2010-2011 Course Catalog

The University Of Montana

Department of Geosciences

William Woessner, Chairman

The Science of Earth directly involves the study of natural geological procedures processes and the interactions of these processes with the environment. The major in Geosciences prepares students to assist society in understanding and addressing complex science-based challenges such as climate change and the utilization of finite energy, mineral, and water resources. Geoscientists are involved in deciphering both ancient and modern records that record Earth history.

Geoscientists advance our understanding of earthquakes, landslides, severe storms, and volcanic eruptions; explore the history of life; investigate changing glacial landscapes and watersheds; evaluate the inner-workings of our planet; and search for natural resources including oil, gas, water, and minerals. Our classrooms include field and laboratory settings in which inquiry-based learning helps students develop skills in creative thinking and problem solving. Geoscientists completing our program are employed by private industry; federal, state, and local governmental agencies; environmental consulting firms; non-profit organizations; and by secondary schools needing earth science teachers. Our graduates have a wide range of educational employment opportunities. They are sought after to work in other natural science fields and as graduate students. Jobs in geosciences are available at the B.S., M.S. and Ph.D. levels. The M.S. degree is highly prized by employers and is considered the working professional degree. The Ph.D. degree is required for positions at universities and with companies specializing in research.

The Department of Geosciences offers five B.S. degree options, an M.S. degree, and a Ph.D. degree. The B.S. degrees include Interdisciplinary Geosciences, Geosciences, Earth Science Education, and two transatlantic institutionally shared degrees: International Field Geosciences Joint B.S. Degree with the University College of Cork (Ireland), and an International Field Geosciences Dual B.S. Degree with Potsdam University (Germany). All degree programs in the department require a student to develop a strong background in geosciences and a sound foundation in other sciences.

High School Preparation: In addition to the general requirements for University admission, recommended high school preparation includes a solid background in mathematics and science.

Special Degree Requirements

See index.

Science courses designed for education majors may not be counted toward Geosciences Department science requirements. Geosciences courses and allied science courses must be taken for a traditional grade.

The Upper-division Writing Expectation must be met by successfully completing an upper-division writing course from the approved list in the Academic Policies and Procedures section of this catalog or by completing GEO 499 (GEOS 499). See index.

The Geosciences Department offers four options for students wishing to major in geosciences. The first option is a highly flexible program designed for those who wish to double major in another science or who simply wish to acquire a broad education of their own design. It features a minimum number of specifically required courses in geosciences and other sciences. The remaining three options are designed for students who desire a more defined path through our curriculum or who are seeking certification to teach. Some paths in each of the options may require prerequisites that are not specifically listed or required.

Interdisciplinary Geosciences B.S.

This flexible option requires the following courses in Geosciences: GEO 101N (GEOS 100N), GEO 102N (GEOS 101N), GEO 211 (GEOS 200), GEO 226 (GEOS 226), and GEO 231 (GEOS 230). In addition, thirteen credits of Geoscience coursework must be taken, relevant to student interests, at the 200, 300, or 400 levels. A minimum of 27 credits from the Geosciences curriculum is required to earn this degree. In addition to 27 credits in Geosciences, at least 27 credits from recognized cognate science classes are required to earn this degree. Required classes include CHMY 121N (Chemistry 151N) or CHMY 141N (Chemistry 161N); M 151 (Math 121) or a more advanced math class; and three credits in Computer Science (modeling or programming), or GIS or Statistics. Additional cognate science courses must be completed from the list below such that the sum of all cognate science classes is a minimum of 27 credits. Student curricular planning should include awareness of prerequisites as listed in this catalog.

CHMY above 121N (CHEM 151N); MATH above M 151 (MATH 121); CSCI 135 (CS 131) or above; PHSX 205N (PHYS 111N) or above; BIOB 101N (BIOL 100N) or above; FOR 210N Introductory Soils, FOR 360 Range Management; FOR 380S Environmental Conservation.

At the discretion of the academic advisor, other sciences courses such as some courses in physical geography may also be acceptable.

Geosciences B.S.

This option is designed for students who seek post-graduate employment as a professional geoscientist and has two major suggested courses of study; Earth History, Evolution and Earth Resources, and Water, Climate, and Environment. The following Geosciences courses are required to earn this degree: GEO 101N (GEOS 100N), GEO 102N (GEOS 101N), GEO 211 (GEOS 200), GEO 226 (GEOS 226), and GEO 231 (GEOS 230).

Earth History, Evolution, and Earth Resources

- GEO 305 (GEOS 306) Igneous and Metamorphic Petrology (4 cr.)
- GEO 310 (GEOS 310) Invertebrate Paleontology (3 cr.)
- GEO 311 (GEOS 311) Paleobiology (3 cr.)
- GEO 327 (GEOS 327) Geochemistry (4 cr.)

- GEO 315 (GEOS 330) Structural Geology (3 cr.)
- GEO 429 (GEOS 429) Field Geology (6 cr.)
- GEO 433 (GEOS 430) Global Tectonics (3 cr.)
- GEO 442 (GEOS 432) Architecture of Sedimentary Deposits (4 cr.)
- GEO 443 (GEOS 433) Sedimentary Petrology (4 cr.)
- GEO 437 (GEOS 437) Seismology and Magnetics (4 cr.)
- GEO 438 (GEOS 438) Gravity and Magnetics (4 cr.)
- GEO 460 (GEOS 460) Process Geomorphology (4 cr.)

Water, Climate, and Environment

- GEO 320 (GEOS 320) Global Water (4 cr.)
- GEO 327 (GEOS 327) Geochemistry (4 cr.)
- GEO 315 (GEOS 382) Structural Geology (3 cr.)
- GEO 382 (GEOS 302) Global Change (3 cr.)
- GEO 391 (GEOS 395) Special Topics (3 cr.)
- GEO 442 (GEOS 432) Architecture of Sedimentary Deposits (4 cr.)
- GEO 443 (GEO 433) Sedimentary Petrology (4 cr.)
- GEO 437 (GEOS 437) Seismology and Magnetics (4 cr.)
- GEO 438 (GEOS 438) Gravity and Magnetics (4 cr.)
- GEO 460 (GEOS 460) Process Geomorphology (4 cr.)
- GEO 420 (GEOS 480) Hydrogeology (4 cr.)

At least 32 credits of Geoscience courses must be completed, of which 18-24 are upper-division (300-400 level) credits. In addition to completing the coursework in Geosciences, students must also complete a minimum of 30 credits in cognate sciences classes. Required are the following: PHSX 205N/206N-207N/208N or PHSX 215N/216N - 217N/218N (PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N); CHMY 121N/122N/123N/124N (CHEM 151N/152N/154N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 (MATH 150/158) or M 171/172 (MATH 152/153); three credits in Computer Science (modeling or programming), or GIS, or Statistics.

Additional cognate science courses must be completed such that the sum is a minimum of 30 credits. These may include additional courses in Chemistry, Computer Science, Math, and Physics above the listed minimum levels specified above. Biology 100N or above is also appropriate, but substitutions or other science courses must be approved by the student's advisor.

International Field Geosciences Joint B.S. Degree with University College of Cork (Ireland)

This option is designed specifically for students who seek to combine a rigorous education in the Geosciences with a year long international geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. Student demonstrating a high level of performance at the University will be eligible for partial financial support as funds are available. Although most of the course work completed during the year abroad will take place at University College Cork in Ireland, additional course work is required at Potsdam University in Germany. For students who satisfy all degree requirements, a B.S. degree in International Field Geosciences will be jointly awarded by The University of Montana and the University College Cork.

The following UM Geoscience courses are required to earn this degree: GEO 101N (GEOS 100N); GEO 102N (GEOS 101N); GEO 108N (GEOS 108N); GEO 211 (GEOS 200); GEO 226 (GEOS 226); GEO 231 (GEOS 230); GEO 315 (GEOS 330); GEO 442 OR 443 (GEOS 432 or 433); and GEO 429 (GEOS 429). Also required are a minimum of 12 credits in upper division UM Geoscience courses selected from among the following: GEO 305,310, 311, 320, 327, 420, 433, 442, 443, 460,491 (GEOS 306, 310, 311, 320, 327, 430, 432, 433, 460, 480, 495) plus GRMN 101/102 (GERM 101/102) or ENIR 101/102.

In addition to Geoscience coursework completed at UM, students must complete one formal field course run by the Institute for Geosciences at Potsdam University to sites in Europe (arranged in consultation with advisor) plus one formal field course module run by University College Cork, selected from GL 2016 (Easter Field Course - Dingle Peninsula), GL3019 (Easter Field Course - Western Scotland), ER3002 (Easter Field Course - North Clare) GL4008 (Easter Field Course - Central Greece). In addition, while in residence at Cork, students must complete any nine of the following courses in consultation with their UCC (Cork) and UM advisor:

- GL2011 Sedimentological Processes and Petrology (3 cr.)
- GL2012 Igneous and Metamorphic Petrology (3 cr.)
- GL2018 Plate Tectonics and Global Geophysics (3 cr.)
- GL 2019 Marine Ecosystems Through Time (3 cr.)
- GL 3005 Geohazards (3 cr.)
- GL3010 Igneous Petrogenesis and Geochemistry (3 cr.)
- GL3011 Metamorphism and Geochronology (3 cr.)
- GL3012 Advanced Structural Geology (3 cr.)
- GL3013 Sedimentary Environments (3 cr.)
- GL3014 Stratigraphy and Geologic Maps (3 cr.)
- GL3017 Environmental Geology (3 cr.)
- GL3024 Terrestrial Ecosystems Through Time (3 cr.)
- GL4001 Micropaleontology and Palynology (3 cr.)
- GL4003 Petroleum Geology and Basin Analysis (3 cr.)
- GL4003 Applied Geophysics and Computer Applications (3 cr.)
- GL4004 Advanced Igneous Petrology and Geochemistry (3 cr.)
- GL4005 Hydrogeology (3 cr.)
- GL4007 Frontiers in Geology (3 cr.)
- GL4011 Geofluids and Ore Geology (3 cr.)

Students seeking this degree must also complete one additional formal upper-level Geosciences course at Potsdam University during their year abroad. Recommended are courses that focus on computer-based visualization of geoscience data, using GIS or other visualization platforms. Along with the formal Geoscience course work completed at UM and abroad, students earning this degree must complete a minimum of 27 credits in cognate sciences classes, including the following: PHSX 205N/206N-207N/208N or PHSX 215N/216N - 217N/218N (PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N); CHMY 121N/122N (CHEM 151N/153N) and CHMY 123N/124N (CHEM 152N/154N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 OR M 171/172 (MATH 150/158 or MATH 152/153); three credits in Computer Science (modeling or programming), or GIS or Statistics. Also required is one year of college German, GRMN 101/102 (GERM 101/102) and

completion of general education requirements relevant to German and Irish culture and history.

International Field Geosciences Dual Degree with Potsdam University (Germany) This option is designed specifically for students who seek to combine a rigorous education in the Geosciences with a year long international geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. Students demonstrating a high level of performance at the University will be eligible for partial financial support as funds are available. Although most of the course work completed during the year abroad will take place at University Potsdam in Germany, additional course work is required at the University College Cork in Ireland. For students who satisfy all degree requirements, a B.S. degree in Geosciences will be awarded by The University of Montana and a second B.S. degree in International Field Geosciences will be awarded by Potsdam University. The following UM Geoscience courses are required to earn this degree: GEO 101N (GEOS 100N); GEO 102N (GEOS 101N); GEO 108N (GEOS 108N); GEO 211 (GEOS 200); GEO 226 (GEOS 226); GEO 231 (GEOS 230); GEO 326 (GEOS 302); and GEO 429 (GEOS 429). Also required are a minimum of 15 credits in upper division UM Geoscience courses selected from among the following: GEO 305, 310, 311, 320, 327, 315, 433, 442, 443, 437, 438, 460, 420, 491 (GEOS 306, 310, 311, 320, 327, 330, 430, 432, 433, 437, 438, 460, 480, 495).

In addition to Geoscience coursework completed at UM, the following overseas field-based Geoscience courses are required: BP15 (Field course C–France, run by Potsdam) or both BW01 (Field course-Norway, run by Potsdam) andBW02 (Field course-Alps, run by Potsdam); plus one of the following courses offered by University College Cork; GL 2016 (Easter Field Course-Dingle Peninsula), GL3019 (Easter Field Course-Western Scotland), ER3002 (Easter Field Course - North Clare), GL4008 (Easter Field Course-Central Greece). Students seeking this degree must also complete any four of the following courses offered by Potsdam University:

- BW04 Regional Geology (3 cr.)
- BW05 Paleoclimate and Quaternary Geology (3 cr.)
- BW06 Analysis of Geologic Maps (3 cr.)
- BW07 Analytic Geochemistry (3 cr.)
- BW16 Natural Hazards (3 cr.)
- BW15 Tectonophysics and Rheology (3 cr.)
- BW11 Seismology (3 cr.)
- BW12 Seismics (3 cr.)
- BW13 Geoelectrics (3 cr.)
- BWP05 Sedimentary Systems and Stratigraphy (3 cr.)
- BWP06 Geomorphology (3 cr.)
- BWP16 Tectonics and Geodynamics (3 cr.)

Along with the formal Geoscience course work, students earning this degree must complete a minimum of 27 credits in cognate sciences classes, including the following: PHSX 205N/206N-207N/208N or PHSX 215N/216N - 217N/218N (PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N); CHMY 121N/123N (CHEM 151N/152N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 (MATH 150/158) or M 171/172 (MATH 152/153); three credits in Computer Science (modeling or programming), or GIS or Statistics. While overseas, the students must complete two of the following cognate science courses at Potsdam University:

- BWP07 Basics in GIS (3 cr.)
- BWP08 Basics in Remote Sensing (3 cr.)
- BWP09 Numerical Methods (3 cr.)
- BWP10 Basic Data Analysis (3 cr.)

Also required is one year of college German GRMN 101/102 (GERM 101/102) and completion of general education requirements relevant to German and Irish culture and history.

Option in Earth Science Education Major Teaching Field of Earth Science: A student must complete GEO 101N, 102N, 105N, 231, 226, 301, 310, 315 (GEOS 100N, 101N, 105N, 230, 226, 301, 310, 330), 3 additional credits from any geosciences course numbered 100 or above and 12 credits from any geosciences courses numbered 300 or above. Also required are ERTH 303N (GEOG 322N), ASTR 131N-132N, M 151, STAT 341 (MATH 121, 341), CSCI 100 (CS 101), CHMY 485 (CHEM 485), and C&I 426. One of BIOE 172N (BIOL121N-122N) or CHMY 121N/123N (CHEM 151N-152N) or PHSX 205N/206N or 207N/208N (PHYS 111N/113N or PHYS 112N/114N); must be completed. For endorsement to teach earth science, a student also must gain admission to Teacher Education Program and meet the requirements for teaching licensure (see the College of Education section of this catalog). The demand in most Montana high school for teaching in this field may be limited, and students must complete the requirements for the required second teaching endorsement (major or minor).

Suggested Course of Study

For questions concerning your special interests or preparation, see a geology advisor.

Interdisciplinary Geosciences B.S.

First Year	A	S
CHMY 121N/122N (CHEM 151N/153N) or CHMY 141N (CHEM 161N)	4(5)	–
CHMY 123N/124N or CHMY 143	–	5
WRIT 101 (ENEX 101) College Writing I	3	–
GEO 101N/102N (GEOS 100N) Intro to Physical Geology	4	–
GEO 108N (GEOS 108N) Climate Change	–	3
CSCI 172 (CS 172) Intro to Computer Modeling	–	3
General Education	5(4)	4
Total	16	15
Second Year	A	S

M 151 (MATH 121) Precalculus	4		–	
M 171 (MATH 152) Calculus	–		4	
FOR 210N Introductory Soils	4		–	
GEO 211 (GEOS 200) Earth History and Evolution	4		–	
GEO 226 (GEOS 226) Earth Materials	–		4	
GEO 231 (GEOS 230) Geosciences Field Methods	–		4	
Electives and General Education	3		3	
Total	15		15	
Third Year		A		S
PHSX 205N/206N-215N/216N (PHYS 111N/113N-211N/213N) College Physics I & lab, Fundamentals of Physics with Calc I & Lab	5		–	
Additional cognate science*	–		5	
GEO (GEOS) any 300 and above	6		6	
Electives and General Education	4		4	
Total	15		15	
Fourth Year		A		S
GEO (GEOS) any 300 and above	6		6	
Additional cognate science*	3		3	
Electives and General Education	6		6	
Total	15		15	

*Suggested, a total of 30 additional science credits are required. See special degree requirements.

Geosciences B.S.

First Year		A		S

CHMY 121N/122N (CHEM 151N/153N) or CHMY 141N (CHEM 161N)	4(5)			–	
CHMY 123N/124N (CHEM 152N/154N) or CHMY 143N (CHEM 162N)	–			5	
WRIT 101 (ENEX 101) College Writing I	3			–	
GEO 101N (GEOS 100N) 102N Intro to Physical Geology	4			–	
GEO 108N (GEOS 108N) Climate Change	–			3	
CSCI 172 (CS 172) Intro to Computer Modeling	–			3	
M 151 (MATH 121) Precalculus (if needed)	–			4(0)	
General Education	2(1)			3(7)	
Total	13			18	
Second Year		A			S
M 171 (MATH 152) Calculus	4			–	
M 172 (MATH 153) Calculus II	–			4	
GEO 211 (GEOS 200) Earth History and Evolution	4			–	
GEO 226 (GEOS 226) Rocks, Minerals, and Resources	4			–	
GEO 231 (GEOS 230) Geosciences Field Methods	–			4	
Electives and General Education	3			7	
Total	15			15	
Third Year		A			S
PHSX 205N/206N (PHYS 111N/113N) College Physics and Lab	5			–	
PHSX 207N/208N (PHYS 112N/114N) Fundamentals of Physics II and Lab	–			5	
GEO at 300 level or above	6			6	

Electives and General Education	4	4
Total	15	15
Fourth Year	A	S
GEO at 300 level or above	6	6
Additional cognate science*	3	3
Electives and General Education	6	6
Total	15	15

*Suggested, a total of 30 additional science credits are required. See special degree requirements.

International Field Geosciences Joint B.S. Degree with University College Cork (Ireland)

First Year	A	S
CHMY 121N/122N (CHEM 151N/153) (or CHMY 141N)	4	–
CHMY 123N/124N (CHEM 152N/154N) (or CHMY 143N)	–	5
WRIT 101 (ENEX 101) College Writing I	3	–
GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Lab	4	–
GEO 108N (GEOS 108N) Climate Change	–	3
GEO 211 (GEOS 200) Earth History and Evolution	–	3
M 151 (MATH 121) Precalculus (if needed)	–	4(0)
General Education	5	0(4)
Total	16	15
Second Year	A	S
M 171 (MATH 152) Calculus (or M 162)	4	–
M 172 (MATH 153) Calculus II (or M 274)	–	4
GEO 226 (GEOS 226) Rocks, Minerals and Resources	4	–

GEO 231 (GEOS 230) Geosciences Field Methods	4		–	
GEO 315 (GEOS 330) Structural Geology	–		3	
GEO 442 (GEOS 432) Architecture of Sedimentary Deposits or GEO 443 (GEOS 433) Sedimentary Petrology	–		4	
GRMN 101 (GERM 101) Elementary German I	5		–	
GRMN 102 (GERM 102) Elementary German II	–		5	
Total	17		16	
Summer (in Montana and Potsdam)				
GEO 429 (GEOS 429) Field Geology (UM)	6			
Field Course (Potsdam)	3			
Third Year (in Cork)		A		S
Field Modules (two field trips)	–		6	
Metamorphism and Geochronology	-		3	
Geohazards	3		3	
Stratigraphy and Geological Maps	3		-	
Advanced Structural Geology	3		-	
Terrestrail Ecosystems Through Time	3		-	
Advanced Igneous Petrology and Geochemistry	3		-	
Geofluids and Ore Geology	-		3	
Petroleum Geology and Basin Analysis	-		3	
Hydrogeology	-		3	
Sedimentary Environments	-		3	
Total	15		24	
Fourth Year		A		S

PHSX 205N/206N (PHYS 111N/113N) College Physics I and Lab	5	–
PHSX 207N/208N (PHYS 112N/114N) College Physics II and Lab	–	5
GEO at 300 level or above	6	6
Electives and General Education	4	4
Total	15	15

International Field Geosciences Dual Degree with Potsdam University (Germany)

First Year	A	S
CHMY 121N/122N (CHEM 151N/153N)	4	–
CHMY 123N/124N (CHEM 152N/154N)	–	5
WRIT 101 (ENEX 101) College Writing I	3	–
GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Lab	4	–
GEO 108N (GEOS 108N) Climate Change	–	3
GEO 211 (GEOS 200) Earth History and Evolution	–	3
M 151 (MATH 121) Precalculus (if needed)	–	(4)
General Education	5	(4)
Total	16	15

Second Year	A	S
M 171 (MATH 152) Calculus (or M 162) (or MATH 150)	4	–
M 172 (MATH 153) Calculus II (or M 274) (or MATH 158)	–	4
GEO 226 (GEOS 226) /Rocks, Minerals and Resources	4	–
GEO 231 (GEOS 230) Geosciences Field Methods	4	–

GEO 326 (GEOS 302) Sedimentary Geology Field Trip	–		2	
GRMN 101 (GERM 101) Elementary German I	5		–	
GRMN 102 (GERM 102) Elementary German II	–		5	
Electives and General Education	–		4	
Total	17		15	
Summer (in Potsdam)				
Field Course	2			
Third Year (in Potsdam)		A		S
Natural Hazards	3		-	
Igneous and Metamorphic Geology	3		-	
Advanced Structural Geology	2.5		-	
Basics in Geochemistry	-		3	
Hydrogeology	-		3	
Basics in GIS	-		3	
German	3		3	
Total	11.5		12	
Easter Break (in Cork)	-		2.5	
Fourth Year				
PHSX 205N/206N (PHYS 111N/113N) College Physics I & Lab	5		–	
PHSX 207N/208N (PHYS 112N/114N) College Physics II & Lab	–		5	
GEO at 300 level or above	6		6	
Electives and General Education	4		4	
Total	15		15	

Earth Science Education Option

First Year		A		S
CSCI 172 (CS 172) Introduction to Computer Modeling or equivalent	–		3	
WRIT 101 (ENEX 101) College Writing I	3		–	

GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Laboratory	4		–	
GEO 105 (GEOS 105) Oceanography	–		2	
GEO 231 (GEOS 230) Geosciences Field Methods	–		3	
M 151 (MATH 121) Precalculus	4		–	
PSYX 100S (PSYC 100S) Introduction to Psychology	4		–	
*Electives and General Education	3		6	
Total	18		14	
Second Year		A		S
ASTR 131N–132N Elementary Astronomy I, II	3		3	
CHMY 121N (CHEM 151N) General and Inorganic Chemistry	3		–	
GEO 226 (GEOS 226) Rocks, Minerals and Resources	–		4	
GEO 301 (GEOS 301) Environmental Geology	3		–	
GEO any 100	–		3	
*Electives and General Education	6		6	
Total	15		16	

Need to formally gain admission to the Teacher Education Program. See requirement in the School of Education, Department of Curriculum and Instruction. Deadlines: March 1 and October 1.

Third Year		A		S
CHMY 485 (CHEM 485) Laboratory Safety	–		1	
C&I 200 Exploring Teaching Through Field Experience	2		–	
C&I 303 Educational Psychology & Measurements	–		4	
C&I Other	3		6	
ERTH 303N (GEOG 322N) Meteorology	3		–	

GEO 310 (GEOS 310) Invertebrate Paleontology	3		–
GEO 315 (GEOS 330) Structural Geology	3		–
GEO any 300 or above	3		6
Total	17		17
Fourth Year		A	S
C&I 426 Teaching Science in Middle and Secondary Schools	3		–
C&I Other	–		6
GEO any 300 or above	3		–
*Electives and General Education	9		12
Total	15		18

*C&I recommends a minor teaching field. A fifth year may be required to obtain a minor field endorsement.

Requirements for a Minor

To earn a minor in Geosciences the student must complete GEO 101N, 102N, 226, 231 (GEOS 100N, 101N, 226, 230) plus at least 12 credits in other geoscience courses numbered 300 or above. All courses must be taken for a traditional letter grade.

Courses

U = for undergraduate credit only, UG = for undergraduate or graduate credit, G = for graduate credit. R after the credit indicates the course may be repeated for credit to the maximum indicated after the R. Credits beyond this maximum do not count toward a degree.

Geosciences (GEO)

U 101N (GEOS 100N) Intro to Physical Geology 3 cr. Offered autumn and spring. General geology including the work of wind, flowing water, glacial ice, gravity, earthquakes, volcanoes and plate tectonics in shaping the earth.

U 102N (GEOS 101N) Intro to Physical Geology Laboratory 1 cr. Offered autumn and spring. Prereq. or coreq., any geoscience courses below GEO 130. A series of laboratory and field experiences designed around basic geologic processes and materials. Familiarization with common minerals, rocks, land forms, and structures. Intended to provide laboratory experience with any geoscience course below GEO 130.

U 105N (GEOS 105N) Oceanography 3 cr. Offered spring. Origin of sea–water and ocean basins; currents, tides, and coastal processes; use and misuse of the oceans by humans.

U 106N (GEOS 106N) History of Life 3 cr. Offered spring. The evolution of plants, invertebrates and vertebrate animals, highlighting major events in the evolution of life on Earth. Includes laboratory experience with fossils.

U 107N (GEOS 103N) Natural Hazards 3 cr. Offered spring. Examination of volcanism, earthquakes, landslides, floods, coastal erosion, hurricanes, and asteroid impacts. Emphasis on processes, recognition and consequences of catastrophic events, and how to minimize their societal impacts.

U 108N (GEOS 108N) Climate Change 3 cr. Offered autumn. The geoscience perspective on the earth's climate system. Climate processes and feedbacks, climate history from early earth to the ice ages, present and future changes due to natural processes and human activities.

U 151 (GEOS 151) Introduction to Fossil Fuels 3 cr. Offered autumn. A broad introduction to the basic principles and concepts related to the exploration for, the composition of, and the utilization of fossil fuels (coal, coal bed methane, natural gas, and oil). Environmental issues related to fossil fuel development and utilization are also addressed.

U 191 (GEOS 195) Special Topics Variable cr. (R–6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

U 207 (GEOS 207) Geological Hazards and Disasters 2 cr. Offered spring. Prereq., minimum grade of C in any 100-level geoscience course except 106. Study of major geological catastrophes, their causes and effects. Probability, frequency and recurrence intervals, magnitudes, the role of overlapping/ unrelated events. Examples of floods, hurricanes, landslides, submarine landslides, tsunamis, earthquakes, volcanic eruptions, asteroid impacts.

U 211 (GEOS 200) Earth History and Evolution 3 cr. Offered autumn. Traces the history of the earth since its inception 4.5 billion years ago. Presents scientific theories for the origin of the earth and the nature of important earth shaping events of the past, including the development of the oceans, atmosphere and climate..

U 226 (GEOS 226) Rocks, Minerals and Resources 4 cr. Offered spring. Prereq., any geoscience 100–level lecture course, GEO 102N (GEOS 101N), CHMY 121N or 141N (CHEM151N or CHEM 161N). Study of minerals and rocks utilizing an Earth Systems approach; mineral identification and paragenesis; survey of the distribution of minerals from the interior to the surfaces of planets and the processes that led to their formation.

U 231 (GEOS 230) Geosciences Field Methods 3 cr. Offered autumn and spring. Prereq., GEO 101N-102N (GEOS 100N–101N). Field methods and interpretations. This course introduces students to a variety of field methodologies routinely used in the collection and interpretation of geoscientific field data.

U 260 (GEOS 260) River Systems 3 cr. Offered spring alternate years. Hydrologic and geomorphic basis of environmental management problems concerning river systems. Analysis of the processes of flooding, sedimentation, and morphological change in channels, flood plains, deltas, and alluvial fans. Effects of climate, land use and engineering.

U 291 (GEOS 295) Special Topics Variable cr. (R–6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

U 301 (GEOS 301) Environmental Geology 3 cr. Offered autumn. Prereq., GEO 101N-102N, (GEOS 100N–101N, 130); M 115 or 151(MATH 117 or 121); CSCI 172 (CS 172) or equiv. experience with spread sheets and word processors. Human

effects on geologic processes and the effect of geologic processes on humans. Group and independent research projects on local and regional environmental geology problems are used to teach scientific problem solving. Topics include population growth, management of surface and groundwater quantity and quality, resource use, global environmental change.

U 304E (GEOS 304E) Science and Society 3 cr. Offered autumn. Role of scientific knowledge in human societies from the pre–Classical to the present. Discussion of tools for integrating science into ethical, political, and social decisions, including analyses of modern case studies from physical sciences.

U 305 (GEOS 306) Igneous and Metamorphic Petrology 4 cr. Offered spring. Prereq., GEO 226 (GEOS 226), CHMY 143N (CHEM 162N). Igneous rock associations, igneous processes and origins; metamorphic minerals and phase relationships, metamorphic zones, facies, and conditions; metamorphic environments, metallic minerals and mineral deposits.

U 309 (GEOS 309) Sedimentation and Stratigraphy 4 cr. Offered spring. Prereq. GEO 101N-102 (GEOS 100N-101N) or 211 (GEOS 200), 226 (GEOS 226). Origins of sediments and sedimentary rocks; climate, weathering, and weathering products; transport, deposition, and depositional environments of sediments; concepts and methods of stratigraphy including correlation of sedimentary rocks and an introduction to basin analysis.

UG 310 (GEOS 310) Invertebrate Paleontology 3 cr. Offered autumn. Prereq., GEO 101N (GEOS 100N) or equiv. Principles of paleontology including morphology, classification and evolution of major groups of fossils and their application to paleoecology and biostratigraphy.

UG 311 (GEOS 311) Paleobiology 3 cr. Offered spring. Prereq., GEO 310 (GEOS 310) or equiv. Application of geologic and biologic principles to problems in paleontology.

UG 313 (GEOS 313) Curation Techniques 2 cr. Offered spring. Prereq., basic course in natural sciences. Instruction in basic techniques of managing natural history collections. Focus on practical applications.

U 315 (GEOS 330) Structural Geology 3 cr. Offered autumn. Prereq., GEO 226 (GEOS 226). Structures of deformed rocks; mechanical principles; graphical interpretation of structural problems, tectonic principles.

UG 317 (GEOS 309) Planetary Science 3 cr. Offered autumn even-numbered years. Prereq., PHSX 205N/206N or PHSX 215N/216N (PHYS 111N/113N or 211N/213N) and M 162, 171 (MATH 150, 152). Same as ASTR 351. Physical and geological characteristics of planets, satellites, asteroids, comets, and meteoroids with an emphasis on comparative planetology.

U 320 (GEOS 320) Global Water 4 cr. Offered spring. Prereq., one semester of college chemistry, WRIT 101 (ENEX 101) or equiv. Study of the chemistry of water as it moves through the hydrological cycles; discussion of how water chemistry evolves through atmospheric water, precipitation, ground water, and surface water.

UG 326 (GEOS 302) Sedimentary Geology Field Trip 2 cr. Offered spring. Prereq., GEO 101N (GEOS 100N). Examination of modern and ancient sedimentary depositional systems in the field through a 9-day spring break field trip. Possible areas of focus include the Permian Reef Complex of West Texas, the California convergent

margin, Oregon coastal processes, geology of the Basin and Range, Death Valley Region, Colorado Plateau, and Oklahoma Aulacogen.

U 327 (GEOS 327) Geochemistry 4 cr. Offered autumn even–numbered years. Prereq., one year of college chemistry and one semester of geology. One semester of mineralogy recommended. Chemical principles applied to geologic processes. Origin and chemical composition of atmosphere and hydrosphere. Methods of radiometric dating and isotope applications.

UG 382 (GEOS 382) Global Change 3 cr. Offered intermittently. Prereq., consent of instr. Lectures, readings, and discussions on geological and geochemical processes that affect global change using recent literature; carbon dioxide buildup, greenhouse effect, ozone depletion, desertification, ice ages, and other global events.

U 391 (GEOS 395) Special Topics Variable cr. (R–9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

U 392 (GEOS 396) Independent Study Variable cr. (R–6) Offered every term. Specific topics of particular interest to individual students.

U 398 (GEOS 398) Internship Variable cr. Offered every term. Prereq., 12 credits in geosciences. Extended classroom experience which provides practical application of classroom learning during placements off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office. No more than 3 credits of GEO 398 (GEOS 398) may be applied to the geosciences minor. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.

UG 407 (GEOS 407) Global Biogeochemical Cycles 3 cr. Offered spring odd numbered years. Same as FOR 408, BIOL/CCS 407. Exploration of how variations in the availability or utilization of critical Earth elements influences the atmosphere, the oceans, and the terrestrial biosphere including the natural and agricultural ecosystems on which we depend.

UG 420 (GEOS 480) Hydrogeology 4 cr. Offered autumn. Prereq., GEO 101N (GEOS 100N)-102N; PHSX 205N/206N or PHSX 215N/216N (PHYS 111N/113N or 211N/213N) ; M 162 OR 171 (MATH 150 or 152) strongly recommended. Occurrence, movement, quality, and methods of quantification of groundwater. Geological framework and physics of groundwater flow. Supply, contamination, and management problems.

U 425 (GEOS 425) Geology of the Pacific Northwest 3 cr. Offered intermittently. Prereq., GEO 101N (GEOS 100N). Narrative discussion of the evolutions of the Pacific Northwest from Archean time to present.

UG 426 (GEOS 402) Sedimentary Geology Field Trip 2 cr. Examination of sedimentary depositional systems through a nine–day spring break field trip off campus.

U 429 (GEOS 429) Field Geology 6 cr. Offered summer. Prereq., GEO 315 (GEOS 330) and consent of instr. Geologic mapping on aerial photos and topographic base maps. Field interpretation in a variety of rock types and structures. Taught every summer near Dillon, Montana. Extra fees. Pre–registration in early spring.

UG 433 (GEOS 430) Global Tectonics 3 cr. Offered spring. Prereq., GEO 315 (GEOS 330), M 162 (MATH 150), and 2.25 or better overall GPA in geosciences courses. Geodynamics and tectonics of the Earth and other planets. Course material includes methods of observing tectonic processes and tectonic phenomena, both at the surface and in the deep earth, over a wide range of time scales.

UG 436 (GEOS 436) Subsurface Imaging in Archaeology 3 cr. Offered Spring. Prereq., successful completion of UM general education requirements for math and natural science. Applied and theoretical aspects of radar, magnetics, gravity, and electrical methods related to the detection of buried archaeological features. The focus is on the development of experimental design, data acquisition, processing, and interpretation. Course content is also applicable to shallow environmental sources and problems.

UG 437 (GEOS 437) Seismology and Magnetics 4 cr. Offered autumn. Prereq. or coreq., M 172 (MATH 153), GEO 101N-102N (GEOS 100N-101N), PHSX 205N/206N (PHYS 111N/113N). Theory and global aspects of seismology and magnetics as well as their practical application to environmental problems.

UG 438 (GEOS 438) Gravity and Magnetics 4 cr. Offered Spring. Prereq. or coreq., M 172 (MATH 153), GEO 101N (GEOS 100N)-102N, PHSX 205N/206N (PHYS 111N/113N). GPS, gravity, and electromagnetic methods with acquisition, processing, and interpretation of locally-collected data. Applications include environmental and crustal scale imaging, tectonic processes, and whole-earth models.

UG 439 (GEOS 439) Applied Magnetics 3 cr. Offered Spring. Prereq. or coreq., M 172 or M 274, GEO 101N-102N, PHSX 205N/206N (PHYS 111N/113N). Theory and applications of magnetic exploration and paleomagnetism directed at: plate trajectories, continental deformation, Precambrian Euler poles, and the delineation of buried sources ranging in scale from environmental targets to continental sutures. Includes 2D frequency-domain signal processing of potential fields and the pitfalls of forward and inverse modeling.

UG 442 (GEOS 432) Architecture of Sedimentary Deposits 4 cr. Offered autumn alternate years. Study of the architectural elements and composition of sedimentary deposits in the context of their tectonic environments and their influence on petroleum and hydrogeologic systems.

UG 443 (GEOS 433) Sedimentary Petrology 4 cr. Offered autumn alternate years. Prereq., graduate standing or GEO 442 (GEOS 432). Field, hand specimen and thin section petrology of siliciclastic and carbonate rocks, emphasis on tectonic and diagenetic interpretation of siliciclastic rock and environments of deposition and diagenesis of carbonate rocks.

UG 451 (GEOS 451) Petroleum Geology 3 cr. Offered spring. Prereq. or coreq., GEO 317, 315 (GEOS 309, 330) M 171 (MATH 152), CHMY 123N (CHEM 152N), PHSX 205N/206N (PHYS 111N/PHYS 113N). Origin, migration, and entrapment of hydrocarbons in sedimentary basins. Course integrates several areas of geology with geophysics, geochemistry and engineering.

UG 460 (GEOS 460) Process Geomorphology 4 cr. Offered autumn, alternate years. Coreq., one year college calculus and physics. Quantitative examination of landforms, runoff generation, weathering, mechanics of soil erosion by water and wind, mass wasting, glacial and periglacial processes and hillslope evolution.

UG 469 (GEOS 465) Computer Modeling in the Physical Sciences with Matlab 3 cr. Offered spring alternate years. Coreq., one year college calculus and physics. Introduction to Matlab and writing and using computer models to address typical problems faced by physical scientists. Topics include heat diffusion, carbon storage, and landscape evolution. No previous computer experience required.

UG 488 (GEOS 488) Snow, Ice and Climate 3 cr. Offered spring. Prereq., M 121 (MATH 100). Study of basic physical processes occurring in snow and ice, and how

these processes govern the interaction between frozen water and the climate system. The first half of the course focuses in snow, with special attention to snow formation in the atmosphere, snow metamorphism, water flow through snow, and basic avalanche mechanics. The second half of the course focuses on ice and includes glacier and ice sheet flow dynamics, glacier hydrology, and ice age theory. Graduate students will be required to complete additional problem sets requiring higher level math; perform additional reading assignments; perform at a higher level on assignments and exams where students are asked to outline and describe various physical processes; submit a well researched and reference research proposal that is able to synthesize previous research and provide a sophisticated research plan.

UG 491 (GEOS 495) Special Topics 1-8 cr. (R-8) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses or one-time offerings of current topics.

UG 492 (GEOS 496) Independent Study Variable cr. (R-6) Offered every term. Specific topics of particular interest to individual students.

U 493 (GEOS 493) Omnibus Variable cr. (R–10) Offered intermittently. Independent work under the University omnibus option. See index.

UG 494 (GEOS 494) Senior Geology Seminar 1–10 cr. (R–10) Offered intermittently. Prereq., upper–division standing in geosciences or consent of instr. Independent study of various topics under the direction of a faculty member.

U 499 (GEOS 499) Senior Thesis/Capstone 3–10 cr. (R–10) Offered every term. Prereq., 18 credits in geosciences. Independent research project in any geosciences topic supervised by faculty member, and leading to completion of baccalaureate degree.

G 502 (GEOS 502) Thesis/Dissertation Proposal 1 cr. Offered spring. Work with advisors to choose a research project and write a proposal.

G 508 (GEOS 508) Fundamentals of Academic Research 3 cr. Offered fall. Prereq., graduate standing. An introduction to research methods and tools in the academic setting intended for first semester graduate students in geosciences. Topics include proposal writing, presenting research results in oral and written formats, using computer tools for research in the geosciences, and ongoing research of department faculty.

G 522 (GEOS 522) Metamorphic Terrain Analysis 3 cr. Offered autumn. Introduction to techniques used to analyze burial and uplift histories of metamorphic terrains. Topics include: geochronology, including closure temperature theory and the use of geochronologic systems as thermochronometers; geothermometry and geobarometry; quantitative thermodynamic modeling of P–T paths; heat flow and the thermal structure of orogenic belts.

G 528 (GEOS 528) Sedimentary Basin Analysis 4 cr. Offered autumn. Influence of allocyclic processes (tectonism, climate, eustacy, etc.,) in shaping the evolution of sedimentary basins. Emphasis on integration and synthesis of tools of sedimentary basins analysis, including the study of depositional systems, provenance, paleocurrents, subsidence, sequence stratigraphy, and well logs.

G 531 (GEOS 531) Environmental Geochemistry of Metal Contamination 4 cr. Offered autumn. Prereq., GEO 570, 579 (GEOS 570, 579); CHMY 442 (CHEM 442); FOR 511 or consent of instr. Integration of major processes and cycles transporting, fixing, and transforming inorganic contaminants in aquatic systems, soils, sediments and

subsurface environments. Concentration on research to solve complex environmental problems.

G 548 (GEOS 548) Topics in the Cryosphere 3 cr. (R–6 M.S., R–12 Ph.D.) Offered spring. Prereq., graduate standing or consent of instructor. Readings, discussions, lectures, and field experiments on various topics related to snow, ice, and climate processes. Recent topics: meltwater infiltration in snow, glacier hydrology, climate cycles, ice, and sea level rise.

G 560 (GEOS 560) Fluvial Geomorphology 4 cr. Offered intermittently. Prereq., one year college calculus and physics. Application of fluid mechanics to sediment transport and development of river morphology. Form and process in river meanders, the pool–riffle sequence, aggradation, grade, and baselevel.

G 570 (GEOS 570) Advanced Geochemistry 4 cr. Offered autumn even–numbered years. Prereq., one year college chemistry. Chemistry of aqueous systems including aqueous kinetics, aqueous thermodynamics, acid/base chemistry, carbonate systematics, oxidation/deduction reactions, mineral solubility, and complexation. Includes an introduction to the use of geochemical models. Concepts applied to natural systems.

G 572 (GEOS 572) Advanced Hydrogeology 3 cr. Offered spring. Prereq., GEO 420 (GEOS 480) or consent of instr. Advanced concepts used in groundwater investigations, including flow systems analysis, hydrogeologic monitoring and sampling, resource evaluation, exploration, development and monitoring, and contaminant transport. Special problem areas in groundwater exploration and management.

G 573 (GEOS 573) Applied Groundwater Modeling 3 cr. Offered autumn. Prereq., GEO 420 (GEOS 480) and consent of instr. Development of numerical modeling techniques, finite difference and finite element modeling of groundwater flow systems. Application of standard 2D and 3D models to field problems.

G 579 (GEOS 579) Geochemistry of Hot Springs 3 cr. Offered autumn, even–numbered years. Prereq., one year of college of chemistry of consent of instr. Chemistry and geology of hydrothermal systems including solute/gas geothermometry, acid/base reactions, oxidation/reduction reactions, mineral equilibrium, and microbial ecology as applied to terrestrial and submarine hydrothermal systems. Includes an introduction to the use of geochemical models.

G 580 (GEOS 580) Topics in Mineralogy and Petrology Variable cr. (R–6 for M.S., R–12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: tectonics and petrology; alkaline igneous rocks.

G 582 (GEOS 582) Topics in Structure and Geophysics Variable cr. (R–6 for M.S., R–12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: structural analysis, Precambrian crustal evolution, field trips on Rocky Mountain structure.

G 583 (GEOS 583) Topics in Stratigraphy, Sedimentation and Paleontology Variable cr. (R–6 for M.S., R–12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: evolution of life; Proterozoic stratigraphy; reefs through time.

G 585 (GEOS 585) Topics in Hydrogeology and Low–Temperature Geochemistry Variable cr. (R–6 for M.S., R–12 for Ph.D.) Prereq., consent of instr. Offerings on

request of graduate students by arrangement with appropriate faculty. Recent topics: field methods, well design, contaminant transport, geochemical modeling.

G 587 (GEOS 587) Topics in Geomorphology Seminar Variable cr. (R–6 for M.S., R–12 for Ph.D.) Offered spring. Prereq., consent of instr. Reading and discussion of relevant papers. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: landscape evolution; weathering processes; tectonic geomorphology.

G 590 (GEOS 590) Supervised Internship 1–12 cr. Offered intermittently.

G 595 (GEOS 595) Special Topics Variable cr. (R–8) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

G 597 (GEOS 597) Advanced Problems Variable cr. (R–10) Offered intermittently. Prereq., consent of instr. Investigations of geological problems exclusive of thesis or dissertation research.

G 599 (GEOS 599) Thesis Research Variable cr. (R–6) Offered every term. Prereq., thesis proposal approval. Directed research to serve as thesis for the master degree. Credit assigned upon submittal of final copy of approved and bound thesis.

G 699 (GEOS 699) Dissertation Research Variable cr. (R–12) Offered every term. Prereq., dissertation proposal approval. Directed research to serve as dissertation for the Ph.D. degree. Credit assigned upon submittal of final copy of approved and bound dissertation.

Faculty

Professors

Marc S. Hendrix, Ph.D., Stanford University, 1992

Nancy W. Hinman, Ph.D., University of California (San Diego), 1987

Johnnie N. Moore, Ph.D., University of California (Los Angeles), 1976 (Chair)

James W. Sears, Pd.D., Queen's University, 1979

Steven D. Sheriff, Ph.D., University of Wyoming, l981

George D. Stanley, Ph.D., University of Kansas, 1977

James R. Staub, Ph.D., University of South Carolina, 1985

William W. Woessner, Ph.D., University of Wisconsin (Madison), 1978

Associate Professor

Joel T. Harper, Ph.D., University of Wyoming, 1997

Assistant Professors

Julia A. Baldwin, Ph.D., Massachusetts Institute of Technology, 2003

Rebecca O. Bendick, Ph.D., University of Colorado, Boulder, 2000

Marco P. Maneta, Ph.D., University of Extremadura (Spain), 2006

Andrew C. Wilcox, Ph.D., Colorado State University, 2005

Emeritus Professors

David Alt, Ph.D., University of Texas, 1961
Donald W. Hyndman, Ph.D., University of California (Berkeley), 1964
Ian M. Lange, Ph.D., University of Washington, 1968
Raymond C. Murray, Ph.D., University of Wisconsin, 1955
Graham R. Thompson, Ph.D., Case Western Reserve, 1971
John P. Wehrenberg, Ph.D., University of Illinois, 1956
Robert M. Weidman, Ph.D., University of California (Berkeley), 1959
Donald Winston, Ph.D., University of Texas, 1963