

**902. Physical Geography**

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Advanced consideration of the distribution and interrelation of components of the earth's physical environment.

**912. Regional Geography**

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits.

Use of primary documents and field work in an effort to understand the complex geographic interrelationships that characterize the areas of the earth.

**918. Problems in Geography**

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits.

Research on specific geographical problems.

**999. Research**

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

**GEOLOGY**

**GLG**

**College of Natural Science**

**200. Foundations of Earth Science**

Fall, Winter, Spring, Summer. 3(3-0) Credit will be given for only one of the following: 200, 201, 306.

An intercollege cultural course for non-geology majors, designed primarily for students who desire to obtain a broad perspective of the science.

**200L. Laboratory—Foundations of Earth Science**

Fall, Winter, Spring, Summer. 1(0-3) 200 concurrently.

Practical training in earth science including work with minerals, rocks, fossils, maps, meteorology, and astronomy; field trips to points of geologic interest.

**201. General Geology—Physical**

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

Minerals and rocks of the earth's crust; constructive and destructive forces including volcanism, mountain building, rock deformation, erosion and deposition; economic aspects of geology; concepts of earth origin and methods of age determination. Laboratory study of minerals, rocks, experimental models and maps; field trips.

**202. General Geology—Historical**

Fall, Winter, Spring. 4(4-2) 201 or 306; or approval of department.

Historical development of the earth including mountain building, marine inundations, formation of mineral deposits and fuels, and reconstruction of fossil representatives of plants and animal life. Laboratory work will include a field trip.

**302. Vertebrate Life of the Past**

Fall. 3(3-0) Not open to zoology majors. Interdepartmental with the Zoology Department.

Fossil vertebrates from fish to man.

**303. Introductory Geomorphology**

Spring. 3(3-0)

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**

Spring. 1(0-2) 303 concurrently.

Methods of map interpretation and use of aerial photographs in geomorphology. Supplemental field trip to study the geology of pertinent landforms.

**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.

**326. Minerals, Rocks and Fossils**

Spring, Summer. 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.

**344. Field Geology—Summer Camp**

Summer. 9 credits. 202, 423; Trigonometry; GLG 431, 434, and 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.

**400H. Honors Work**

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

**411. Ground Water Geology**

Winter. 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.

**421. Mineralogy**

Fall. 4(3-4) 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.

**422. Mineralogy**

Winter. 4(3-4) 421.

Selective qualitative analysis of minerals by blow pipe and other methods.

**423. Lithology**

Spring. 4(3-4) 421.

Identification of common rocks with hand lens. Origin, variation, occurrence, associations and field classifications of important rock types.

**430. Vertebrate Paleontology**

Winter. 4(3-3) 302 or ZOL 305 or 315, or approval of department. Interdepartmental with and administered by 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.

**431. Invertebrate Paleontology**

Spring. 4(3-4) 202 or ZOL 381 or approval of department.

Identification and morphology of fossil invertebrates. Nomenclature, evolution, fossilization, uses of fossils in correlation and determining origins of sediments. Laboratory techniques in preparation. Observations and collections will be made in the field.

**432. Introduction to Meteorology**

For course description, see Interdisciplinary Courses.

**433. Introductory Meteorology Laboratory**

For course description, see Interdisciplinary Courses.

**434. Principles of Stratigraphy**

Fall. 3(3-0) 431 concurrently; 492; or approval of department.

Covers principles of stratigraphy and application and exemplification of these principles to known geologic occurrences.

**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.

**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.

**461. Optical Mineralogy**

Winter. 3(2-4) 421.

Theory and practice of determining optical constants of crystals with aid of polarizing microscope.

**462. Petrography**

Fall. 4(3-4) 423.

Analysis, with the aid of polarizing microscope, of a set of specimens and thin sections of the most common igneous, sedimentary and metamorphic rocks.

**471. Photogrammetry**

Winter. 4(2-6) MTH 102 or approval of department; Sophomores.

Map construction from aerial photographs using standard photogrammetric equipment, interpretation of topographic and geologic features from aerial maps, relation of surface features to underlying rock character and structure.

**474. Geophysical Methods**

Winter. 4(3-2) 201; MTH 112; PHY 239.

Principles of gravitational, magnetic, seismic, electrical, radioactive, and well logging methods. Application to mining, petroleum, and engineering problems.

**475. Geophysics**

Spring. 3(3-0) MTH 112; PHY 239.

General aspects of geophysics. Topics chosen from the following: earth's origin, age determinations, earthquakes, seismology, volcanism, isostasy, mountain building, figure of earth, earth's interior, and terrestrial magnetism and electricity.

**476. Geophysical Laboratory Investigations**

Fall, Winter, Spring. Variable credit.

May re-enroll for a maximum of 9 credits. Approval of department.

Independent laboratory research emphasizing geophysical model studies, instrumentation, and physical properties of earth materials.

**477. Geophysical Field Studies**

Fall, Winter, Spring. Variable credit.

May re-enroll for a maximum of 9 credits. Approval of department.

Independent geophysical field studies and interpretation of data.

**482. Economic Geology—Principles**

Spring. 3(3-0) 422.

Formation of mineral deposits except petroleum. Mineral economics, mining law, and mining methods discussed briefly. Writing of geological reports of important districts.

**483. Petroleum Geology**

Winter. 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**

Spring. 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) 461 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 I**

Fall. 3(3-0) 201, 422; CEM 152.

Qualitative and quantitative study of the element distribution in rocks, soils, oceans, and continental waters; geochemical processes governing their distribution, and introduction to phase equilibria and crystal chemistry.

**496. Geochemistry II**

Winter. 3(3-0) 495.

Continuation of 495. Application of thermodynamics to geochemical problems. Study of isotope ratios and their application to geochemical problems in the earth's crust.

**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.

**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. Physical Oceanography**

Spring. 3(3-2) Approval of department.

Study of geomorphic, sedimentary, geochemical and geophysical aspects of oceans, including marine hydrodynamics, ocean waves, tides, currents, methods and instruments of ocean study.

**812. Principles of Geomorphology**

Fall. 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.

**821. X-Ray Crystallography**

Fall. 3(2-4) 421.

Mineral structures studied by X-ray diffraction methods.

**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. 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 paleoecologic interpretations of most sedimentary accumulations and rocks. (Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.

**833. Micropaleontology**

Winter. 3(2-4) Approval of department.

Classification and morphology of microscopic organisms with emphasis of Foraminifera and Ostracoda.

**838. Advanced Paleobotany**

Winter. 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.

**842. Pre-Cambrian Geology**

Spring. 3(2-4) 344, 434.

Pre-Cambrian of North America with special reference to stratigraphic correlation and economic development.

**843. Paleozoic Stratigraphy**

Winter. 4(5-0) 434, 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**

Spring. 3(3-0) 434.

Stratigraphy and paleontology with emphasis on tectonics and sedimentation.

**851. Petrofabrics**

Winter of odd-numbered years. 3(2-4)

462.

The use of the petrographic microscope and universal stage in determining rock fabrics; the interpretation of these fabrics in terms of regional structural geology.

**852. Advanced Structural Geology**

Winter of even-numbered years. 3(2-4) 451, MTH 214.

Mathematics and physics applied to problems in structural geology.

**862. Petrology—Igneous**

Winter. 3(2-4) 462.

Theoretical and practical application of fundamental physicochemical principles in petrogenesis.

**863. Petrology—Metamorphic**

Spring. 3(2-4) 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.

**864. Advanced Sedimentology**

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

Selected topics of current sedimentological interest.

**870. Geophysics Seminar**

Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 12 credits. Approval of department.

Selected topics in geophysics.

**871. Advanced Geophysical Laboratory**

Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.

Laboratory research on selected geophysical problems.

**872. Field Seismology**

Fall. 4(2-4) 474.

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

**873. Fundamentals of Seismology I**

Winter. 3(3-0) MTH 215 or concurrently; PHY 289 or concurrently.

Theory and application of seismic wave propagation in earth materials.

**874. Fundamentals of Seismology II**  
Spring. 3(3-0) 873 or approval of department.  
Continuation of 873.

**875. Magnetic Exploration**  
Winter. 4(3+2) 474.  
Theory and technique of magnetic exploration methods. Associated geophysical survey will be conducted and a report prepared.

**876. Gravity Exploration**  
Fall. 4(3-2) 474; MTH 214.  
Theory and technique of gravity exploration methods. Associated geophysical survey will be conducted and a report prepared.

**877. Electrical Exploration**  
Spring. 4(3-2) 474; MTH 215.  
Theory and technique of electrical exploration methods. Associated geophysical survey will be conducted and a report prepared.

**884. Regional Petroleum Geology**  
Fall. 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.

**886. Economic Geology—Metallics**  
Spring of even-numbered years. 3(3-3) 461, 482.  
Occurrence and geology of metallic ore deposits. Methods of study, exploration and exploitation discussed.

**887. Economic Geology—Nonmetallics**  
Fall of even-numbered years. 3(3-3) 461, 482.  
Occurrence and geology of industrial mineral deposits. Methods of study, exploration and exploitation discussed.

**894. Geochemistry of Aqueous Systems**  
Spring. 3(3-0) 495 and CEM 384, or approval of department.  
Ionic and molecular equilibria related to stabilities and solubilities of minerals:  $Eh-p^H$ , and  $PO_4-p^H$  relations applied to ground water, sea water, and hydrothermal fluids.

**895. Selected Topics in Geochemistry**  
Winter. 3(3-0) 462, 495.  
Chemistry of selected geologic processes.

**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.

## 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. Also, registration for credit is not permitted in courses for which the equivalent high school credit has been earned. In general, one year of high school language study is considered equivalent to one term of university study. This means that a student with two years high school credit in a language should place no lower than 103 on the placement test. If he places higher, for example, in 201, 103 is waived without credit. However, if his placement examination indicates that he is not qualified for 103, he must enroll in the appropriate lower course without credit.  
To receive credit in first year foreign language courses, all three terms, 101, 102, 103, must be completed satisfactorily.

### German and Russian Courses G R

**299. Special Projects**  
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 18 credits. Approval of department.  
Work in areas outside regular course offerings.

**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**  
(C L 418.) Fall. 3(3-0) Approval of department.  
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**  
(C L 418.) Winter. 3(3-0) Approval of department.  
Continuation of 417.

**419. Scandinavian Contributions to Literary Tradition**  
(C L 418.) Spring. 3(3-0) Approval of department.  
Continuation of 418.

**499. Special Projects**  
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 18 credits. Approval of department.  
Work in areas outside regular course offerings.

### German GRM

**101. Elementary German**  
Fall, Winter, Spring, Summer. 4(4 1)  
Beginner's course. Drill in pronunciation, elementary principles of inflection and syntax; easy reading and conversation.

**102. Elementary German**  
Fall, Winter, Spring, Summer. 4(4-1)  
101.  
Continuation of 101.

**103. Elementary German**  
Fall, Winter, Spring, Summer. 4(4-1)  
102.  
Continuation of 102.

**201. Intermediate German**  
Fall, Winter, Spring, Summer. 4(3-1)  
103.  
Systematic review of grammar, oral practice, intensive and extensive reading of modern texts.

**202. Intermediate German**  
Fall, Winter, Spring, Summer. 4(3-1)  
201.  
Continuation of 201.

**203. Intermediate German**  
Fall, Winter, Spring, Summer. 4(3-1)  
202.  
Continuation of 202.

**301. Introduction to German Literature**  
Fall. 3(3-0) 203. Required of majors.  
Representative works of eighteenth and early nineteenth century authors.

**302. Introduction to German Literature**  
Winter. 3(3-0) 301.  
Representative works of nineteenth century authors.

**303. Introduction to German Literature**  
Spring. 3(3-0) 302.  
Representative works of twentieth century authors.

**321. German Composition and Conversation**  
Fall. 3(3-0) 203.  
Essential and difficult points of grammar reviewed. Written and oral reports; active participation in class discussion. Designed especially for students who plan to teach German.

**322. German Composition and Conversation**  
Winter. 3(3-0) 321.  
Continuation of 321.

**323. German Composition and Conversation**  
Spring. 3(3-0) 322.  
Continuation of 322.

**341. Masterpieces in German in Translation**  
Fall. 3(3-0) Knowledge of German not required. Not applicable to major requirements.  
Selections from narrative prose, drama, and lyric poetry chosen to encourage and develop an appreciation of German literature.

**342. Masterpieces in German in Translation**  
Winter. 3(3-0) Knowledge of German not required. Not applicable to major requirements.  
Continuation of 341.

**343. Masterpieces in German in Translation**  
Spring. 3(3-0) Knowledge of German not required. Not applicable to major requirements.  
Continuation of 342.