

**826. Research Design in Geography**  
*Winter, Spring. 3(3-0) Approval of department.*

Formalized approach to research and writing in geography: Identification of geographic problems and their relative importance, structuring and stating hypotheses, data acquisitions, and tests for validity.

**827. Contemporary Theory and Methodology in Geographic Research**  
*(816.) Spring. 3(3-0) Approval of department.*

Examination of the forward edges of geographic research, particularly with respect to its relation to other disciplines, scientific methodology in general, and the evolution of geography as a professional scholarly discipline.

**828. Seminar in Recreation Geography**  
*Spring. 3(3-0) 309 or approval of instructor.*

Selected current problems in recreation geography in the U.S. and abroad.

**834. Seminar in Physical Geography**  
*Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits. Approval of department.*

Analysis of classical and contemporary problems in physical geography treated as follows: climatology (winter), biogeography (spring), geomorphology (spring).

**835. Seminar in Location Theory**  
*Fall. 3(3-0) Approval of department, 435.*

Recent developments and research in location analysis and regional science.

**836. Population Geography Seminar**  
*Spring. 3(3-0) Approval of department.*

Studies of particular topics and problems in population geography.

**IDC. Interdisciplinary Seminar on Africa**  
*For course description, see Interdisciplinary Courses.*

**850. Advanced Field Techniques**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits.*

Instruction and practical training in the selection, data-gathering, on-site analysis, and presentation of geographic field problems.

**858. Seminar in Geographic Education**  
*Spring. 3(3-0) Approval of department.*

Treatment of selected topics in geographic education.

**870. Seminar in Medical Geography**  
*Winter. 3(3-0).*

Spatio-environmental analysis of selected health problems.

**899. Research**  
*Fall, Winter, Spring, Summer. Variable credit. Approval of department.*

**901. Problems in Cultural Geography**  
*Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.*  
Special research problems.

**902. Problems in Physical Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits.*

Supervised research in specific topics of physical geography.

**906. Problems in Economic Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.*  
Special research problems.

**908. Problems in Political Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department, 416.*  
Special research problems.

**910. Problems in Historical Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.*  
Special research problems in historical geography.

**912. Independent Study in Regional Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits. Approval of department.*  
Individual studies in regional geography.

**918. Problems in Geography**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.*  
Research on specific geographical problems.

**934. Problems in Population**  
*Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.*  
Special research problems.

**970. Problems in Medical Geography**  
*Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.*  
Selected research topics in medical geography.

**999. Research**  
*Fall, Winter, Spring, Summer. Variable credit. Approval of department.*

## GEOLOGY GLG

### College of Natural Science

**200. The Geology of Man's Environment**  
*Fall, Winter, Spring, Summer. 3(3-0) Not open to Geology majors. Credit will be given in only one of the following: 200, 201, 306.*

The relation of geological processes and Earth materials to man. The nature and evolution of the Earth and life upon it. Man's exploitation of the non-renewable resources of the Earth.

**200L. Laboratory—Geology of Man's Environment**  
*Fall, Winter, Spring, Summer. 1(0-3) 200 or concurrently.*  
The geological reasoning concerning the nature and evolution of the Earth.

**201. Earth Processes**  
*Fall, Winter, Spring. 4(4-2) Credit will be given for only one of the following: 200, 201, 306.*

Physical processes concerning evolution of Earth and its environments. Conservation and interaction of energy and matter through time. Laboratory stresses interpretation of process through studies of geologic data.

**202. Evolution of the Earth**  
*Fall, Winter, Spring. 4(4-2) 200; or 201; or 306.*  
Integration of physical, chemical and biological processes from which man's present environment has evolved; problems and controversies in the development of ideas of geologic and organic evolution.

**IDC. Introduction to Study of the Moon**  
*For course description, see Interdisciplinary Courses.*

**205. Oceanology—The Marine Environment and Man**  
*Fall. 3(3-0)*  
Physical oceanography, including origin, hydrologic, chemical, geological properties; and environmental quality of the oceans. Man-sea interactions are emphasized including resource utilization and pollution.

**221. Minerals, Rocks and Fossils**  
*(326.) Spring 3(2-3) Not open to majors.*  
Description, occurrence and identification of minerals, rocks, fossils, and additional features of especial significance to general science teachers and other earth science interest groups.

**230. The Role of the Natural Sciences in Future Environments**  
*Fall. 4(4-0) Approval of department.*  
*Interdepartmental with the departments of Entomology, Physics and Zoology and the College of Natural Science and administered by the College of Natural Science.*

Physical and biological science concepts relevant to understanding of environmental issues. Options for action in areas of population size, energy and life support system. Illustrated by case studies.

**271. Geophysics and the Earth**  
*Spring. 3(3-0) 200 or 201 or 306 or approval of department.*  
Basic concepts used in geophysics, including description of the Earth and its interior, methods of exploring for mineral and energy resources. Contributions of physical methods to understanding our terrestrial environment.

**281. Mineral Resources of the Earth**  
*Fall. 3(3-0)*  
Mineral resources; their genesis, occurrence, exploitation and use. Future projections from historic and current developments. The impact on international affairs and the welfare of nations. Field trip.

**282. Energy Resources of the Earth**  
*Winter. 3(3-0)*  
World energy resources of petroleum, coal, and atomic fuel. Social, political, economic and environmental problems of fuels.

**295. Introductory Earth Chemistry**  
*Winter. 3(3-0) 200 or 201 or 306, or approval of department.*  
Qualitative description of processes affecting distribution of elements in rocks, soils, waters, the atmosphere, and meteorites. Age of the earth. Origin of the elements. Geochemical methods to study the evolution of the mantle, crust, atmosphere and oceans.

**Descriptions — Geology  
of  
Courses**

**302. Vertebrate Life of the Past**

Fall. 3(3-0) One course in a physical or biological science or Juniors. Interdepartmental with the Zoology Department.  
Fossil vertebrates from fish to man.

**303. Introductory Geomorphology**

Winter. 3(3-0) 200 or 201 or 306.  
Descriptive course treating the geological origin and development of important surface features including special consideration of Pleistocene landforms of the Great Lakes region.

**303L. Laboratory—Introductory Geomorphology**

Winter. 1(0-2) 303 or concurrently.  
Methods of map interpretation and use of aerial photographs in geomorphology. Supplemental field trip to study the geology of pertinent landforms.

**304. Geology of Michigan**

Fall. 3(3-0) 200 or 201 and/or 202; or approval of department.  
A historical accounting of the physical, historical and economic geology of Michigan and its environs; a course designed for students seeking an overall picture of the rather unique Michigan geological environment.

**305. Field Glaciology**

Summer. 6 credits. May re-enroll for a maximum of 12 credits. Approval of department.  
Study of existing glaciers, glacial and periglacial features, providing first-hand experience in glaciology and allied disciplines on and near Juneau Icefield, Alaska. Lectures, demonstrations, research participation with field methods training. Inquire at the department about cost.

**306. Engineering Geology**

Fall. 3(3-2) Credit will be given for only one of the following: 200, 201, 306. Sophomore Engineering students.  
Fundamental principles of geology as applied to civil engineering practice. Minerals and rocks, aerial photographs, topographic and areal geologic maps and geologic cross sections studied in laboratory. Source of geologic literature and maps.

**307. Geology Central Appalachians**

Winter. 1(0-2) 200, or 201, or 202, or concurrently.  
General geology of the Central Appalachians. A preparatory course for 308. Field excursions—Central Appalachians during spring vacation.

**308. Field Excursion—Central Appalachians**

Spring. 2 or 3 credits. 307.  
Training in stratigraphic, sedimentological, paleontologic, and structural principles as applied to field methods.

**321. Mineralogy**

(421.) Fall. 5(4-4) One term of chemistry.  
Introduction to crystal systems and forms exhibited by minerals, followed by study of composition, occurrence, classification, and identification of nonmetallic minerals.

**322. Mineralogy**

(422.) Winter. 4(3-4) 321.  
Economic and chemical importance of minerals; mineralogy of non-silicates; practical crystallography; geochemistry of minerals.

**335. Fossil Plants, Their History and Paleocology**

Spring. 3(3-0) One course in geology or botany or biology or approval of department. Interdepartmental with the Botany and Plant Pathology Department.  
History of plants through geologic time; their form and evolution; how and where found, identified and reconstructed; their use in determining ancient geographic patterns, paleoenvironments, paleoclimates and community structure. Field trip.

**344. Field Geology—Summer Camp**

Summer. 9 credits. 202, 363. Trigonometry; GLG 446, 437, 451 recommended.  
Methods and techniques of geological surveying and mapping. Field interpretation of geological phenomena in igneous, metamorphic and sedimentary rocks in northern Michigan and Wisconsin.

**A. Introduction to Field Techniques**

3 credits.  
Introduction to field techniques with stress on those that apply to sedimentary rocks. Stratigraphic correlation.

**B. Methods of Geological Mapping**

4 credits.  
Plane table surveys, aerial photo and reconnaissance mapping. Examination and interpretation of structural and textural relationships in igneous and metamorphic rocks.

**C. Geologic Interpretation of Selected Areas**

2 credits.  
Independent mapping and interpretation.

**363. Lithology**

(323, 423.) Spring. 4(3-4) 321.  
Processes that form igneous, metamorphic and sedimentary rocks, origin, distribution, variation and occurrence of rock. Study of rock properties in the field, in laboratory, and with the microscope.

**400H. Honors Work**

Fall, Winter, Spring. Variable credit.  
Approval of department.

**401. Environmental Geology**

Spring of odd-numbered years. 3(3-0) 200, or 201, or 306, MTH 113, or approval of department.  
Quantitative solution of geological problems applied to environmental planning and management, including surface and ground water waste disposal, urban geology, and methods for prediction of geologic hazards and resources.

**411. Hydrogeology**

Spring. 3(3-2) One term of geology and trigonometry.  
Principles of the source, occurrence, and movement of ground water. Surface and subsurface investigations of ground water and elementary ground water hydrology.

**413. Glacial Geology**

Spring. 3(3-2) 201.  
Geological aspects of glaciers and glaciation. Theories of ice ages through geologic time. Origin and development of glacial geomorphic features. Character and chronology of the Pleistocene. Laboratory techniques, with field trips to observe glacial materials and features of Michigan.

**415. Physical Limnology of the Great Lakes**

Spring of even-numbered years. 3(3-0) Approval of department.  
Discusses the Great Lakes physical system, including regional geology, hydrodynamics, hydrology, chemistry, sedimentology interaction with the biota, environmental degradation and restoration. Special emphasis on topics of current interest. Field trips.

**426. Optical and X-ray Mineralogy**  
(461.) Winter. 4(3-4) 321, PHY 239 or 289.

Theory, principle and application of the polarizing microscope and X-ray diffractometer in mineral analysis.

**430. Vertebrate Paleontology**

Winter. 4(3-3) ZOL 314 or approval of department. Interdepartmental with the Zoology Department.  
Fossil vertebrates with emphasis on the evolution of major groups. Laboratories on modern techniques and on the identification and interpretation of fossils.

**IDC. Introduction to Meteorology**

For course description, see Interdisciplinary Courses.

**IDC. Introductory Meteorology Laboratory**

For course description, see Interdisciplinary Courses.

**437. Invertebrate Paleontology**

Fall. 4(3-4) 202 or ZOL 381 or approval of department. Interdepartmental with the Zoology Department.  
Systematics and evolution of marine invertebrates; uses of fossils in correlation and delineation of geologic time; structure and morphology of fossils as related to evolutionary development.

**438. Paleocology**

Winter. 4(3-4) 202 or ZOL 389 or approval of department. Interdepartmental with the Zoology Department.  
Distribution and abundance of marine fossils; response of skeletal morphology to environmental conditions; uses of fossils in reconstructing ancient climates and depositional environments.

**445. Field Studies**

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 12 credits. Approval of department.  
Advanced geological or geophysical field studies.

**446. Principles of Stratigraphy**

(434.) Fall. 3(3-0) 437, 492 or approval of department.  
Covers principles of stratigraphy and application and exemplification of these principles to known geologic occurrences.

**451. Structural Geology**

Spring. 4(2-6) 202.  
Description, classification, and origin of secondary structures such as folds, faults, joints, cleavages, foliations and lineations. Three-dimensional visualization stressed in economic laboratory problems involving descriptive geometry, stereographic projections, areal, and structural geologic maps.

**462. Petrology**

Fall. 4(3-4) 363.  
Introduction to the chemical and physical processes that are responsible for the origin and evolution of igneous and metamorphic rocks. Laboratory studies of rock suites that illustrate basic processes in petrology.

**474. Exploration Geophysics**

Winter. 4(3-2) 201 or 306; MTH 112; PHY 239 or 289.  
Techniques used in geophysical exploration, with application in petroleum prospecting, minerals exploration, and engineering. Includes gravity, magnetic, seismic, electrical and other methods, and well logging. Interpretation of geophysical data.

**475. Solid Earth Geophysics**  
Fall. 3(3-0) MTH 112; PHY 239  
or 289, one term of geology.

Geophysics, including Earth's composition and structure, its dynamic character, radioactivity and age determinations, seismicity and seismology, gravity and magnetic fields, heat flow, physical properties of earth materials.

**479. Geotectonics**  
Winter of even-numbered years. 3(3-0)  
451 or approval of department.

Aspects of global dynamics and geotectonics. Includes the origin and distribution of major structural features, geological and geophysical evidence for crustal movements, continental drift, behavior of earth materials.

**482. Mineral Resources—Metallic and Industrial**  
Spring of odd-numbered years. 3(3-0)  
May re-enroll for a maximum of 6 credits. 201,  
202.

World-wide, metallic and industrial minerals resources will be discussed from a geological viewpoint. Aspects of exploration, recovery and beneficiation will be presented.

**483. Petroleum Geology**  
Fall. 3(3-2) Approval of department.

Fundamental principles of the origin, migration and accumulation of petroleum. Exploration techniques to include well drilling, electric and radioactivity well logging, surface and subsurface exploration methods, seismic surveys, land leasing and oil field development. Laboratory study of well log plotting and subsurface mapping technique.

**484. Applied Petroleum Geology**  
Winter. 3(1-4) 483.

Microscopic examination of well cuttings, practice in the use of electric and radioactivity logs, exploration for petroleum in selected areas by subsurface mapping techniques, economics of petroleum exploration.

**492. Sedimentology I**  
Fall. 3(2-3) 426 or approval of department.

Grain and aggregate properties of sediments; relationships of these properties to processes in the environment of deposition and to the pre-depositional and post-depositional history.

**493. Sedimentology II**  
Winter. 3(2-3) 492.

Quantitative evaluation of sediment properties; sedimentary structures; regional analysis of sediment variation.

**495. Geochemistry**  
Spring. 3(3-0) 201, CEM 152 or approval of department.

Processes affecting the distributions of elements in rocks, soils, waters, the atmosphere, interior of the earth and in meteorites. Origin of the elements. Evolution of the mantle, crust, atmosphere and oceans.

**800. Special Problems**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallography, petrology, paleontology, structural geology, and petrofabrics, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentation, and geochemistry.

**803. World Regional Geology**  
Spring of even-numbered years. 3(3-0)  
One course each in structural geology, sedimentation.

World regional geology emphasizing mountain building, basin structure and associated sediments, continental drift and plate tectonics.

**810. Seminar**  
Fall, Winter, Spring. 1 credit. May re-enroll for a maximum of 3 credits.

Selected topics relating to current research in geology.

**811. Marine Geology**  
Fall of even-numbered years 3(3-2)  
Approval of department.

Geomorphic, sedimentary, and chemical oceanography including origin of ocean basins, chemical loading and history of the sea, buffering and sediment-water interactions, and sediment genesis.

**812. Principles of Geomorphology**  
Fall of odd-numbered years. 3(3-2)  
201, 303, or approval of department.

Landforms and processes involved in their origin and development. Emphasis on fundamental concepts as they relate to destructional and constructional stresses on earth materials. Introduction to quantitative laboratory and field methods.

**814. Field Glaciology**  
Summer. Variable credit. Approval of department.

Expeditionary camp in an area of existing glaciers providing field training in glaciology and associated disciplines. Usually conducted at the Institute field stations on the Juneau Icefield, Alaska. Formal lectures given concurrently with a program of related field research.

**825. Clay Mineralogy**  
Winter. 4(3-4) SLS 840, 850 or approval of department. Interdepartmental with Soil Science.

Structures and properties of clays; their origins, occurrence, and utilization. Methods of studying clays including x-ray diffraction, differential thermal analysis, infrared absorption and other chemical and physical techniques.

**830. Paleobotany**  
Fall. 4(3-4) Approval of department.  
Interdepartmental with and administered by the Botany and Plant Pathology Department.

Survey of fossil plants: their preservation, occurrence, geology, paleogeography, paleoecology, evolutionary history, classification and representative types. One weekend field trip to fossil plant locality.

**831. Palynology**  
Spring of even-numbered years. 4(3-4)  
Approval of department. Interdepartmental with the Botany and Plant Pathology Department.

An introduction to the principles and techniques of spore and pollen analysis, both fossil and recent, and utilization of plant micro-fossils for stratigraphic determinations and paleoecological interpretations of most sedimentary accumulations and rocks. Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.

**833. Advanced Invertebrate Paleontology**

A. MICROPALAEONTOLOGY  
Spring. 3(2-4) 437 or 438. Interdepartmental with the Zoology Department.

Functional and adaptive morphology of microscopic fossil invertebrates, emphasizing foraminifera, ostracoda, and conodontachordata.

B. QUANTITATIVE PALEONTOLOGY  
Spring. 3(2-4) 437 or 438. Interdepartmental with the Zoology Department.

Application of mathematical tools to paleontological problems, including statistical applications and numerical taxonomy; computer applications.

C. PALEONTOLOGY  
Spring. 3(2-4) 437 or 438. Interdepartmental with the Zoology Department.

Advanced problems in the distribution and abundance of fossil invertebrates; morphological adaptations to environmental pressures.

D. FOSSIL MORPHOLOGY  
Spring. 3(2-4) 437 or 438. Interdepartmental with the Zoology Department.

Skeletal morphology of fossil invertebrates, emphasizing the multivariate morphometric approach and other modern methods of morphological analysis.

**834. Advanced Vertebrate Paleontology**  
Winter of even-numbered years. 3(3-0)  
430 or approval of department. Interdepartmental with the Zoology Department.

Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.

**838. Advanced Paleobotany**  
Winter of odd-numbered years. 3(2-4)  
Approval of department. Interdepartmental with and administered by the Botany and Plant Pathology Department.

Morphology, anatomy, phylogenetic relationship and classification of fossil plants. Microscopic analysis of tissues and organs prepared by thin section, transfers, peels, polished and etched surfaces, and macerations.

**843. Paleozoic Stratigraphy**  
Winter of even-numbered years. 4(5-0)  
446, 492.

Classification, distribution, paleogeography, paleontology, interrelation, and structural setting of stratigraphic units within the Paleozoic systems. Laboratory work involves construction of correlation charts, structure and restored sections, paleogeologic, paleogeographic, and lithofacies maps, and study of certain key fossils.

**844. Mesozoic and Cenozoic Stratigraphy**  
Winter of odd-numbered years. 3(3-0)  
446.

Stratigraphy and paleontology with emphasis on tectonics and sedimentation.

**852. Advanced Structural Geology**  
Winter of even-numbered years. 3(2-4)  
451, MTH 214.

Mathematics and physics applied to problems in structural geology.

**861. Evolution of the Earth's Crust and Mantle**  
Spring. 3(3-0) 462.

The composition, mineralogy and petrology of the Earth's mantle and crust. Plate tectonics and its relationship to earlier models of geosynclines, orogenic cycles, continental drift, etc.

**862. Petrology—Igneous**  
Winter of even-numbered years. 2 to 4 credits. May re-enroll for a maximum of 8 credits. 462.

Physical and chemical principles involved in the origin of igneous rocks. Application of experimental techniques in petrology.

**863. Petrology—Metamorphic**  
Winter of odd-numbered years. 2 to 4 credits. May re-enroll for a maximum of 8 credits. 462.

Origin and classification of metamorphic rocks. Study includes thin section investigation of the metamorphic textures and mineral associations and the physical-chemical principles involved in their development.

**Descriptions — Geology  
of  
Courses**

**870. Topics in Geophysics**

Spring. 1 to 3 credits. May re-enroll for a maximum of 12 credits. Approval of department.

Topics and problems in geophysics, such as tectonophysics, terrestrial heat flow, processing and analysis of geophysical data, geomagnetism, paleomagnetism, high-pressure geophysics.

**872. Exploratory Seismology**

Fall of even-numbered years. 4(2-4) 474.

Theory and technique of field seismic exploration methods. An associated geophysical survey will be conducted and a report prepared.

**873. Seismology I**

Winter of odd-numbered years. 3(3-0) MTH 215 or concurrently; PHY 289 or concurrently.

Theory and application of seismic wave propagation in earth materials.

**874. Seismology II**

Spring of odd-numbered years. 3(3-0) 873 or approval of department. Continuation of 873.

**875. Advanced Geophysical Exploration I**

Fall of odd-numbered years. 4(3-2) 474.

Theory and technique of gravity and magnetic methods, and their use in geophysical exploration. Associated practical exercises and laboratory work.

**876. Advanced Geophysical Exploration II**

Winter of even-numbered years. 4(3-2) 474, MTH 214.

Methods and techniques in geophysical exploration, including electrical, electromagnetic, radioactivity, magnetotelluric, and the physical principles of well logging. Associated practical exercises.

**879. Rock Magnetism and Paleomagnetism**

Spring of even-numbered years. 3(3-0) 321, 475, one year mathematics, one year physics; or engineering or physics majors.

Geomagnetism, and application to earth science. Character and history of the Earth's magnetic field, physics of remanent magnetism, magnetic properties of minerals and rocks, paleomagnetism, experimental results and procedures.

**884. Regional Petroleum Geology**

Spring of odd-numbered years. 3(3-0) Approval of department.

Regional study of tectonics, stratigraphy and sedimentation in the U.S. and their relationship to petroleum occurrences in sedimentary basins. Analysis of petroleum distribution with emphasis on creative thinking in petroleum exploration. Practice in the analysis of petroleum possibilities in selected foreign areas.

**891. Advanced Sedimentology**

**A. RECENT DEVELOPMENTS IN SEDIMENTOLOGY**

(864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.

New techniques for study of sediments and sedimentary rocks. Discussion of significant new findings and applications of sedimentology.

**B. QUANTITATIVE ANALYSIS OF SEDIMENTS**

(864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.

Representation and analysis of sediment variation from microscale to regional scale. Definition of efficient empirical variables. Role of mathematical and stochastic models.

**C. ENVIRONMENTAL SEDIMENTOLOGY**

(864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.

Determination of rates of sediment erosion, transport, and deposition. Partitioning of deposited sediment with regard to sources. Sediment as a biologic substrate.

**D. ANALYSIS OF DEPOSITIONAL ENVIRONMENTS**

(864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.

Depositional processes, common depositional environments, migration of environments, environmental interpretations of three dimensional patterns of variation in sedimentary rocks.

**893. Carbonate Sedimentation**

Fall of odd-numbered years. 3(2-2) Approval of department.

Genesis of carbonate sediments including carbonate-secreting organisms, effect of environment on mineralogy, depositional environments, and the dolomite problem. Field trips.

**895. Topics in Geochemistry**

**A. THERMODYNAMICS IN GEOLOGY**

Fall. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 462, 495.

Interpretation and prediction of natural mineral assemblages from thermochemical studies. High pressure and high temperature techniques in petrology. Phase equilibria studies and diffusion phenomena in natural systems.

**B. AQUEOUS GEOCHEMISTRY**

Fall. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 462, 495.

Ideal and non-ideal solutions, ion activities in natural waters, carbonate sedimentation, evaporite deposits, colloids, chemical weathering and diagenesis. Importance of organic species in natural waters and their effect in metal complexing. Redox reactions.

**C. ANALYTICAL GEOCHEMISTRY**

Fall. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 462, 495.

Instrumental techniques for the analysis of geological materials. Topics on application of X-ray diffraction, X-ray fluorescence, neutron activation analysis, and atomic absorption spectrometry. Recently developed techniques in geochemistry will be discussed.

**897. Isotope Geochemistry**

(892.) Winter of odd-numbered years. 3(3-0) 495 or approval of department.

The abundances of stable and radiogenic nuclides and their variations in nature. Applications to geochronology and petrogenesis. Principles and application of neutron activation analysis to geological problems.

**899. Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**900. Special Problems**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallography, petrology, paleontology, structural geology and petrofabrics, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentation, and geochemistry.

**999. Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**Earth Science**

**E S**

**407. Earth Science for Teachers**

(PHS 407.) Fall. 3(3-0) or 4(3-3)

Fundamentals of climatology and its relationship to weathering in rocks; agents of erosion, transportation, and deposition; study of the common minerals; the three classes of rocks, and igneous, sedimentary and metamorphic processes; geomorphic features including glaciers, volcanoes, oceans, lakes, deserts, caves and others. Laboratory includes identification of minerals, rocks; study of topographic maps; and field trips to points of geologic interest.

**410. Earth Science Seminar for Teachers**

Fall. 1(2-0) May re-enroll for a maximum of 4 credits. One earth science subject matter course or concurrently.

Earth science subject matter areas will be inter-related through student presentation and discussion and their interdisciplinary significance developed.

**445. Field Studies**

Fall, Winter, Spring, Summer. 1 to 9 credits. May re-enroll for a maximum of 15 credits. Approval of department.

Experience and techniques in field investigation of the near surface layers of the earth.

**446. Laboratory Investigations**

Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 15 credits. 445 or concurrently.

Independent laboratory investigation of materials and phenomena obtained from field studies.

**GERMAN AND RUSSIAN**

**College of Arts and Letters**

Students who have had high school work in the foreign language in which they wish to continue their studies must take a placement examination in that language. Placement in the appropriate course is determined by the results of this examination. University credit is not given for courses waived by performance on the placement examination.

**German and Russian Courses**

**G R**

**303. Folklore**

Spring. 3(3-0)

Folk heritage of peoples as revealed in their legends, superstitions, ballads, folksongs, hero tales, sayings, customs, and beliefs. Historical development of traditional lore as a reflection of social attitudes and the source for national mythologies.

**417. Scandinavian Contributions to Literary Tradition**

Fall. 3(3-0) Approval of department. Interdepartmental with the departments of English and Romance Languages.

Development and influence of the ideas, forms and motifs of the Scandinavian literatures in the literatures of the world.

**418. Scandinavian Contributions to Literary Tradition**

Winter. 3(3-0) Approval of department. Interdepartmental with the departments of English and Romance Languages.

Continuation of 417.