ESCI-1410: PHYSICAL GEOLOGY

Cuyahoga Community College

Viewing: ESCI-1410 : Physical Geology

Board of Trustees:
May 2022

Academic Term:
Fall 2022

Subject Code
ESCI - Earth Science

Course Number:
1410

Title:
Physical Geology

Catalog Description:
This introductory course covers Earth history, materials, and the processes that develop and modify the structure, composition and dynamic topography of the earth. Included is an overview of minerals, rocks, volcanoes, earthquakes, plate tectonics, geologic time, water resources, glaciation, coastal and aeolian processes, ocean basins and their features, energy and mineral resources. Students will identify patterns, interpret surface features, and explore their connection to our physical world through scientific exploration and understanding. Social implications of geological processes are emphasized throughout the course, including geological hazards, the benefits and complications of data monitoring, and the anthropogenic impacts on the planet.

Credit Hour(s):
3

Lecture Hour(s):
3

Lab Hour(s):
0

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
ENG-0985 Introduction to College Literacies or appropriate score on English Placement Test.
Note: ENG-0980 Language Fundamentals I taken prior to Fall 2021 will also meet prerequisite requirements.

Outcomes

Course Outcome(s):
Demonstrate knowledge of physical and chemical properties of the lithosphere and hydrosphere (minerals, rocks, soils, and water); geologic time and Earth history; and crustal materials and dynamics in the context of plate tectonic theory.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Describe the tectonic forces that produce earthquakes, volcanism, and related phenomena.
2. Describe the formation of, locations of, and structures of igneous, sedimentary, and metamorphic rocks and the methods used to identifying them.
3. Explain development of major landforms and recognize and discuss the actions and interactions of gravity, water, ice, and wind on the earth's surface.
4. Differentiate between chemical and physical weathering and explain the different processes of each of these.

5. Identify and describe soil horizons and the origin of soil.
6. Recognize and measure geological features in the field.
7. List valuable geologic resources, their distributions, methods of extraction, and uses.
8. Recognize and identify the dynamic relationship between surface and groundwater, aquifers and surface water features.
9. List the components and dates of the geologic column.
10. Describe features of the sea floor.
11. Illustrate the processes of orogeny (mountain building), and the correlation to plate boundary activity.

Course Outcome(s):

Demonstrate competence in fundamental geological skills including: mineral, rock and soil identification; interpretation of topographic maps, geologic maps, and various forms of imagery; analyses and construction of geologic maps and cross sections; three-dimensional conceptualization; and collection and analysis of data.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Identify main components of a geological map and correlate surficial processes to geological features.
2. Construct a geologic block diagram and describe each geological event.
3. Describe and label satellite images, and compare surface features over a series of time periods.
4. Utilize near-to-real time data sources from scientific organizations, analyze and summarize data in context of geological processes.

Course Outcome(s):

Demonstrate knowledge of endogenic and exogenic processes, utilizing peer reviewed literature, real time data, graphs, and models.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Explain the various types of mass wasting.
2. Describe erosional and depositional processes and the features of gravity, water, wind and ice.
3. Differentiate between P, S, and L seismic waves and explain how they are measured and their implications both socially and geologically.
4. Describe the features of the ocean floor and how they change over time.
5. Outline the evolution of the plate tectonic theory.
6. Locate plate boundaries and identify the lithospheric plates, types of boundaries, and activities at each type of boundary.
7. Explain different methods of mountain formation.
8. Differentiate between relative and absolute dating and explain the methods used in both processes.

Course Outcome(s):

Gain an understanding of the societal relevance of earth systems.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.
Cultural Sensitivity: Demonstrate sensitivity to the beliefs, views, values, and practices of cultures within and beyond the United States.

Objective(s):

1. Identify the main types of geohazards and describe their historical and modern significance.
2. Explain how humans use technology and various instrumentation to measure changes, identify locations of natural resources and describe our understanding of endogenic and exogenic/surficial processes and hazards.
3. Explore sources of near to real time data, and how these data are used to protect humans and human interests.

Methods of Evaluation:

1. Exploration and reports using near to real time data
2. Lecture exams
3. Participation in class discussions
4. Article summaries on current literature and research in physical sciences
5. Chapter homework, reviews of each chapter and its content
6. Photographic essays, students analyze physical processes in their world

Course Content Outline:

1. General introduction
   a. Outline of course
   b. Goals of the course
   c. Scientific method
   d. Concept of geologic time: catastrophism and uniformitarianism
   e. Compositions and interactions of the parts of the ecosphere: lithosphere; atmosphere; hydrosphere; biosphere
2. Introduction to plate tectonics
   a. Layers of the earth: crust, mantle, and core; lithosphere and asthenosphere
   b. Plate boundaries and their relationships to earthquakes and volcanoes: rift zones; subduction zones; and transform boundaries
3. Comparison of rocks and minerals
4. Atomic structure
   a. Composition of the atom
   b. Determination and significance of atomic number, atomic mass, and electron shells
   c. Arrangement of electrons as basis for the formation of ions
   d. Compare and contrast a cation and an anion as to change in size and change in number of electrons
   e. Bonding: ionic bonding; covalent bonding; metallic bonding; van der Waal forces
   f. Crystal structure
   g. Polymorphism and solid solutions
   h. Crustal abundance of the atoms
5. Minerals
   a. Chemical environment of formation
   b. Chemical composition and atomic structure of the silicates: isolated tetrahedral; single chains; double chains; sheets; frameworks
   c. Descriptions, chemistry, and uses of the mineral groups: silicates; carbonates; sulfates; sulfides; oxides; native elements
6. The rock cycle
   a. Magma, lava, and igneous rocks
   b. Erosion, sediments, and sedimentary rocks
   c. Heat, pressure, fluids, and metamorphic rocks
7. Volcanism
   a. Sources of heat for forming magma
   b. Types of volcanoes, their characteristics, and their occurrences: shield; composite/stratovolcano; cinder cones; fissure eruptions
   c. Different types of lava, their characteristics, and their occurrences: mafic; intermediate; felsic
   d. Extrusive rock types: pillow vs. columnar structures; aa vs. pahoehoe
   e. Correlation of volcano and lava types with plate tectonic theory
   f. Volcano prediction
   g. Recognition of extrusive igneous rocks using texture and composition
8. Intrusive igneous rocks
   a. Cooling rate and place of formation for each of the intrusive igneous rocks
   b. Correlation of intrusive igneous rock types with plate tectonics theory
   c. Recognition of intrusive igneous rocks by texture and composition
   d. Intrusive igneous bodies: concordant; discordant
   e. Processes involved with magnetic differentiation: Bowen's Reaction Series; crystal settling; assimilation; stoping
9. Weathering
   a. Concept of equilibrium
   b. Influence of climate, composition, topography, vegetation, and time
   c. Physical weathering processes: frost action; abrasion; pressure changes - exfoliation; root pressure
   d. Chemical weathering processes: solution; oxidation; hydration; hydrolysis

e. Relations between chemical and physical processes: salt crystallization; spheroidal weathering
f. Products of weathering
g. Soils: horizons; types; characteristics; factors that affect soil-forming processes

10. Sedimentary rocks
    a. Types of sedimentary rocks: clastic; bioclastic; chemical precipitates - crystalline, oolitic, and amorphous
    b. Processes needed to make a sedimentary rock: transportation; deposition; preservation; lithification
    c. Textures: clastic - size and shape of particles; bioclastic; crystalline; amorphous; oolitic
    d. Environment of formation of the different sedimentary rocks
    e. Sedimentary structures and their historical geological significance: types of bedding; fossils; geodes; mud cracks; ripple marks
    f. Recognition of sedimentary rocks by texture and composition
11. Metamorphic rocks
    a. Definition of metamorphism
    b. Sites of metamorphism
    c. Types of metamorphism and relationship to plate boundaries: regional; contact
    d. Metamorphic facies as distinguished by mineral types
    e. Hydrothermal processes
    f. Recognition of metamorphic rocks by texture and composition
12. Geologic time
    a. Relative time and its determination - principles of: superposition; original lateral continuity; crosscutting relationships; inclusions
    b. Fossils and their uses in dating
    c. Absolute time and its determination: alpha decay; beta decay; beta capture; proton decay
    d. Theory of radiometric dating - half-life concept
    e. Uses of and limitations of radiometric dating
    f. Dendrochronology and varves
    g. Geologic time: eons; eras; periods; epochs
13. Mass wasting
    a. Classification of types of mass wasting: rates of movement; types of material; types of movement
    b. Controlling factors of mass wasting
    c. Flow movements: creep; debris flow/avalanche; mudflows; earthflows; solifluction
    d. Slip movements: slump; debris slide
    e. Fall movements: rock fall; debris fall; subsidence
    f. Prevention of mass wasting
14. Running water
    a. Runoff: sheet flow; streams
    b. Types of streams and their characteristics: straight; braided; meandering
    c. Concept of drainage basins
    d. Factors that determine deposition vs. erosion: velocity; gradient; channel shape and roughness; discharge
    e. Erosional processes: solution; hydraulic action; abrasion
    f. Transportation: solution; suspension; bedload
    g. Erosional features: stream valleys; undercut banks
    h. Depositional features: bars; floodplains; deltas and alluvial fans
    i. Steps in valley development: downcutting; lateral erosion; headward erosion
    j. Rejuvenation: incised meanders; terraces
    k. Stream piracy
    l. Base level changes
15. Ground water
    a. The hydrologic cycle
    b. Porosity vs. Permeability
    c. Types of aquifers and their characteristics: confined/artesian; unconfined; perched
    d. Water tables
    e. Wells
    f. Relation of water tables and aquifers to springs, streams, oceans
    g. Extracting water from the ground
    h. Effect of pumping on aquifers
    i. Pollution of ground water
    j. Erosional effects of ground water: cave formation; sink holes; karst topography

   k. Depositional effects of ground water: stalactites, stalagmites, etc.; tera rosa
   l. Geothermal energy: geysers and hot springs; advantages and disadvantages
16. Glaciers
   a. Theories of glacial ages
   b. Formation of glaciers
   c. Types of glaciers and their movement: continental; alpine; piedmont
   d. Glacial budgets: positive; negative
   e. Erosional features: horns; cirques; rock basin lakes; U-shaped valleys
   f. Depositional features: moraines - lateral, medial, terminal, recessional; outwash; loess; varves
   g. Effects of past glaciations: exposure of bedrock; sea level changes; isostatic depression and rebound; lakes - kettle, morainal, eroded, pluvial; erratics and till
17. Deserts and wind action
   a. Location of deserts: global pressure belts; leeward of mountains; distance from oceans
   b. Characteristics of deserts: precipitation; soil types
   c. Transportation by wind
   d. Erosional features: blowouts; desert pavement
   e. Depositional features: types of dunes; loess
   f. Control of wind erosion and deposition: vegetation; wind
   g. Wind energy: where available; technology
18. Waves, beaches, and coasts
   a. Causes of waves
   b. Characteristics of waves: wavelength; wave amplitude; wave refraction
   c. Erosional features: undercutting and mass wasting; arches and sea stacks; longshore drift
   d. Depositional features: beaches; dunes; bars; spits
   e. Types of coasts: drowned; emergent; formed by organisms - reefs
19. Geologic Structures
   a. Stress: tectonic forces; compression; tension; shear
   b. Strain: elastic; plastic - folds; brittle - faults and joints
   c. Folds: anticlines; synclines; horizontal vs. inclined axes
   d. Faults: normal; reverse; transform
   e. Representation of structural features on geologic maps: strike and dip; fault lines
   f. Types of unconformities: angular unconformities; disconformities
20. Earthquakes
   a. Causes and relationship to plate boundaries
   b. Types of seismic waves and their characteristics: P-waves; S-waves; Surface waves
   c. Location of epicenters: seismometers; travel-time curves
   d. Measurement of earthquakes: Mercalli Scale; Richter Scale; Moment Magnitude
   e. Effects of earthquakes: land displacement; tsunamis
   f. Distribution of earthquakes and relation to plate tectonics theory
   g. Depth of earthquakes and relation to plate tectonics theory: shallow focus; deep focus
   h. Pattern of earthquakes and angle of subduction
   i. Earthquake prediction
   j. Earthquake control
21. Earth's Interior
   a. Interpretation of seismic waves
   b. Layers of the earth and their characteristics: seismic wave classification; plate tectonics classification
   c. Principle of isostasy
   d. Geothermal gradient
22. The ocean floor
   a. Formation of oceans
   b. Methods used to study the ocean floor
   c. Continental shelf
   d. Continental slopes and turbidity currents
   e. Continental rises
   f. Abyssal plains
   g. Seamounts, guyots and aseismic ridges
   h. Mid-oceanic ridges: volcanism; earthquakes; biota
   i. Trenches: volcanism; earthquakes; ophiolites

   j. Active vs. passive continental margins
   k. Aseismic Ridges
   l. Reefs
   m. Ocean floor sediments: pelagic; terrigenous
   n. Mineral deposits and their relationship to ocean features
   o. Ages on ocean floors and relationship to plate tectonics
23. Plate Tectonics
   a. Evidence of previous continental positions
   b. The role of continental drift in development of the theory
   c. Role of paleomagnetism in promoting the theory
   d. Causes of sea floor spreading and plate motions
   e. Diverging plate boundaries
   f. Transform faults
   g. Converging plate boundaries
   h. Types of convergences: ocean-ocean; ocean-continent; continent-continent
   i. Back arc spreading
   j. Names, locations, and relative motions of the plates
24. Mountain belts
   a. Characteristics of mountain belts formed at converging boundaries: faults; folds; metamorphism; batholiths
   b. The evolution of mountain belts: accumulation stage; orogenic stage; uplift and block faulting stage
   c. The growth of continents by exotic terranes
25. Geologic resources
   a. Definition of a resource
   b. Renewable vs. nonrenewable resources
   c. Exploration for resources and locations as related to plate tectonics
   d. Mineral resources: metallic ores; non-metallic ores
   e. Rock resources: igneous; sedimentary
   f. Energy sources: fossil fuels; uranium; other sources of energy
   g. Methods of obtaining these resources
   h. Effects on the environment from mining
   i. Conservation of resources by substitution, recycling, and more efficient use

Resources

Plummer, C. C., Diane Carlson and Lisa Hammersley. *Physical Geology*. 17th edition. New York, NY: McGraw Hill, 2022.

Tarbuck, E. J., and F. K. Lutgens. *Earth - An Introduction to Physical Geology*. 13th edition. Upper Saddle River, NJ: Pearson, 2020.

Marshak, Stephen. *Essentials of Geology*. 6th edition. New York, W.W. Norton, 2019.

Christiansen, E.H and Hamblin, K. . *The Dynamic Earth, and Introduction to Physical Geology*. 1st. Jones & Bartlett Learning, 2014.

Earle, Stephen. *Physical Geology*. 2nd edition. Free, Open Source. BC Campus, British Columbia, 2019.

Instructional Services

OAN Number:
Ohio Transfer 36 TMNS and Transfer Assurance Guide OSC025 (Course 1 of 2; Both must be taken)

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