825. History and Philosophy of Geography
Fall, 3(3-0) Approval of department.
Analysis of the mono graphical and serial literature dealing with the theory and evolution of geographic science.

826. Research Design in Geography
Winter, 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 acquisition, 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.

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.
Recent developments and research in location analysis and regional science.

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.
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.

912. Independent Study in Regional Geography
Fall, Winter, Spring. 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.

GEOLGY

College of Natural Science

200. The Geology of Man's Environment
Fall, Winter, Spring, Summer. 3(3-0)
Not open to Geology majors.
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. General Geology—Physical Geology
Fall, Winter, Spring. 4(2-2) 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 Geology
Fall, Winter, Spring. 4(2-2) 201 or 306; or approval of department.
Physical and biological history of the Earth; environmental interpretation of sedimentary rocks and fossils; mountain building, sea-floor spreading and continental drift; organic evolution and diversification; paleoecology.

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

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
Winter, 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
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.

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.

308. Field Excursion—Central Appalachians
Spring. 2 or 3 credits. 307.
Training in stratigraphic, sedimentological, paleontological and structural principles as applied to field methods.
321. Mineralogy
Fall. 4(0-4) 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
Winter. 4(3-4) 321.
Selective qualitative analysis of minerals by blow pipe and other methods.

323. Lithology
Spring. 4(3-4) 321.
Identification of common rocks with hand lens. Origin, variation, occurrence, associations and field classifications of important rock types.

326. Minerals, Rocks and Fossils
Spring. 2(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. 3 credits. 202, 333.
Trigonometry; GLG 434, 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 exploration.

B. Methods of Geological Mapping
4 credits.
Plane table surveys, aerial photo and reconnaissance mapping. Examination and interpretation of structural and tectonic 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 investigation 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.

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.

432. Introduction to Meteorology
Fall. 4(3-4) One term of chemistry.
Course description, see Interdisciplinary Courses.

433. Introductory Meteorology Laboratory
Fall. 3(3-9) 457, 492 or approval of department.
For course description, see Interdisciplinary Courses.

434. Principles of Stratigraphy
Fall. 3(3-9) 437, 492 or approval of department.
Covers principles of stratigraphy and application and exemplification of these principles to known geologic occurrences.

437. Invertebrate Paleontology
Winter. 4(3-4) 203 or ZOL 391 or approval of department.
Systematics and evolution of marine invertebrates; use of fossil in correlation and delineation of geologic time; structure and morphology of fossils as related to evolutionary development.

438. Paleocology
Spring. 4(3-4) 437.
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.

451. Structural Geology
Spring. 4(3-6) 202.
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.

476. Petroleum Geology
Winter. 3(3-2) 492.
Quantitative evaluation of sediment properties; sedimentary structures; regional analysis of sediment variation.

477. Geophysical Field Studies
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, lease, and oil field development. Laboratory study of well log plotting and subsurface mapping technique.

482. Economic Geology
Fall, Winter, Spring. Variable credit.
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) 492 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.
Geological aspects of modern and ancient environments of deposition and the processes involved. Quantitative determination of sediment properties; general principles of sedimentary structure, classification and processes. Quantitative determination of sediment properties; general principles of sedimentary structure, classification and processes.

495. Geochemistry I
Fall. 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.

496. Geochemistry II
Winter. 3(3-0) 495.

800. Special Problems
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallography, paleontology, structural geology, and petroleum geology, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentation, and geochemistry.
Selected topics relating to current research in and introduction to quantitative laboratory and field methods.

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, depositional and erosional processes, 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 station on the Juneau Icefield, Alaska. Formal lectures given concurrently with a program of related field research.

821. X-Ray Crystallography
Fall. 3(2-4) 321.
Mineral structures studied by X-ray diffraction methods.

825. Clay Mineralogy
Winter. 4(3-4) SLS 640, 589 or approval of department. Interdepartmental with Soil Science.
Structures and properties of clays; their origin, 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, morphology, 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
Fall. 3(3-4) Approval of department.
Classification and morphology of microscopic organisms with emphasis on Foraminifera and Ostracods.

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, transfer, peels, polished and etched surfaces, and maceration.

843. Paleozoic Stratigraphy
Winter. 4(3-0) 414, 420.
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, paleogeologie, paleoecologic, 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) 461, 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.

856. Corporation—Nonmetals
Fall of even-numbered years. 3(2-3) 461, 482.
Occurrence and geology of industrial mineral deposits. Methods of study, exploration and exploitation discussed.

859. Selected Topics in Geology
Winter. 3(3-0) 492, 495.
Chemistry of selected geologic processes.

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
Spring. 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. Application and applications of reservoir geology with emphasis on creative thinking in petroleum exploration. Practice in the analysis of petroleum possibilities in selected foreign areas.

885. Economic Geology—Metallies
Fall of odd-numbered years. 3(3-3) 461, 482.
Occurrence and geology of metallic ore deposits. Methods of study, exploration and exploitation discussed.

887. Economic Geology—Nonmetals
Fall of even-numbered years. 3(2-3) 461, 482.
Geology of industrial mineral deposits. Methods of study, exploration and exploitation discussed.

892. Isotope Geochemistry
Fall. 3(3-0) 495 or approval of department.
The abundances of stable and radiogenic nuclides and their variations in nature. Application to geochronology and petrogenesis. Principles and applications of neutron activation analysis to geological problems.

895. Selected Topics in Geochimistry
Winter. 3(3-0) 492, 495.
Chemistry of selected geologic processes.

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 petrofabric, stratigraphy, aerogeology, geophysics, economics and chemistry, and geochemistry.

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

Geology — Descriptions of Courses

407. Earth Science for Teachers (PHE 407.) Fall. 3(3-0) or 4(3-3).
Fundamentals of climatology and its relationship to weathering in rocks; agents of weathering, 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.

Earth Science E S
408. Earth Science for Teachers (FTS 408.) Winter, 3(3-0) or 4(3-2)
Continuation of physical geology and introduction to historical geology, containing discussions of earth structures, mountain building, economic geology; geologic time, basic astronomy, theories of earth origin; the earliest geologic era; first evidences of life.

409. Earth Science for Teachers (FTS 408.) Spring, 3(3-0) or 4(3-3)
Historical development of the various geologic periods through time with reference to the evolutionary development of the physical landscape, ancient geography, past climate, diastrophic events and marine and land animals and plants. Laboratory includes identification of important animals and plant fossils, fossil environments, geologic maps; field trips to collecting localities.

410. Earth Science Seminar for Teachers
Fall, Winter, Spring, 1(2-0) May re-enroll for a maximum of 4 credits. One earth science subject matter course or concurrently. Earth science subject matter area will be inter-related through student presentation and discussion and their interdisciplinary significance developed.

445. Field Studies
Fall, Winter, Spring, 1-9 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, 1-6 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 granted for courses waived by performance on the placement examination.

German and Russian Courses

299. Special Projects
Fall, Winter, Spring, Summer, Variable credit. May re-enroll for a maximum of 16 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, heroic 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 417.) 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.