Ohio Science

Physical Geology Content Statements: Grades 9-12

Adopted 2018

Physical Geology

1. **Atoms and elements** PG.M.1
   - a. Evaluate the appropriateness of extracting minerals such as uranium, platinum, copper, phosphorus, aluminum, sodium or iron in populated areas. PG.M.1.DTES.A
   - a. Develop a system to recycle used minerals from a product (e.g., tin cans, aluminum foil, copper pipes). PG.M.1.DSK.A
   - a. Explain how crystalline structure relates to a mineral's properties as well as its use and application in daily life. PG.M.1.ICSC.A
   - b. Represent the chemical compositions of common minerals with a drawing and/or 3D model. Explain what is represented in the depiction of the chemical formula. PG.M.1.ICSC.B
   - a. Classify the groups of minerals by chemical composition. PG.M.1.RAS.A
   - b. Compare minerals and ores and identify their uses. PG.M.1.RAS.B
   - c. Given a chemical formula for a mineral, identify the elemental composition and relate this to its properties. PG.M.1.RAS.C

2. **Chemical bonding (ionic, covalent, metallic)** PG.M.2
   - a. Conduct tests to differentiate between ionically and covalently bonded materials. PG.M.2.ICSC.A
   - b. Design a 3-D model of the different types of chemical bonding. PG.M.2.ICSC.B
   - a. Identify types of bonds present in each mineral group/family. PG.M.2.RAS.A

3. **Crystallinity (crystal structure)** PG.M.3
   - a. Explain why specific crystalline structures are different from each other. PG.M.3.ICSC.A
   - b. Use crystal or atomic models to illustrate the crystal structure of common minerals. Relate the structure to a specific quantifiable property (e.g., cleavage, hardness). PG.M.3.ICSC.B
   - a. Categorize crystalline shapes (7) and list what minerals would be found in each category. PG.M.3.RAS.A

4. **Criteria of a mineral (crystalline solid, occurs in nature, inorganic, defined chemical composition)** PG.M.4

    a. Design a method to use GIS to target mineral exploration or evaluate mining conditions and extraction methods. Then, construct a model of a site which has minimal environmental impact. PG.M.4.DTES.A

    a. Plan and conduct an investigation to determine the specific gravity of minerals. PG.M.4.DSK.A

    a. Construct a graphic model depicting how minerals are classified into groups by chemical composition and crystal formation. PG.M.4.ICSC.A

    b. Create an atom building game that demonstrates how elements combine to build minerals. PG.M.4.ICSC.B

    a. Identify and classify a mineral based on tested properties. PG.M.4.RAS.A

    b. Use a variety of rock samples to identify the minerals present. PG.M.4.RAS.B

    c. Examine mineral samples for crystalline structure and cleavage/fracture. PG.M.4.RAS.C

5. **Properties of minerals (hardness, luster, cleavage, streak, crystal shape, fluorescence, flammability, density/specific gravity, malleability)** PG.M.5

    a. Research social issues relating to conflict minerals (e.g., coltan, tungsten, gold). Determine whether there are alternative sources for these minerals. PG.M.5.DTES.A

    a. Develop a method to determine the difference between pyrite and gold using tools available to early gold prospectors. PG.M.5.DSK.A

    a. Determine the best use of a mineral based on observable properties. PG.M.5.ICSC.A

    b. Select a consumer product. Determine the minerals used in the product and the reason(s) for their use. PG.M.5.ICSC.B

    a. Differentiate between cleavage and fracture. PG.M.5.RAS.A

    b. Test a mineral for hardness (Mohs Scale), malleability and streak. PG.M.5.RAS.B

1. **Igneous** PG.IMS.1

    a. Determine the feasibility of building a tunnel or road in a specific location based on the type of rocks present. PG.IMS.1.DTES.A

    a. Create a dichotomous key allowing for the identification of various igneous rocks. PG.IMS.1.ICSC.A

    b. Use Bowen's reaction series to identify the origins of several rocks. Provide evidence to support the identification. PG.IMS.1.ICSC.B

    a. Identify characteristics of different classifications of igneous, metamorphic, and sedimentary rocks PG.IMS.1.RAS.A

2. **Metamorphic** PG.IMS.2
    a. Create a building construction task based on student criteria. Analyze the pros and cons of different rock types to determine the most appropriate rock(s) for various aspects of the project. PG.IMS.2.DTES.A
    a. Create a dichotomous key allowing for the identification of various metamorphic rocks. PG.IMS.2.ICSC.A
    a. Sort metamorphic rocks by the grade of metamorphism. Describe the conditions under which various metamorphic rocks were formed from parent material. PG.IMS.2.RAS.A

3. **Sedimentary** PG.IMS.3
    a. Design a mining method (large or small scale) that allows material to be removed without collapse. PG.IMS.3.DTES.A
    a. Evaluate the ability of various sedimentary rocks to transport fluids (e.g., groundwater, oil, natural gas). PG.IMS.3.DSK.A
    a. Create a dichotomous key allowing for the identification of various sedimentary rocks. PG.IMS.3.ICSC.A
    b. Use fossils found in sedimentary rock to determine changes in sea level over geological time. PG.IMS.3.ICSC.B
    a. Identify and classify sedimentary rocks based on characteristics. PG.IMS.3.RAS.A
    b. Describe the depositional environment for various samples of sedimentary rocks. PG.IMS.3.RAS.B

4. **Ocean** PG.IMS.4
    a. Design and engineer a method to use ocean waves, tides or currents to produce energy. PG.IMS.4.DTES.A
    b. Research historic changes in the course of the Mississippi River. Discuss the pros and cons of the engineering methods being used to maintain its current course. PG.IMS.4.DTES.B
    a. Trace the development of an El Niño or La Niña event and explain how thermal energy shifts alter local and regional conditions. PG.IMS.4.ICSC.A
    b. Analyze why the Colorado River no longer flows into the Sea of Cortez. Use aerial photos over the last century to explain what happened to the delta. PG.IMS.4.ICSC.B
    c. Analyze how neap and spring tides impact coastal regions, especially during storm events and other natural occurrences. PG.IMS.4.ICSC.C
    a. Identify the various features around and within a stream system using Google Earth. PG.IMS.4.RAS.A
    b. Map major ocean currents and identify various types of currents. PG.IMS.4.RAS.B
    c. Map major trenches, ridges and island systems in each ocean. PG.IMS.4.RAS.C

1. **The geologic rock record** PG.EH.1

    a. Design and conduct a field study in a local area to locate fossil evidence that can be combined with other rock evidence to interpret the geologic history of the area. Document the fieldwork and steps of the investigation. Present an analysis of the data and the interpretation of the geologic history. PG.EH.1.DSK.A

    a. Use a geologic cross-section (or conduct a field investigation) for a specific location to analyze/interpret geologic history (e.g., rock type, formation, fossils or minerals present) and environmental conditions (e.g., volcanic activity, transgressing and regressing sea levels). PG.EH.1.ICSC.A

    b. Use evidence (e.g., glacial maps) to describe climate changes which occurred in Ohio. PG.EH.1.ICSC.B

    c. Develop a 3D model that shows the geologic layers of the local area using data published by scientists. PG.EH.1.ICSC.C

    d. Research the glacial history of a specific location using data from the rock record, contemporary field data (research conducted and published by scientists) and/or glacial features that can be documented (e.g., maps, virtual aerial documentation, remote sensing data). Relate the history to contemporary evidence of changing climate. PG.EH.1.ICSC.D

    e. Examine a glacial map of Ohio to compare the northern counties with the southern counties. What features would you expect to find in each location? PG.EH.1.ICSC.E

    f. Explain why there could be differences in the absolute age determination of rock when different isotopes are used. PG.EH.1.ICSC.F

    a. Describe fossils that are common to the local area and relate them to the geologic history of that region of Ohio. PG.EH.1.RAS.A

    b. Explain how absolute age is determined using different radioactive isotopes. Select which isotopes would be best for dating rock in a particular location (e.g., bottom of Grand Canyon, rocks in a dinosaur dig). PG.EH.1.RAS.B

    c. Describe the different divisions of geologic history and what specific events can be found within each division. PG.EH.1.RAS.C

1. **Internal Earth** PG.PT.1

    a. Design model buildings to withstand earthquakes. Use shake tables to test the models. Refine designs based on test results. Compare designs within the class to evaluate to most effective design techniques. PG.PT.1.DTES.A

    a. Construct a three-dimensional model that illustrates plate subduction using earthquake foci depth data. PG.PT.1.DSK.A

    b. Determine how an earthquake can cause the reversal of flow in a river using a project-based approach. PG.PT.1.DSK.B

    a. Determine the distance of an epicenter from a seismic station using travel time curves. Locate the epicenter of an earthquake by triangulation. Calculate the time of origin of an earthquake based on seismic data. PG.PT.1.ICSC.A

    b. Create a marketing pamphlet describing features of an earthquake resistant building/structure. PG.PT.1.ICSC.B

    c. Given earthquake and damage data (e.g., photos, reports, eyewitness accounts), rate each occurrence on the Mercalli scale. Create an approach for using this data to pinpoint the epicenter of the earthquake. Determine the rating of the earthquake on the Richter Scale using historic descriptions of earthquake occurrences. PG.PT.1.ICSC.C

    a. Identify P, S, and surface waves on three-component seismograms. PG.PT.1.RAS.A

    b. Identify the difference between reflection and refraction of seismic waves. PG.PT.1.RAS.B

    c. Perform basic velocity calculations related to P and S wave speed. PG.PT.1.RAS.C

2. **Structure of Earth** PG.PT.2

    a. Research a specific area with active geologic processes or events. Develop a plan to harness the available energy (e.g., heat from magma, water movement) from the process. Build a working model using specific data from the location. Evaluate the efficiency of the type of energy chosen. PG.PT.2.DTES.A

    a. Provide evidence to dispute the hypothesis that Earth is homogeneous throughout. PG.PT.2.ICSC.A

    a. Explain how seismic wave behavior helps scientists determine where Earth's interior layers are located. PG.PT.2.RAS.A

3. **Historical review** PG.PT.3

   a. Use data to investigate the magnetic reversals and the resulting magnetic striping that occurs at oceanic ridges. PG.PT.3.ICSC.A

   b. Create a model demonstrating how paleomagnetic stripes on the seafloor provided clues to magnetic reversals of the planet. PG.PT.3.ICSC.B

   c. Create a seafloor profile using maps and depth charts to illustrate seafloor spreading. PG.PT.3.ICSC.C

   d. Create a chart or table using evidence from the rock record to document the pattern of climate change that has occurred throughout geologic time. Use scientific data to document periods of climate fluctuation. Evaluate patterns and cause and effect that may be evident in the research. PG.PT.3.ICSC.D

   e. Assemble a puzzle based on Pangaea and use it to explain the processes that separated Pangaea. Project future plate movement. PG.PT.3.ICSC.E

   f. Evaluate various methods used to map and collect samples from the seafloor. PG.PT.3.ICSC.F

   g. Explain how ancient ice, pollen and tree ring samples provide evidence of ancient climate changes on Earth. PG.PT.3.ICSC.G

   a. Explain the cause of seafloor spreading and continental drift. PG.PT.3.RAS.A

4. **Plate motion** PG.PT.4

   a. Identify specific geologic features using LANDSAT or other remote sensing data. Identify the factors required to create the specific features. PG.PT.4.ICSC.A

   b. Create a 3-D working model of a real landform created by plate tectonics (e.g., faults, fault block mountains, volcanoes, rift valleys). PG.PT.4.ICSC.B

   c. Create a digital bulletin board or a 360 Google Map tour of a geologic feature created by plate tectonics. PG.PT.4.ICSC.C

   d. Use isotopic, petrological and/or geochemical evidence to identify motion at plate boundaries. PG.PT.4.ICSC.D

   e. Research the most recent measurements of North America. Using this data and the movement of North America throughout geologic time, predict where North America will be in 600 million years or more. Create a model to demonstrate that movement. PG.PT.4.ICSC.E

   a. Identify characteristics of oceanic and continental plates using data. PG.PT.4.RAS.A

   b. Correlate locations of volcanoes and earthquakes with plate boundaries. PG.PT.4.RAS.B

   c. Identify plate motion as a cause for construction and destruction of landforms and surface features on Earth's crust. PG.PT.4.RAS.C

   d. Explain how heat transfer causes plate motion. PG.PT.4.RAS.D

   e. Explain the causes and evidence of plate motion. PG.PT.4.RAS.E

1. **Energy resources** PG.ER.1
    a. Design and build (virtual, blueprint or 3-D model) an Eco-House that uses green technology and allows the house to be off-grid. Select a specific location and evaluate the different options that would be efficient and effective for that area. PG.ER.1.DTES.A
    a. Compare mineral uses versus availability and demand. PG.ER.1.RAS.A
    b. Identify different energy resources as renewable and non-renewable. PG.ER.1.RAS.B

2. **Air** PG.ER.2
    a. Design a technology to remove either particulate or chemical pollutants from air. PG.ER.2.DTES.A
    b. Collect samples of air to investigate a local contamination issue. Recommend ways to reduce or prevent contamination based on scientific data and research. PG.ER.2.DTES.B
    a. Determine the amount and size of particulate matter in the air at the school or community. Analyze the results using information from the Environmental Protection Agency and the Department of Health (e.g., lung diseases, including emphysema and asthma). Locate specific Ohio data for comparative analysis. Report class findings and recommendations orally or in written form to school administrators or community leaders. PG.ER.2.DSK.A
    b. Survey the indoor school environment for the presence of ozone using Schoenbein's papers prepared in class. PG.ER.2.DSK.B
    a. Describe the components and processes involved in the generation of photochemical smog. PG.ER.2.ICSC.A
    b. Describe positive and negative feedback loops that impact the greenhouse effect and climate change. PG.ER.2.ICSC.B
    a. Describe the characteristics of each layer of the atmosphere, including any benefits to or uses by humans. PG.ER.2.RAS.A
    b. Describe how the atmosphere and the oceans interact to sequester atmospheric carbon. PG.ER.2.RAS.B

3. **Water** PG.ER.3
    a. Investigate different methods (e.g., aeration, filtration) for removing pollutants from water. Design, build and test water filters. PG.ER.3.DTES.A
    b. Collect samples of water to investigate a local contamination issue. Recommend ways to reduce or prevent contamination based on scientific data and research. PG.ER.3.DTES.B
    a. Deconstruct the events leading up to a fish kill in a local river, given data including times, locations, and eye-witness accounts. PG.ER.3.ICSC.A
    b. Use topographic maps to decide on an area to locate wells or a reservoir for drinking water for a city. PG.ER.3.ICSC.B

4. **Soil and sediment** PG.ER.4

   a. Collect samples of soil to investigate a local contamination issue. Recommend ways to reduce or prevent contamination based on scientific data and research. PG.ER.4.DTES.A

   b. Build a model construction site and use it to develop techniques to manage storm water runoff and construction mud. PG.ER.4.DTES.B

   a. Construct a model to explore how soil type (e.g., sand, silt, clay), water content and slope affect severity of landslides. PG.ER.4.DSK.A

   b. Create a topographic, soil or geologic map of the school or community using actual data collected from the field (e.g., GPS/GIS readings, field investigation, aerial maps). Present a final map in a poster session, along with data used in the development of the map and an analysis of the data. PG.ER.4.DSK.B

   a. Describe the steps of desertification and identify areas on a globe that represent each of the transitions. PG.ER.4.ICSC.A

   a. Identify types of mass wasting that are present in the local area. PG.ER.4.RAS.A

1. **Glaciers and glaciation** PG.GG.1

   a. Design an investigation to determine/evaluate how changes in slope, substrate and temperature affect glacial flow dynamics. PG.GG.1.DSK.A

   a. Use Google Earth to identify locations of features created by glaciers. Take or find pictures of the features and add them to Google Earth in the correct locations. PG.GG.1.ICSC.A

   b. Develop a model to reconstruct glacial history that includes resulting features (e.g., U-shaped valleys, moraines, tills, kettles, eskers, erratics, outwash). Use the model to explain the processes. PG.GG.1.ICSC.B

   a. Recognize and identify different types of glaciers and glacial features using aerial photographs, LANDSAT data, surficial geology maps or topographic maps. PG.GG.1.RAS.A

   b. Identify topographic features in Ohio and explain the geological processes involved in creating those features. PG.GG.1.RAS.B