### Energy Resources of the World

Energy resources of petroleum, coal, and atomic fuel. Social, political, economic, and environmental problems of fuels.

### Geology — Descriptions of Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Term(s)</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>The Geology of Man's Environment</td>
<td>3(3-0)</td>
<td>Fall, Winter, Spring, Summer</td>
<td>Not open to Geology majors. Credit will be given in only one of the following: 200, 201, 306. Man and his geologic environment: earthquakes, volcanoes, landslides, subsidence, flooding, coastal erosion, hydrology and human use, waste disposal, geologic aspects of environmental health, resources and energy, environmental problems.</td>
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<tr>
<td>200L</td>
<td>Laboratory—Geology of Man's Environment</td>
<td>200 or conc.</td>
<td>Fall, Winter, Spring, Summer</td>
<td>Laboratory study of geologic processes associated with environmental hazards. Emphasis placed on land use planning, applying geologic criteria to evaluate land potentials.</td>
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<tr>
<td>201</td>
<td>Earth Processes</td>
<td>4(4-2)</td>
<td>Fall, Winter, Spring</td>
<td>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.</td>
</tr>
<tr>
<td>202</td>
<td>Evolution of the Earth</td>
<td>4(4-2)</td>
<td>Fall, Winter, Spring</td>
<td>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.</td>
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<tr>
<td>205</td>
<td>Oceanology—The Marine Environment and Man</td>
<td>3(3-0)</td>
<td>Fall</td>
<td>Physical oceanography, including origin, hydrologic, chemical, geological properties and environment of the ocean. Man-ocean interactions are emphasized including resource utilization and pollution.</td>
</tr>
<tr>
<td>221</td>
<td>Minerals, Rocks and Fossils</td>
<td>3(2-3)</td>
<td>Fall</td>
<td>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.</td>
</tr>
<tr>
<td>271</td>
<td>Geophysics and the Earth</td>
<td>3(3-0)</td>
<td>Spring</td>
<td>Basic concepts used in geophysics, including description of the Earth and its interior, methods of exploring for mineral and energy resources. Contribution of physical methods to understanding our terrestrial environment.</td>
</tr>
<tr>
<td>282</td>
<td>Energy Resources of the Earth</td>
<td>3(3-0)</td>
<td>Winter</td>
<td>World energy resources of petroleum, coal, and atomic fuel. Social, political, economic and environmental problems of fuels.</td>
</tr>
</tbody>
</table>
426. Optical and X-ray Mineralogy
Fall. 4(3-4) 321, PHY 339 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 Department of Zoology.
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 Department of Zoology. 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
Spring. 4(3-4) 202 or ZOL 389 or approval of department. Interdepartmental with the Department of Zoology. 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, 392 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) 203.
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
Winter. 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 119; PHY 339 or 289.
Techniques used in geophysical exploration, with application in petroleum prospecting, mineral exploration, and engineering. Includes gravity, magnetic, seismological, and electrical and other methods, and well logging. Interpretation of geophysical data.

475. Solid Earth Geophysics
Fall. 3(3-0) MTH 119; PHY 339 or 289.
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) or approval of department.
Aspects of geologic 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.

482A. Mineral Resources
(482) Spring of odd-numbered years. 4(4-0) 321, 451.
Genetics, distribution, and classification of ore deposits. Emphasis on metallic ores. Global patterns and tectonic relationships.

482B. Mineral Resources Evaluation
Spring of even-numbered years. 3(3-0) 321, 451, and approval of department.
Emphasis on practical applications of geoscience to mineral resources and the extractive industries. Aspects of exploration and development of reserves including evaluation, grade estimation, drilling, recovery, and beneficiation.

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) 433.
Microscopic examination of well cuttings, practice in the use of electric and radioactivity logs, exploration for petroleum in selected areas by subsurface mapping technique, economics of petroleum exploration.

485. Geochemistry
Winter. 3(3-0) 201, CEM 152 or approval of department.
Processes affecting the distributions of elements in rocks, soils, water, 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, paleoecology, structural geology, and paleomagnetism. Includes stratigraphy, biostratigraphy, paleogeology, 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 to 3 credits. May re-enroll for a maximum of 12 credits. Seminar relating to current research in geology.

825. Clay Mineralogy
Winter. 4(3-4) CSS 440, 540 or approval of department. Interdepartmental with the Department of Crop and Soil Sciences. 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 Department of Botany and Plant Pathology. Survey of fossil plants; their preservation, occurrence, geology, palaeoecology, paleobotany, 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 Department of Botany and Plant Pathology. 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 past depositional environments and rocks. Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.

833. Advanced Invertebrate Paleontology
B. QUANTITATIVE PALYNOLOGY
Fall. 3(2-4) 437 or 458. Interdepartmental with the Department of Zoology. Application of mathematical tools to palynological problems, including statistical applications and numerical taxonomy; computer applications.

C. PALEOCOLONY
Fall. 3(2-4) 437 or 438. Interdepartmental with the Department of Zoology. Survey of fossil plants: their preservation, occurrence, and utilization of plant micro-fossils for stratigraphic determinations and paleoecologic interpretations of past depositional environments and rocks. Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.

D. FOSSIL MORPHOLOGY
Fall. 3(2-4) 437 or 438. Interdepartmental with the Department of Zoology. 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 Department of Zoology.
Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.

838. Advanced Paleobotany
Winter. 3(2-4) Approval of department. Interdepartmental with and administered by the Department of Botany and Plant Pathology.
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(3-0)
446, 392.
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, paleogeographic, paleoclimatic, and lithofacies maps, and study of certain key fossils.

844. Mesozoic and Cenozoic Stratigraphy
Winter of odd-numbered years. 3(2-0)
446.
Stratigraphy and paleontology with emphasis on tectonics and sedimentation.

852. Advanced Structural Geology
Winter of even-numbered years. 3(3-4)
451, MTH 214.
Mathematics and physics applied to problems in structural geology.

861. Evolution of the Earth's Crust and Mantle
Fall. 3(3-0) or 469.
The composition, mineralogy and petrology of the Earth's mantle and crust. Plate tectonics and its relationship to earlier models of geosynclines, orogeny cycles, continental drift, etc.

862. Petrology-Igneous
Spring of even-numbered years. 2 to 4 credits. May re-enroll for a maximum of 8 credits. 462. Must enroll for laboratory with initial registration.
Physical and chemical principles involved in the origin of igneous rocks. Application of experimental techniques in petrology.

863. Petrology-Metamorphic
Spring of odd-numbered years. 2 to 4 credits. May re-enroll for a maximum of 8 credits. 462. Must enroll for laboratory with initial registration.
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.

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 odd-numbered years. 4(3-4)
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 295 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(3-4)
474.
Theory and techniques of gravity and magnetic methods, and their use in geophysical exploration. Associated practical exercises and laboratory work.

876. Advanced Geophysical Exploration II
Fall 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, properties 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)
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
B. Sandstone Petrology
(884.) Spring. 3(2-4) or 392.
Origin, deposition and diagenesis of sandstones. Study includes thin section, X-ray, and XEM analysis of sediments.

895. Topics in Geochemistry
A. THERMODYNAMICS IN GEOLOGY
Fall of odd-numbered years. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 462, 495.
Interpretation and prediction of natural mineral assemblages from thermodynamical studies. High pressure and high temperature techniques in petrology. Phase equilibria studies and diffusion phenomena in natural systems.
B. AQUATIC GEOCHEMISTRY
Winter of even-numbered years. 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, chemical weathering and diagenesis. Importance of organic species in natural waters and their effect in metal complexing. Redox reactions.
C. ANALYTICAL GEOCHEMISTRY
Fall of even-numbered years. 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) 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.

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

999. Special Problems
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Special problems in hydrogeology, geomorphology, palaeoecology, mineralogy and crystallography, petrology, paleontontology, structural geology and petrofabrics, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentology, and geochemistry.

Earth Science

407. Earth Science for Teachers
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 glacial, volcanism, oceans, lakes, deserts, caves and others. Laboratory includes indentifications of mineral rocks, study of topographic maps; and field trips to points of geologic interest.

410. Earth Science Seminar for Teachers
Fall. 1(3-0) 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.
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

303. Folklore

Spring. 3(3-0). Folk heritage of peoples as revealed in their legends, superstitions, ballads, folklore, 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 and Classical 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 and Classical Languages. Continuation of 417.

825. Comparative Literature: Studies in Theme and Idea

Fall. 3(3-0). May re-enroll for a maximum of 9 credits. Interdepartmental with the departments of Romance and Classical Languages and English and administered by the Department of Romance and Classical Languages. Myths, archetypes, Topoi, significant ideas and intellectual currents in different periods and cultural traditions.

856. Comparative Literature: Literature and Other Disciplines

Winter. 3(3-0). May re-enroll for a maximum of 9 credits. Interdepartmental with the departments of Romance and Classical Languages and English and administered by the Department of Romance and Classical Languages. Relations between literature and the sciences and other arts: social, historical, psychological, philosophical bases of literary study.

878. Comparative Literature: Methods in the Study of Comparative Literature

Fall. 3(3-0). Interdepartmental with the departments of English and Romance and Classical Languages and administered by the Department of English. Rationale and techniques of study in comparative literature.

902. Comparative Literature: Studies in Form and Genre

Winter, Spring. 3(3-0). Interdepartmental with the departments of English and Romance and Classical Languages and administered by the Department of English. Development and interrelationships of individual and collective forms and genres of literatures of the Western world, including the drama, tragedy, the novel, the short story, the theory and forms of poetry, popular literature, and the tale.

903. Comparative Literature: Studies in Periodization

Fall, Winter, Spring. 3(3-0). Interdepartmental with the departments of English and Romance and Classical Languages and administered by the Department of English. Analysis of the manner in which various genres, conventions and continuing traditions of literature interact with the creative and critical climates of particular periods and movements, such as classicism, the Middle Ages, the baroque, or romanticism, in qualifying or modifying characteristic literary works.

857. Seminar: Special Topics in Comparative Literature

Spring. 3(3-0). Advanced graduates. Interdepartmental with the departments of Romance and Classical Languages and English and administered by the Department of Romance and Classical Languages.

German

101. Elementary German

Fall, Winter, Spring, Summer. 5(3-0). Knowledge of German language, civilization, and culture. Development of language skills in contemporary German. Independent practice in the language laboratory.

102. Elementary German

Fall, Winter, Spring, Summer. 5(5-0). Continuation of 101.

103. Elementary German

Fall, Winter, Spring, Summer. 5(5-0). Continuation of 102.

201. Intermediate German

Fall, Winter, Spring, Summer. 4(3-1). 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.

202. Intermediate German

Fall, Winter, Spring, Summer. 4(3-1). Continuation of 201.

203. Intermediate German

Fall, Winter, Spring, Summer. 4(3-1). Continuation of 203.

241. German Literature in English 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.

242. German Literature in English Translation

Winter. 3(3-0). Knowledge of German not required. Not applicable to major requirements. Continuation of 241.

243. German Literature in English Translation

Spring. 3(3-0). Knowledge of German not required. Not applicable to major requirements. Continuation of 242.

299. Special Projects

(GR 299.) Fall, Winter, Spring. 1 to 12 credits. May re-enroll for a maximum of 12 credits. Approval of department. Work in areas outside regular course offerings.

301. Introduction to German Literature

Fall. 3(3-0). 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.

325. German Civilization and Culture

Fall. 3(3-0). 203 or approval of department. A third year sequence for students not primarily interested in literature. The cultural heritage of the German peoples. Readings and discussions in German based upon texts from history, the arts, philosophy, psychology, etc., from 1850 to World War I.