

Credits: 2 TO 3. Offered intermittently. Concepts and techniques in geography, with emphasis on their use in teaching geography in Montana schools. Students are required to prepare and present a teaching unit project. Designed for pre-service or in-service teachers.

#### GPHY 498 - Internship

Credits: 1 TO 6. Offered every term. Consent of instructor. Extended classroom experience which provides practical application of classroom learning during placements within governmental agencies or the business community. A maximum of 6 credits of Internship may count toward graduation. Course Attributes: Internships/Practicums

#### GPHY 499 - senior thesis / capstone

Credits: 3. (R-6) Offered autumn and spring. Senior standing and consent of instructor. Independent research project in any geographical topic supervised by a faculty member, and leading to completion of the baccalaureate degree. Course Attributes: Writing Course-Advanced

#### GPHY 500 - Geography Graduate Colloquium

Credits: 1. (R-3) Offered autumn. Presentation of faculty and student research. Guest lecturers. Graded pass/not pass only. Enrollment required every autumn graduate students are in residence. Level: Graduate

#### GPHY 504 - Geographical Research

Credits: 1. Offered autumn. To be taken during first semester of graduate studies. Understanding of diverse research approaches in geography and development of a thesis topic. To be continued in spring in GPHY 505. Level: Graduate

#### GPHY 505 - Research Design

Credits: 2. Offered spring. Prereq., GPHY 504. Preparation of a thesis proposal: research design, data collection, analysis, interpretation, and presentation. Recommended to be taken during the second semester of graduate studies. Level: Graduate

#### GPHY 520 - Seminar Geographical Thought

Credits: 3. Offered autumn. Geographical ideas, concepts, approaches, and techniques from ancient to modern times. Recommended to be taken during first semester of graduate studies. Level: Graduate

#### GPHY 525 - Advanced Physical Geography

Credits: 3. (R-9) Offered intermittently. Advanced topics in climate and global change, paleo-environments and biogeography, landform analysis, soils, and other selected topics. Topic titles will appear in the Class Schedule. Level: Graduate

#### GPHY 550 - Seminar in Geography

Credits: 3. (R-9) Offered intermittently. Seminar topics in geography and society, human-environmental interaction, physical geography, regional geography, or geographical techniques. Level: Graduate

#### GPHY 560 - Seminar in Planning

Credits: 3. Offered spring odd-numbered years. A critical analysis of land planning history, theory, approaches, and practice. Emphasis is on the United States and England. Level: Graduate

#### GPHY 561 - Land Use Planning Law

Credits: 3. Offered autumn. Same as ENST 561 and LAW 687. Basic overview of the law of land-use planning including, background in the traditional governmental regulatory, proprietary, and fiscal land use tools. Examination of modern techniques for land-use planning; consideration of constitutional limits of the authority of state and local governments. Focus on skills in interpreting, drafting, and applying state legislation and local ordinances. Level: Graduate

#### GPHY 562 - Land Use Planning Clinic

Credits: 1 TO 6. (R-6) Offered every term. Prereq. or coreq., GPHY 561. Same as ENST 562. Students assist local communities in long-range planning efforts and development of growth management plans as required by Montana law; ordinance drafting, development proposals, and land use issues. Level: Graduate

GPHY 564 - Planning Design

Credits: 3. Offered spring even-numbered years. Prereq., graduate standing or Consent of Instructor. Analysis of land-use problems and design. Level: Graduate

GPHY 578 - Preceptorship in Geography

Credits: 1 TO 3. (R-6) Offered autumn and spring. Graduate standing and Consent of Instructor. Assisting a faculty member by tutoring, helping students with research projects, and carrying out other class-related activities. Level: Graduate

GPHY 580 - Seminar GIS & Cartography

Credits: 3. (R-9) Offered spring. Seminar topics in cartography and GIS. Applications to advanced studies in human and physical geography. Level: Graduate

GPHY 587 - Image Analysis & Modeling

Credits: 3. Offered every two years. Prereq., GPHY 487 or FORS 351 or Consent of instructor; coreq., GPHY 589. Advanced topics in image analysis (e.g. hyperspectral images and pattern-recognition-based classification) and foundations of simple raster-based models. Level: Graduate

GPHY 588 - Spatial Analysis and Modeling

Credits: 3. Offered autumn. Coreq., GPHY 589. Theoretical/conceptual and practical aspects of entity-based GIS modeling and spatial analysis. Point pattern analysis (i.e. cluster detection, density analysis, kriging), network analysis (i.e. network construction, network-based spatial statistics, accessibility modeling), and areal pattern analysis (i.e. spatial autocorrelative pattern, spatial regression modeling). Applications in urban and environmental planning, transportation, natural resource management, ecology, health, criminology, engineering, and business. Level: Graduate

GPHY 589 - Cartography/GIS Laboratory

Credits: 1. (R-4) Offered autumn and spring. Laboratory to accompany GPHY 587 or 588. Level: Graduate

GPHY 595 - Special Topics

Credits: 1 TO 8. (R-9) Offered intermittently. Prereq., Consent of Instructor. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics. Level: Graduate

GPHY 596 - Independent Study

Credits: 1 TO 9. (R-9) Offered every term. Graduate standing and consent of instructor. Independent research in geography or planning. Level: Graduate Course Attributes: Service Learning/Volunteer

GPHY 597 - Professional Paper

Credits: 1 TO 6. (R-6) Offered autumn and spring. Graduate standing in Geography and Consent of Advisor. Level: Graduate

GPHY 598 - Internship

Credits: 1 TO 9. (R-9) Offered every term. Graduate standing and consent of instructor. Extended classroom experience which provides practical application of classroom learning during placements off campus. Level: Graduate Course Attributes: Internships/Practicums

GPHY 599 - Thesis

Credits: 1 TO 6. Offered every term. Graduate standing in Geography and Consent of Advisor. Level: Graduate

# Geosciences Department

**James R. Staub, Chair**

Human impact on Earth systems and reliance on Earth's resources will increase as human population and economic production grows. These impacts are creating "global grand challenges": complex, globally important problems that require an interdisciplinary approach. The most pressing grand challenges over the next decade will be resource scarcity/depletion (especially water and petroleum), adaptation to and mitigation of climate change and natural hazards, and environmental stewardship of highly stressed physical and biological Earth systems. As University of Montana Geoscientists, we address these challenges in our research and teaching. We develop the knowledge to find and extract mineral and water resources, solve problems caused by using those resources and develop models of the past, present and future Earth. Faculty, staff, graduate students, and undergraduate students are helping Montana and the World develop a sustainable future.

## **Our Vision:**

We will build and teach a fundamental understanding of Earth processes to benefit humankind and sustain Earth systems.

## **Our Goals:**

1. Conduct geoscience research, including obtaining extramural funding to perform essential and transformative research.
2. Disseminate research findings by publishing in peer-reviewed journals and presenting at national and international scientific conferences.
3. Teach students how to learn from known sources of information and create new knowledge from their own research.
4. Engage all graduate students and selected undergraduates in research and publication.
5. Produce graduates competent in their disciplines who can perform well in field, laboratory and computational settings, and who are prepared to serve as high-quality professionals in geoscience and related fields.
6. Provide opportunities for students to work and learn in other countries through international research and learning opportunities.
7. Educate the general student population about the nature of science and basic scientific principles through the study of Earth and its natural systems.
8. Engage the public with important geoscience issues through outreach and community education.

## **UM Geosciences in the National Context**

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With B.S., M.S. and Ph.D. degrees, UM Geosciences is one of 120 Ph.D. granting Geoscience departments in the United States. U.S. News & World Report ranks the UM Geosciences program with Universities like Florida State, Michigan Tech, University of Georgia, University of Pennsylvania, and University of South Carolina. We are ranked above schools like University of Idaho, University of Missouri, UNLV, and Notre Dame.

## **Employment**

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Geoscientists completing our program are employed by private industry, federal, state, and local governmental agencies, environmental consulting firms, non-profit organizations, and by schools needing Earth Science teachers. Jobs in geosciences are available at the B.S., M.S. and Ph.D. levels. The M.S. degree is considered the main working professional degree. The Ph.D. degree is required for positions at universities and with organizations specializing in research. However, there are ample opportunities for geoscience employment with the B.S. degree. Our graduates have a wide range of educational and employment opportunities. Over the last decade, 95% of our graduate program alumni are employed in Geosciences: 13% work for government, 23% for industry, 31% for consultancies and 2% for non-governmental organizations, 10% are teaching, and 17% went on for a Ph.D. UM Geosciences graduates have exceptional placement rates.

## Undergraduate Degree Requirements

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We offer three Bachelor of Science degrees: Geosciences B.S., International Field Geosciences Joint B.S. with University of Cork (Ireland), and International Field Geosciences Dual B.S. with Potsdam University (Germany). We also offer an option in Earth Science Education.

The Upper-division Writing Expectation must be met for all degree options 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).

### College Humanities & Sciences      Catalog Year: 2015-2016

Degree Type: Bachelor of Science      Level: **Major**      Subject: **Geosciences**

Total Credits: 62      Cumulative GPA Required: 2.0

Lower Division Core

Category Name: Lower Division Core

Rule: Must complete all of the following courses

Criterion: C-      Number of Credits 8

Course Listing

GEO 101N      Intro to Physical Geology      3

GEO 102N      Intro to Physical Geology Lab      1

GEO 211      Earth's History and Evolution      4

Commentary: Upper Division Core

Category Name: Degree Electives

Rule: Must complete 24 credits from the following list of courses

Criterion: C-

Course Listing      Number of Credits 24

GEO 225      Earth Materials 4

GEO 305      Igneous & Metamorph Petrology      4

GEO 309      Sedimentation/Stratigraphy      4

GEO 311      Paleobiology      3

GEO 315      Structural Geology      4

GEO 318      Surface Processes      4

GEO 320      Global Water      4

GEO 327	Geochemistry	4
GEO 420	Hydrogeology	4
GEO 421	Hydrology	3
GEO 433	Global Tectonics	3
GEO 443	Prin of Sedimentary Petrology	4
GEO 460	Process Geomorphology	4
GEO 482	Global Change	3
GEO 488	Snow, Ice and Climate	3
GEO 491	Special Topics 1 To 8	

Upper Division Core

Category Name: Cognate Sciences

Rule: In addition to completing course work in Geosciences, a minimum of 30 credits in cognate science classes must be completed. Criterion: Number of Credits

Course Listing

Commentary: More advanced courses in Chemistry, Computer Science, Math, and Physics may be used to meet the 30 credit minimum total in cognate sciences. Biology 100N or above is also appropriate. Course substitutions for the 30 credit minimum in cognate sciences must be approved by a departmental advisor.

Commentary: Cognates

Category Name: Physics

Rule: Must complete 1 of the following sequences

Criterion: Number of Credits 10

Course Listing Commentary:

Subcategory Name: Physics

Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 205N	College Physics I	4
PHSX 206N	College Physics I Laboratory	1
PHSX 207N	College Physics II	4
PHSX 208N	College Physics II Laboratory	1

Subcategory Name: Physics with Calculus Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 215N	Fund of Physics w/Calc I	4
PHSX 216N	Physics Laboratory I w/Calc	1
PHSX 217N	Fund of Physics w/Calc II	4
PHSX 218N	Physics Laboratory II w/Calc	1

Cognates

Category Name: Chemistry

Rule: Must complete the following courses

Criterion: C- Number of Credits 10

Course Listing

CHMY 141N	College Chemistry I	5
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CHMY 143N College Chemistry II 5

Commentary: Cognates

Category Name: Math

Rule: Must complete 1 of the following subcategories

Criterion: Number of Credits 7-8

Course Listing Commentary:

Subcategory Name: Math Option 1

Rule: May complete the following 2 courses

Criterion: C- Number of Credits 7

Course Listing

M 162 Applied Calculus 4

M 274 Intro to Differential Equation 3

Subcategory Name: Math Option 2

Rule: May complete the following 2 courses

Criterion: C- Number of Credits 8

Course Listing

M 171 Calculus I 4

M 172 Calculus II 4

Cognates

Category Name: Computer Science

Rule: Must complete 1 course in Computer Science (Programming or Modeling) Criterion: C- Number of Credits 3

Course Listing

CSCI 172 Intro to Computer Modeling 3

CSCI 250 Computer Mdlng/Science Majors 3

GPHY 284 Intro to GIS and Cartography 3

STAT 216 Introduction to Statistics 4

Commentary: These courses are recommended to complete the Computer Science requirement. Credit may be received for only 1 of these 4 courses for the 30 credit minimum cognate science requirement.

Upper Division Writing

Category Name: Upper Division Writing

Rule: Must complete 1 upper division writing course

Criterion: C- Number of Credits 3

Course Listing

GEO 320 Global Water 4

GEO 499 senior thesis / capstone 3 To 10

Commentary: These courses are recommended to complete the upper division writing requirement in Geosciences but students may also select from the university- approved list of upper division writing courses to fulfill this requirement.

Degree Specific Modern & Classical Languages Category Name: Languages

Rule: Must complete 1 of the following courses

Criterion: C- Number of Credits 3

Course Listing

M 162 Applied Calculus 4

Commentary: Students graduating in Geosciences may substitute one of these courses in place of the Modern and Classical Language requirement.

Degree Commentary: This option is designed for students who seek post-graduate employment as a professional geoscientist or preparation for graduate study in geosciences.

## **College Humanities & Sciences Catalog Year: 2015-2016**

Degree Type: Bachelor of Science Level: **Major** Subject: **Geosciences** Option: **Earth Science Education**

Total Credits: 60 Cumulative GPA Required: 2.0

Individuals interested in teaching in K-12 schools must complete a degree in the content area they want to teach plus the teacher preparation program through the Department of Curriculum and Instruction. Individuals must complete the teaching major/teaching track within that degree program, which may contain different course requirements than the academic major since the sequence of courses is designed to meet state standards. Upon completion of the degree program with the teaching track and the secondary licensure program, one will be eligible for a standard Montana teaching license in this content area.

Lower Division Core

Category Name: Lower Division Core

Rule: Must complete all of the following courses

Criterion: C- Number of Credits 17

Course Listing Commentary:

Subcategory Name: Geosciences Core

Rule: Must complete all of the following courses.

Criterion: C- Number of Credits 12

Course Listing

GEO 101N Intro to Physical Geology 3

GEO 102N Intro to Physical Geology Lab 1

GEO 211 Earth's History and Evolution 4

GEO 225 Earth Materials 4

Commentary:

Subcategory Name: Environmental Geoscience Course Rule: Must complete one of the following.

Criterion: C- Number of Credits 3

Course Listing

GEO 105N Oceanography 3

Commentary: Upper Division Core

Category Name: Upper Division Geosciences Rule:

Subcategory Name: Required Upper Division Geoscience Rule: Complete all of the following.

Criterion: C- Number of Credits 14

Course Listing

GEO 304E Science and Society 3

GEO 311 Paleobiology 3

GEO 315 Structural Geology 4

GEO 318 Surface Processes 4

Subcategory Name: Elective Upper Division Geoscience

Rule: Complete one additional GEO course at the 300- or 400-level

Criterion: C- Number of Credits 3

Course Listing

Commentary: GEO 320 Global Water is recommended to complete the upper division writing requirement in Geosciences but students may also select from the university-approved list of upper division writing courses to fulfill this requirement.

Commentary: Cognates

Category Name: Physics

Rule: Must complete 1 of the following sequences

Criterion: Number of Credits 10

Course Listing Commentary:

Subcategory Name: Physics

Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 205N	College Physics I	4
PHSX 206N	College Physics I Laboratory	1
PHSX 207N	College Physics II	4
PHSX 208N	College Physics II Laboratory	1

Subcategory Name: Physics with Calculus Rule: May complete the following sequence

Criterion: C- Number of Credits 10

PHSX 216N	Physics Laboratory I w/Calc	1
PHSX 217N	Fund of Physics w/Calc II	4
PHSX 218N	Physics Laboratory II w/Calc	1

Commentary: Cognates

Category Name: Chemistry

Rule: Must complete the following courses

Criterion: C- Number of Credits 7

Course Listing

CHMY 121N	Intro to General Chemistry	3
CHMY 123	Intro to Organic & Biochem	3
CHMY 485	Laboratory Safety	1

Commentary: Cognates

Category Name: Math

Rule: Must complete one math and one statistics course

Criterion: C- Number of Credits 8

Course Listing

M 162	Applied Calculus	4
M 171	Calculus I	4
STAT 216	Introduction to Statistics	4

Commentary: Cognates

Category Name: Astronomy

Rule: Must complete the following course



Criterion: C- Number of Credits 3

Course Listing

ASTR 131N Elementary Astronomy I 3

Track Requirements

Category Name: Teaching Methods Course Rule: Must complete the following course.

Criterion: C- Number of Credits 3

Course Listing

EDU 497 Teaching and Assessing 0 To 4 F

Commentary: The EDU 497 course number is used for multiple courses. Students should register for EDU 497

Methods: 5-12 Science.

Degree Specific Modern & Classical Languages Category Name: Languages

Rule: Must complete 1 of the following courses

Criterion: C- Number of Credits 3

Course Listing

M 162 Applied Calculus 4

M 171 Calculus I 4

Commentary: Students graduating in Geosciences may substitute one of these courses in place of the Modern and Classical Language requirement.

Degree Commentary: Students must be formally admitted to the Teacher Education Program and complete all of the professional education licensure requirements. See the Department of Curriculum & Instruction in the College of Education and Human Sciences for more information. A major GPA of 2.75 is required to be eligible for student teaching. This major does not qualify as a single field endorsement. Individuals must complete a second teaching major or minor in another content area.

## **College Humanities & Sciences Catalog Year: 2015-2016**

Degree Type: Minor Level: Minor Subject: **Geosciences (Minor)**

Total Credits: 18 Cumulative GPA Required: 2.0

Lower Division Core

Category Name: Lower Division Core Courses Rule: Must complete all of the following

Criterion: C- Number of Credits 8

Course Listing

GEO 101N Intro to Physical Geology 3

GEO 102N Intro to Physical Geology Lab 1

GEO 211 Earth's History and Evolution 4

Commentary: This sequence of courses is recommended but alternative sequences may be approved by an advisor.

Upper Division Core

Category Name: Degree Electives

Rule: Must complete an additional 10 credits in Geosciences courses numbered 200 and above Criterion: C-

Number of Credits 10

Course Listing Commentary:

Commentary: Degree Commentary

College Humanities & Sciences Catalog Year: 2015-2016

Degree Type: Minor Level: Minor Subject: Global Public Health (Minor) Total Credits: 21 Cumulative GPA

Required: 2.0

Lower Division Core

Category Name: Required Courses Rule: Must complete all of the following:

Criterion: C- Number of Credits 6

Course Listing

BIOM 227 Vectors and Parasites 3

PSCI 227 Global Health Issues 3

Commentary: Major Electives

Category Name: Core Electives

Rule: Must complete 9 credits from the following courses:

Criterion: C- Number of Credits 9

Course Listing

AHHS 430 Health Aspects of Aging 3

ANTY 349 Social Change in NnWstrn Socts 3

ANTY 426 Culture, Health and Healing 3

BIOM 400 Medical Microbiology 3

BIOM 427 General Parasitology 2

BIOM 428 General Parasitology Lab 2

CHTH 355 Theory Pract Comm Hlth Ed 3

CHTH 445 Prgrm Plan in Comm Health 3

COMX 425 Comm in Health Organizations3

PHAR 320 Am Ind Health Issues 2

PHAR 391 Special Topics 1 To 9

PHAR 491 Special Topics 1 To 9

PHL 321E Philosophy & Biomedical Ethics 3

PSCI 431 Politics of Global Migration 3

PSCI 463 Development Administration 3

S W 465 Social Work Global Context 3

SOCI 355 Population and Society3

Commentary: The student should select the Ethnobotany of Amerindians section of PHAR 391 Special Topics. The student should select the Public Health Genetics section of PHAR 491 Special Topics.

Commentary: Major Electives

Category Name: Content Electives

Rule: Must complete 6 credits from the following courses

Criterion: C- Number of Credits 6

Course Listing

ANTY 227 Human Sexuality 3

ANTY 333 Culture and Population3

ANTY 391 Special Topics 1 To 9

ANTY 402 Quan Ethnographic Field Methds 3

ANTY 418 Ecol Genet Var Human Pops 3

ANTY 422 Mind, Culture and Society 3

ANTY 431	Ethnographic Field Methods	3	
ANTY 435	Drugs, Culture and Society	3	
BIOB 130N	Evolution and Society	3	
BIOH 112	Human Form and Function I	3	
BIOH 113	Human Form and Function II	3	
BIOH 462	Principles Medical Physiology	3	
BIOM 250N	Microbiology for Hlth Sciences	3	
BIOM 402	Medical Bacteriology& Mycology		3
BIOM 435	Virology	3	
COMX 204X	International & Dvlpmnt Comm	3	
COMX 415	Intercultural Communication	3	
COMX 485	Communication and Health	3	
HTH 430	Hlth and Mind/Body/Spirit	3	
NASX 303E	Ecol Persp in Nat Amer Trad	3	
NASX 304E	Native American Beliefs/Philos	3	
NASX 388	Native Amer Health & Healing	3	
NUTR 221N	Basic Human Nutrition	3	
PSCI 324	Climate Policies: China & U.S.	3	
PSCI 326	Politics of Africa	3	
PSCI 348	US Multicultural Politics	3	
PSYX 362	Multicultural Psychology	3	
PUBH 595	Special Topics 1 To 12		
S W 300	Hum Behav & Soc Environ	3	
S W 310	S W Policy & Services	3	
S W 323	Women & Soc Action Amer	3	
S W 324	Gender and Welfare	3	
S W 410E	Social Work Ethics	3	
S W 455	Social Gerontology	3	
S W 475	Death, Dying and Grief	3	
SOCI 332	Sociology of the Family	3	
SOCI 371	Gender and Global Development		3
SOCI 443	Sociology of Poverty	3	
WGSS 263S	Women's and Gender Studies	3	

Commentary: Degree Commentary

Students must take all core courses from The University of Montana's curriculum, but can receive content credit for relevant practicum and internships experience and for relevant courses taken at other universities if approved by the program director.

## College Humanities & Sciences Catalog Year: 2015-2016

Degree Type: Bachelor of Science Level: Major Subject: **International Field Geos Dual**

Total Credits: 65 Cumulative GPA Required: 2.0

Lower Division Core

Category Name: Lower Division Core

Rule: Must complete all of the following courses

Criterion: C- Number of Credits 12

Course Listing

GEO 101N Intro to Physical Geology 3  
GEO 102N Intro to Physical Geology Lab 1  
GEO 211 Earth's History and Evolution 4  
GEO 225 Earth Materials 4

Commentary: Upper Division Core

Category Name: Upper Division Core

Rule: Must complete all of the following courses

Criterion: C- Number of Credits 8

Course Listing

GEO 315 Structural Geology 4  
GEO 318 Surface Processes 4

Rule: Must complete 17 credits from the following courses:

Criterion: C- Number of Credits 17

Course Listing

GEO 305 Igneous & Metamorph Petrology 4  
GEO 309 Sedimentation/Stratigraphy 4  
GEO 311 Paleobiology 3  
GEO 320 Global Water 4  
GEO 327 Geochemistry 4  
GEO 420 Hydrogeology 4  
GEO 433 Global Tectonics 3  
GEO 460 Process Geomorphology 4  
GEO 491 Special Topics 1 To 8

Commentary: Cognates

Category Name: Physics

Rule: Must complete 1 of the following sequences

Criterion: Number of Credits 10

Course Listing Commentary:

Subcategory Name: Physics

Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 205N College Physics I 4  
PHSX 206N College Physics I Laboratory 1  
PHSX 207N College Physics II 4  
PHSX 208N College Physics II Laboratory 1

Subcategory Name: Physics with Calculus Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 215N Fund of Physics w/Calc I 4

PHSX 216N Physics Laboratory I w/Calc 1

Commentary: Cognates

Category Name: Chemistry

Rule: Must complete 1 of the following subcategories

Criterion: Number of Credits 8-10

Course Listing Commentary:

Subcategory Name: Chemistry Option 1

Rule: May complete all of the following courses

Criterion: C- Number of Credits 8

Course Listing

CHMY 121N Intro to General Chemistry 3

CHMY 123N Intro to Organic & Biochem 3

CHMY 124N Intro to Organic & Biochem Lab 2

Subcategory Name: Chemistry Option 2

Rule: May complete all of the following courses

Criterion: C- Number of Credits 10

Course Listing

CHMY 141N College Chemistry I 5

CHMY 143N College Chemistry II 5

Commentary: Cognates

Category Name: Math

Rule: Must complete 1 of the following subcategories

Criterion: Number of Credits 7-8

Course Listing Commentary:

Subcategory Name: Math Option 1

Rule: May complete the following 2 courses

Criterion: C- Number of Credits 7

M 274 Intro to Differential Equation 3

Subcategory Name: Math Option 2

Rule: May complete the following 2 courses

Criterion: C- Number of Credits 8

Course Listing

M 171 Calculus I 4

M 172 Calculus II 4

Cognates

Category Name: Computer Science

Rule: Must complete 1 of the following courses

Criterion: C- Number of Credits 3

Course Listing

CSCI 250 Computer Mdlng/Science Majors 3

GPHY 284 Intro to GIS and Cartography 3

STAT 216 Introduction to Statistics 4

Commentary:

## Upper Division Writing

Category Name: Upper Division Writing Rule: Must complete the following course

Criterion: C- Number of Credits 4

### Course Listing

GEO 320 Global Water 4

Commentary: This course is recommended to complete the upper division writing requirement in Geosciences but students may also select from the university- approved list of upper division writing courses to fulfill this requirement.

Degree Specific Modern & Classical Languages Category Name: Languages

Rule: UM outgoing students must complete the following language sequence (the "test out provision" applies as administered by the Department of Modern and

### Course Listing

GRMN 101 Elementary German I 5

GRMN 102 Elementary German II 5

Commentary:

Degree Specific Natural Sciences Category Name: Overseas Coursework

Rule: Must complete the following courses and field work at Potsdam University Criterion: C- Number of Credits 27-30

### Course Listing

Commentary: In addition to Geosciences coursework completed at UM students must complete the following:

1. Selection of one field course run by Potsdam University listed below 1a. BP 15 (Field Course - France)  
1b. BW01 (Field Course - Norway) 1c. BW02 (field Course - Alps)
2. Any 4 of the following courses offered by Potsdam University 2a. Regional Geology  
2b. Paleoclimate @ Quaternary Geology 2c. Analysis of Geologic Maps  
2d. Analytic Geochemistry 2e. Natural Hazards  
2f. Tectonophysics & Rheology 2g. Seismology  
2h. Seismics  
2i. Geoelectrics  
2j. Sedimentary Systems & Stratigraphic Geomorphology 2k. Tectonics and Geodynamics
3. 2 additional cognate science courses to be taken at Potsdam University

Degree Commentary: This degree is designed specifically for students who seek to combine a rigorous education in the Geosciences with a yearlong international Geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. For students who satisfy all degree requirements, a B.S. degree in International Field Geosciences will be awarded by The University of Montana and a second B.S. degree in International Field Geosciences will be awarded by the Potsdam University. The degree requirements specified below pertain both to UM-based and Potsdam-based students seeking their UM diploma. Potsdam-based students are eligible to satisfy any of the following specific requirements through credits that are transferred from Potsdam and approved as equivalent by the UM Geosciences undergraduate advisors.

## **College Humanities & Sciences Catalog Year: 2015-2016**

Degree Type: Bachelor of Science Level: Major Subject: **International Field Geos Joint**

Total Credits: 67 Cumulative GPA Required: 2.0

### Lower Division Core

Category Name: Lower Division Core

Rule: Must complete all of the following courses

Criterion: C- Number of Credits 12

Course Listing

GEO 101N Intro to Physical Geology 3

GEO 102N Intro to Physical Geology Lab 1

GEO 211 Earth's History and Evolution 4

GEO 225 Earth Materials 4

Commentary: Upper Division Core

Category Name: Upper Division Core

Rule: Must complete all of the following subcategories

Criterion: C- Number of Credits 12

Course Listing Commentary:

Subcategory Name: Subcategory 1

Rule: Must complete all of the following courses

Criterion: C- Number of Credits 8

Course Listing

GEO 315 Structural Geology 4

GEO 318 Surface Processes 4

Subcategory Name: Subcategory 2

Rule: Must complete 1 of the following courses

Criterion: C- Number of Credits 4

Course Listing

GEO 309 Sedimentation/Stratigraphy 4

GEO 443 Prin of Sedimentary Petrology 4

Commentary:

Rule: Must complete 15 credits from the following courses:

Criterion: C- Number of Credits 15

Course Listing

GEO 305 Igneous & Metamorph Petrology 4

GEO 309 Sedimentation/Stratigraphy 4

GEO 311 Paleobiology 3

GEO 320 Global Water 4

GEO 327 Geochemistry 4

GEO 420 Hydrogeology 4

GEO 433 Global Tectonics 3

GEO 443 Prin of Sedimentary Petrology 4

GEO 460 Process Geomorphology 4

GEO 491 Special Topics 1 To 8

Commentary: Cognates

Category Name: Physics

Rule: Must complete 1 of the following sequences

Criterion: Number of Credits 10

Course Listing Commentary:

Subcategory Name: Physics

Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 205N College Physics I 4  
PHSX 206N College Physics I Laboratory 1  
PHSX 207N College Physics II 4  
PHSX 208N College Physics II Laboratory 1

Subcategory Name: Physics with Calculus Rule: May complete the following sequence

Criterion: C- Number of Credits 10

Course Listing

PHSX 215N Fund of Physics w/Calc I 4  
PHSX 218N Physics Laboratory II w/Calc 1

Commentary: Cognates

Category Name: Chemistry

Rule: Must complete 1 of the following subcategories

Criterion: Number of Credits 8-10

Course Listing Commentary:

Subcategory Name: Chemistry Option 1

Rule: May complete all of the following courses

Criterion: C- Number of Credits 8

Course Listing

CHMY 121N Intro to General Chemistry 3  
CHMY 123N Intro to Organic & Biochem 3  
CHMY 124N Intro to Organic & Biochem Lab 2

Subcategory Name: Chemistry Option 2

Rule: May complete all of the following courses

Criterion: C- Number of Credits 10

Course Listing

CHMY 141N College Chemistry I 5  
CHMY 143N College Chemistry II 5

Commentary: Cognates

Category Name: Math

Rule: Must complete 1 of the following subcategories

Criterion: Number of Credits 7-8

Course Listing Commentary:

Subcategory Name: Math Option 1

Rule: May complete the following 2 courses

M 162 Applied Calculus 4  
M 274 Intro to Differential Equation 3

Subcategory Name: Math Option 2

Rule: May complete the following 2 courses

Criterion: C- Number of Credits 8



Course Listing

M 171 Calculus I 4

M 172 Calculus II 4

Cognates

Category Name: Computer Science

Rule: Must complete 1 of the following courses

Criterion: C- Number of Credits 3

Course Listing

CSCI 250 Computer Mding/Science Majors 3

GPHY 284 Intro to GIS and Cartography 3

STAT 216 Introduction to Statistics 4

Upper Division Writing

Category Name: Upper Division Writing Rule: Must complete the following course

Criterion: C- Number of Credits 4

Course Listing

GEO 320 Global Water 4

Commentary: This course is recommended to complete the upper division writing requirement in Geosciences but students may also select from the university- approved list of upper division writing courses to fulfill this requirement.

Degree Specific Modern & Classical Languages Category Name: Languages

Criterion: Number of Credits 6-10

Course Listing Commentary:

Subcategory Name: German

Rule: May complete the following language sequence

Criterion: C- Number of Credits 10

Course Listing

GRMN 101 Elementary German I 5

GRMN 102 Elementary German II 5

Subcategory Name: Irish

Rule: May complete the following language sequence

Criterion: C- Number of Credits 6

Course Listing

ENIR 101 Elementary Irish I 3

ENIR 102 Elementary Irish II 3

Commentary:

Degree Specific Natural Sciences Category Name: Overseas Coursework

Rule: Must complete the following courses and field work at University College of Cork and Potsdam University

Criterion: C- Number of Credits 33-36

Course Listing

Commentary: In addition to Geosciences coursework completed at UM students must complete the following:

1. 1 formal field course module run by University College Cork, selected from 1a. GL 2016 (Easter Field Course - Dingle Peninsula)
- 1b. GL 3019 (Easter Field Course - Western Scotland) 1c, ER 3002 (Easter Field Course - North Clare)
- 1d. GL 4008 (Easter Field Course - Central Greece)

- 1e. another equivalent-level field course run by UCC and approved apriori by their UCC and UM advisors
2. While in residence at Cork, students must complete any 9 of the following courses in consultation with their UCC and UM advisors
- 2a. Sed Processes and Petrology
- 2b. Igneous and MM Petrology
- 2c. Invertebrate Paleontology & Evolution 2d. Plate Tectonics & Global Geophysics 2e. Igneous Petrogenesis & Geochemistry 2f. Metamorphism & Geochronology
- 2g. Advanced Structural Geology
- 2j. Environmental Geology
- 2k. Terr Ecosystems Through Time 2l. Micropaleontology & Palynology
- 2m. Petroleum Geology & Basin Analysis
- 2n. Applied Geophysics & Computer Applications 2o. Advanced Igneous Petrology
- 2p. Hydrogeology
3. 1 formal upper-level Geosciences course at Potsdam University. Recommended are courses that focus on computer-based visualization or geoscience data using GIS or other visualization platforms
- Commentary: Degree Commentary

This degree is designed specifically for students who seek to combine a rigorous education in the Geosciences with a yearlong international Geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. Most of the course work completed during the year abroad will take place at University College Cork (UCC) in Ireland. For students who satisfy all degree requirements, a joint B.S. degree in International Field Geosciences will be awarded by The University of Montana and the University College Cork.

## Department Faculty

### Professor

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- Joel T. Harper, Ph.D, University of Wyoming, 1998
- Marc S. Hendrix, Ph.D., Stanford University, 1992
- Nancy W. Hinman, Ph.D., University of California (San Diego), 1987
- James W. Sears, Ph.D., Queen's University, 1979
- George Stanley, Ph.D., University of Kansas, 1977
- James R. Staub, Ph.D., University of South Carolina, 1985 (Dept. Chair)

### Associate Professor

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- 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

### Assistant Professor

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- Payton Gardner, PhD., University of Utah, 2009

### Lecturer

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- Kathleen M. Harper, Ph.D., University of Wyoming, 1997

## Research Faculty

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- Carrine E. Blank, Ph.D., University of California, Berkeley; Integrative Biology, 2002
- Michael Hofmann, Ph.D., The University of Montana, 2005

## Affiliates

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- Robert Lankston, Faculty Affiliate
- Patrick Meere
- Tetsuji Onou
- Jill Scott
- Alisa Wade

## Emeritus

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- Donald W. Hyndman
- Ian M. Lange, Ph.D., University of Washington, 1968
- Johnnie N. Moore, Ph.D., University of California (Los Angeles), 1976
- Raymond C. Murray, Ph.D., University of Wisconsin, 1955
- Steven D. Sheriff, University of Wyoming, 1981
- Graham R. Thompson, Ph.D., Case Western Reserve University, 1971
- Donald Winston, Ph.D., University of Texas, 1963
- William W. Woessner, Ph.D., University of Wisconsin (Madison), 1978

## Course Descriptions

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### Geoscience

#### GEO 101N - Introduction to Physical Geology

Credits: 3. 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. Course Attributes: Natural Science Course

#### GEO 102N - Introduction to Physical Geology Lab

Credits: 1. Offered autumn and spring. Prereq. or coreq., GEO 101N (preferred) or 105N or 108N. 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 primarily with GEO 101N, but can be taken with or following any of the other freshman GEO courses listed above. Course Attributes: Natural Science Lab Course

#### GEO 105N - Oceanography

Credits: 3. Offered spring. The ocean covers 70 % of the globe, and yet vast regions remain unexplored. Interactions between the atmosphere and the sea moderate and control our climate. Nearly 40 % of the world's population lives within 100 kilometers of the coast. The oceans are geographically, environmentally, culturally, and economically critical to society. This course introduces oceanography, including the origin of water and ocean basins; marine resources; atmospheric circulation; air-sea interaction; ocean-climate feedback; currents, tides, and coastal processes; marine ecology; and use and misuse of the oceans. Course Attributes: Natural Science Course

#### GEO 106N - History of Life

Credits: 3. 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. Course Attributes: Natural Science Lab Course

#### GEO 107 - Natural Hazards

Credits: 3. 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.

#### GEO 108N - Climate Change

Credits: 3. 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. Course Attributes: Natural Science Course

#### GEO 151 - Introduction to Fossil Fuels

Credits: 3. 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.

#### GEO 191 - Special Topics

Credits: 1 TO 6. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

#### GEO 191N - Special Topics

Credits: 1 TO 6. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics. Course Attributes: Internships/Practicums

#### GEO 211 - Earth's History and Evolution

Credits: 4. Offered autumn and spring. Prereq., GEO 101N and GEO 102N. Traces the history of the Earth since its inception 4.6 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.

#### GEO 225 - Earth Materials

Credits: 4. Offered autumn. Prereq., any geoscience 100 level lecture course, GEO 102N, CHMY 121N or 141N. 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.

#### GEO 291 - Special Topics

Credits: 1 TO 6. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

#### GEO 304E - Science and Society

Credits: 3. 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. Course Attributes: Ethical & Human Values Course

#### GEO 305 - Igneous & Metamorph Petrology

Credits: 4. Offered spring. Prereq., GEO 225, CHMY 143N. Igneous rock associations, igneous processes and origins; metamorphic minerals and phase relationships, metamorphic zones, facies, and conditions; metamorphic environments, metallic minerals and mineral deposits.

#### GEO 309 - Sedimentation/Stratigraphy

Credits: 4. Offered spring. Prereq. GEO 211, 225. 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.

#### GEO 311 - Paleobiology

Credits: 3. Offered spring. Prereq. GEO 101N or equiv. level Biology. Survey of the major groups of organisms in the geologic record and hands-on study of fossils; application of geologic and biologic data and principles to solve problems in geoscience and bioscience.

#### GEO 315 - Structural Geology

Credits: 4. Offered autumn. Prereq., GEO 211, 225. Structures of deformed rocks; mechanical principles; graphical interpretation of structural problems, tectonic principles.

#### GEO 317 - Planetary Science

Credits: 3. Offered autumn even-numbered years. Prereq., PHSX 205N/206N or PHSX 215N/216N and M 162, 171. Same as ASTR 351. Physical and geological characteristics of planets, satellites, asteroids, comets, and meteoroids with an emphasis on comparative planetology.

#### GEO 318 - Surface Processes

Credits: 4. Offered spring. Prereq., GEO 101/102, GEO 211, M 162 or M 171, and PHSX 205/206 or PHSX 215/216. This course will introduce students to the study of the earth using the laws and principles of physics. The course will describe the mechanisms underlying the processes that shape the earth and drive its evolution, including climate, tectonics, hydrology, glaciers, and geomorphology. The course will combine lectures, field data collection, data analysis, and lab activities.

#### GEO 320 - Global Water

Credits: 4. Offered autumn. Prereq. one semester of college chemistry, WRIT 101 or equiv., and completion of one writing course. Students are encouraged to take the UDWPA prior to taking this course. Fulfills the Upper Division Writing Requirement. Water is necessary for life. Without it, life as we know it cannot exist. This course discusses the chemistry of water as it moves through the hydrological cycle. We discuss how water chemistry evolves through atmospheric water, rain water, ground water, surface water, and sea water. Students will have an understanding of the chemical attributes of water in major water reservoirs. Class discussions, formal and informal writing assignments, a short laboratory experiment, and a field trip highlight examples of water chemistry. Students will use excel to solve problems and will learn citation conventions relevant for scientific writing. Course Attributes: Writing Course-Advanced

#### GEO 327 - Geochemistry

Credits: 4. Offered alternate years. Prereq. one year of college chemistry, one semester of calculus, and one semester of physical geology, or consent of instructor. One semester of mineralogy recommended. The chemical properties of elements control their geological distribution and underlie the basic physical properties of rocks. An understanding of geochemistry will help students understand water chemistry, sediment geochemistry, and igneous petrology. The course covers chemical principles applied to geologic materials and processes, including the origin and chemical composition of earth, atmosphere, and hydrosphere. Principles of stable and radiogenic isotope geochemistry are discussed. Students will use excel to solve problems. Class discussions, problems sets, and exams are used to assess student performance.

#### GEO 391 - Special Topics

Credits: 1 TO 9. (R-9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

#### GEO 392 - Independent Study

Credits: 1 TO 6. (R-6) Offered every term. Specific topics of particular interest to individual students.

#### GEO 398 - Internship

Credits: 1 TO 6. 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 may be applied to the geosciences minor. A maximum of 6 credits of Internship may count toward graduation. Course Attributes: Internships/Practicums

#### GEO 420 - Hydrogeology

Credits: 4. Offered spring. Prereq., GEO 101N-102N; PHSX 205N/206N or PHSX 215N/216N ; M 162 or 171 strongly recommended or consent of instr. Occurrence, movement, quality, and methods of quantification of groundwater. Geological framework and physics of groundwater flow. Supply, contamination, and management problems.

#### GEO 421 - Hydrology

Credits: 3. Offered autumn. Prereq. one semester college calculus and physics or consent of instructor. Introduction to the physical mechanisms that drive the water cycle at different scales. The course covers heat, momentum and mass transfer and storage mechanisms in turbulent systems and their role in the global and local climates. At the local scale, the equations that govern surface and subsurface water flows are studied. Along with the overarching goals, students will improve their quantitative skills, will gain experience accessing and reading the professional literature and will improve their capabilities to acquire knowledge independently.

#### GEO 433 - Global Tectonics

Credits: 3. Offered autumn. Prereq., GEO 315, M 162, 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.

#### GEO 443 - Principles of Sedimentary Petrology

Credits: 4. Offered autumn. Prereq., GEO 225 or graduate standing. 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.

#### GEO 460 - Process Geomorphology

Credits: 4. Offered autumn. Prereq., one semester 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.

#### GEO 482 - Global Change

Credits: 3. Offered Spring. Same as CCS 482. Prereq., upper division/higher standing in Geosciences or consent of instructor. Lectures, readings, discussions and practicum on the complexity of global climate. Emphasizes the physical, geochemical and geologic processes affecting climate change over geologic and recent time scales.

#### GEO 488 - Snow, Ice and Climate

Credits: 3. Offered spring. Prereq., M 121. 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.

#### GEO 491 - Special Topics

Credits: 1 TO 8. (R-8) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses or one-time offerings of current topics.

#### GEO 492 - Independent Study

Credits: 1 TO 6. (R-6) Offered every term. Specific topics of particular interest to individual students.

#### GEO 494 - Senior Geology Seminar

Credits: 1 TO 10. (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.

#### GEO 498 - Internship

Credits: 1 TO 6. 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 GEOS 398 may be applied to the geosciences minor. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.

Course Attributes: Internships/Practicums

#### GEO 499 - Senior Thesis /Capstone

Credits: 3 TO 10. (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. Course

Attributes: Writing Course-Advanced

#### GEO 508 - Fundamentals of Academic Research

Credits: 2. Offered autumn. 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. Level: Graduate

#### GEO 528 - Sedimentary Basin Analysis

Credits: 4. Offered intermittently. Influence of allocyclic processes (tectonism, climate, eustasy, 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. Level: Graduate

#### GEO 531 - Environmental Geochemical Metal Contamination

Credits: 4. Offered intermittently. Prereq., GEO 570, 579; CHMY 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.

Level: Graduate

#### GEO 548 - Topics in Cryosphere

Credits: 3. (R-6 M.S., R-12 Ph.D.) 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. Level: Graduate

#### GEO 560 - Fluvial Geomorphology

Credits: 3. Offered spring. Prereq., graduate standing or consent of instructor. 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. Level: Graduate

#### GEO 570 - Aqueous Geochemistry

Credits: 4. Offered alternate years. Prereq. one year college chemistry and one year of calculus, or consent of instructor. Water is necessary for life. Water carries nutrients, dissolved minerals, and contaminants through the hydrological cycle and within living systems. This course discusses the chemistry of aqueous systems including aqueous kinetics, aqueous thermodynamics, acid/base chemistry, carbonate systematics, oxidation/reduction reactions, mineral solubility, and complexation. It includes an introduction to the use of geochemical models to model kinetic and thermodynamic systems. Concepts are applied to examples from natural systems that are selected based on the interests of the students in the class. Students are evaluated by problem sets, exams, and a term paper Level: Graduate

#### GEO 572 - Advanced Hydrogeology

Credits: 3. Offered autumn. Prereq., GEO 420 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. Level: Graduate

#### GEO 573 - Application Groundwater Modeling

Credits: 3. Offered spring. Prereq., GEO 420 or 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. Level: Graduate

#### GEO 579 - Chemistry of Hot Springs

Credits: 3. Offered alternate years. Prereq., one year of college of chemistry or consent of instr. Hydrothermal systems support the most ancient microorganisms and may have been the locus for the first appearance of life on Earth. Terrestrial hot springs are the surface expression of deep circulation of fluids that concentrate elements, opening a window into processes leading to ore formation. This course discusses the 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. The course includes an introduction to the use of geochemical models and a field trip to a hot spring system. Students are evaluated on class discussions and presentations, problems sets, and a term paper. Level: Graduate

#### GEO 580 - Topics Mineral & Petrol

Credits: 1 TO 12. (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. Level: Graduate

#### GEO 582 - Tps Structure & Geophysics

Credits: 1 TO 12. (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. Level: Graduate

#### GEO 583 - Tps Strat, Sed & Paleo

Credits: 1 TO 12. (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. Level: Graduate

#### GEO 585 - Tps Hydro Low-Temp Geochem

Credits: 1 TO 12. (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. Level: Graduate



### GEO 587 - Geomorph Seminar

Credits: 1 TO 6. (R–6 for M.S., R–12 for Ph.D.) Offered alternate years. 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. Level: Graduate

### GEO 590 - Supervised Internship

Credits: 1 TO 12. Offered intermittently. Directed individual research and study appropriate to the back ground and objectives of the student. Level: Graduate Course Attributes: Research & Creative Schlrshp

### GEO 595 - Special Topics

Credits: 1 TO 8. (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. Level: Graduate Course Attributes: Internships/Practicums

### GEO 597 - Advanced Problems

Credits: 1 TO 10. (R–10) Offered intermittently. Prereq., consent of instr. Investigations of geological problems exclusive of thesis or dissertation research. Level: Graduate

### GEO 599 - Thesis Research

Credits: 1 TO 12. (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. Level: Graduate

### GEO 699 - Dissertation Research

Credits: 1 TO 12. (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. Level: Graduate

# History Department

## **Robert H. Greene, Chair**

The History Department offers an exciting program of instruction for undergraduates in search of a broad education. The curriculum is designed to provide knowledge and understanding of the background and ramifications of present local, national, and world affairs. The program emphasizes historical analysis and critical thought rather than the memorization of facts. History majors are taught how to read critically, analyze thoughtfully, conduct research carefully, and write intelligently.

The department offers a wide variety of courses ranging in time, space, and theme. Courses span the full range of American history from the colonial period through the recent past. More specialized courses in local and regional history focus on Montana, the West, and the northern Rockies. Offerings in European and world history emphasize social, cultural, and intellectual history, French and German history, British history, Russian and Soviet history, Latin American history, Islamic civilization, East Asian history, and Central and Southwest Asian history. Topical courses explore issues of democracy, diplomacy, human rights, war and peace, terrorism, race and gender, religion, and environmental history.

History provides not only a basis for future employment but also, more importantly, furnishes knowledge and perspective for intelligent leadership in community affairs. Graduates are employed in federal, state, or local governments, with positions ranging from elected office to research analysts. Many teach history in middle schools