many courses as they choose outside the department as long as the coursework is approved by their advisory committee.

**PROFESSIONAL STUDIES AREA OF EMPHASIS**

This option is designed specifically for students seeking experience in preparing and presenting professional problems. Students choosing this option typically expect to seek professional employment in the profession using the master’s as their terminal degree. A minimum of thirty-three formal course hours, six directed study research hours (GEOL 692), and two hours of GEOL 699 are required for graduation. The research hours are in lieu of a thesis and are designed to simulate the work of professional geologists as they seek solutions to open-ended problems within a limited time frame. Experience in presentation of problems and solutions are an integral part of the program. Research hours may be earned in conjunction with off-campus experiences by consent of the candidate’s advisory committee.

Geology Courses | 33
Approved graduate courses in biology, chemistry, physics, computer science, mathematics, engineering, soil sciences, business, or law may be taken as outside courses by geology graduate students. Students are free to take as many courses as they choose outside the department as long as the coursework is approved by their advisory committee.

**Doctor of Philosophy**

The candidate for the Ph.D. must complete a program of courses outlined by the candidate’s doctoral research committee. A candidacy preliminary examination must be successfully completed within one year after enrollment. The proposal defense and oral examination must also be successfully completed. Participation in two GEOL 796 Graduate Seminars is required. No other formal course requirements exist; these are chosen by the student in conjunction with his or her research committee.

### MAJOR REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Colloquium</td>
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<tr>
<td>GEOL 699 Graduate Colloquium</td>
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<tr>
<td>Seminar</td>
<td>2</td>
</tr>
<tr>
<td>GEOL 796 Graduate Seminar</td>
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<tr>
<td>Comprehensive Examination</td>
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<tr>
<td>Dissertation Proposal</td>
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<tr>
<td>Dissertation</td>
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<tr>
<td>Dissertation Defense</td>
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</table>

**Total Hours**: 4

### Major Learning Goals

**GEOLOGY**

Students obtaining a masters in geology degree will be able to:

- Communicate geologic concepts orally and in writing
- Apply research skills to analyze geologic questions
- Propose, produce and defend original research in their field of study
- Explain geologic principles as they relate to their area of research

Students obtaining a doctorate in geology degree will be able to:

- Communicate geologic concepts orally and in writing
- Apply research skills to analyze geologic questions
- Propose, produce and defend original research of publishable quality
- Explain geologic principles as they relate to their area of research
- Effectively communicate the state of knowledge in their research area
- Identify research questions in geology
- Critique and assess peer-reviewed literature