| Course: Earth Sciences 11 | |
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| Big Ideas | Elaborations |
| **Earth Materials**<br>Earth materials are changed as they cycle through the geosphere and are used as resources, with economic and environmental implications. | *Sample opportunities to support student inquiry:*<br>• What role does the rock cycle play in the diversity of earth materials?<br>• Why are only some earth materials considered "resources"? |
| **Plate Tectonic Theory**<br>Plate tectonic theory explains the consequences of tectonic plate interactions. | *Sample opportunities to support student inquiry:*<br>• What determines the type and distribution of volcanoes and earthquakes? |
| **Atmospheric Science and Climate**<br>The transfer of energy through the atmosphere creates weather and is affected by climate change. | *Sample opportunities to support student inquiry:*<br>• Why are extreme weather events predicted to become more frequent? |
| **Oceanography and the Hydrosphere**<br>The distribution of water has a major influence on weather and climate. | *Sample opportunities to support student inquiry:*<br>• How does the weather in coastal and inland communities compare?<br>• How do we know what the bottom of the ocean looks like? |
| **Earth within the Solar System**<br>Astronomy seeks to explain the origin and interactions of Earth and its solar system. | *Sample opportunities to support student inquiry:*<br>• Where did the solar system come from?<br>• Why is Earth the only planet in our solar system that supports life? |



| Curricular Competencies | Elaborations | Content | Elaborations |
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| *Students are expected to be able to do the following:*<br>**Questioning and predicting**<br>• Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest<br>• Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world<br>• Formulate multiple hypotheses and predict multiple outcomes<br><br>**Planning and conducting**<br>• Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative)<br>• Assess risks and address ethical, cultural, and/or environmental issues associated with their proposed methods | **Questioning and predicting:**<br>*Sample opportunities to support student inquiry:*<br>• Consider earthquake potential, locally and globally, based on plate boundary information.<br>• What is the difference between weather and climate?<br>• What is the difference between El Niño and La Niña?<br>• Is the greenhouse effect a "bad thing"?<br>• Is water Earth's most important resource?<br>• How would Earth be different if we had more or less surface water?<br>• Explore a First Peoples narrative based on astronomy.<br>**Planning and conducting:**<br>*Sample opportunities to support student inquiry:*<br>• Make and record observations of a variety of earth | *Students are expected to know the following:*<br><br>Earth Materials<br>• Earth materials can be identified and classified based on their properties:<br>○ **minerals**<br>○ **igneous rocks**<br>○ **sedimentary rocks**<br>○ **metamorphic rocks**<br>○ **geologic resources**<br>• the rock cycle explains how rocks are formed, destroyed, and transformed:<br>○ **surface processes**<br>○ **internal processes**<br>• economic and environmental implications of geologic resources within BC and globally:<br>○ First Peoples perspectives<br>○ **economic feasibility** | Earth Materials<br>**minerals:**<br>• common minerals found in igneous, metamorphic, and sedimentary environments<br>• valuable, ore-forming minerals found in BC<br>**igneous rocks:**<br>• common types of igneous rocks (e.g., basalt, granite, pumice)<br>• relationship between texture, crystal size, and rate of cooling<br>• intrusive versus extrusive<br>**sedimentary rocks:**<br>• common types of sedimentary rocks (e.g., conglomerate, shale, coal, limestone)<br>• chemical/biochemical versus clastic<br>**metamorphic rocks:**<br>• common types of metamorphic rocks (e.g., slate, schist, gneiss) |

- Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data
- Apply the concepts of accuracy and precision to experimental procedures and data:
  - significant figures
  - uncertainty
  - scientific notation

**Processing and analyzing data and information**

- Experience and interpret the local environment
- Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information
- Seek and analyze patterns, trends, and connections in data, including describing relationships between variables, performing calculations, and identifying inconsistencies
- Construct, analyze, and interpret graphs, models, and/or diagrams
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence
- Analyze cause-and-effect relationships

**Evaluating**

- Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions
- Describe specific ways to improve their investigation methods and the quality of the data
- Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled
- Demonstrate an awareness of assumptions, question information given, and identify bias in their own work and in primary and secondary

materials based on their chemical and physical differences (e.g., fizz in acid, hardness, colour, crystal size).

- Collect weather-related data and create a daily weather report for the school.
- Investigate the various properties of water through lab activities, such as:
  - the specific heat of water — compare water's ability to store heat energy to that of other common substances
  - acidic and alkaline waters — explore the pH scale and the effect that acidic and alkaline solutions have on minerals (e.g., limestone) and on living things (e.g., shellfish, coral)
  - salt and salinity — explore the effects of salt and salinity on density and currents
  - temperature — explore the effects that local heating/cooling of water may have in producing convection currents and thermoclines
- Make a chart of the moon phases for each night in a calendar month.
- Compare a lunar year to a calendar year.

**Processing and analyzing data and information:**
*Sample opportunities to support student inquiry:*

- Classify various types of earth materials based on their similarities and differences (e.g., igneous, metamorphic, and sedimentary rocks).
- Determine the conditions and the environment required to form various types of earth materials.
- Compare a "cookie-mining activity" with real mining operations.
- Use evidence (e.g., fossil data, mountain ranges, coastline puzzle fit, paleo-glacial data, rock types) to illustrate how continents have shifted over time.
- Collect and map earthquake and volcanic eruption

  - **exploration methods**
  - **extraction methods**
  - **site remediation**

Plate Tectonic Theory

- plate tectonic theory unifies evidence from:
  - continental drift theory
  - distribution of mountain ranges, volcanoes, and earthquake epicentres
  - sea-floor spreading and hot spots
- convection of **heat** within Earth's interior drives **plate motion** and creates unique **features** at different **plate boundaries**
- plate tectonic settings within BC and local geological terrains:
  - features and processes
  - First Peoples knowledge

Atmospheric Science and Climate

- the hydrologic cycle is driven by the **transfer of energy** within the atmosphere and hydrosphere
- the atmosphere is divided into **layers** that have unique **properties**
- the **composition** of the atmosphere has changed over time:
  - **evidence of change**
  - **impacts on the carbon cycle**
- the interaction of water, air, and energy creates **weather**
- solar radiation interacts with the atmosphere, hydrosphere, and geosphere and has **impacts on the energy budget**

Oceanography and the Hydrosphere

- the hydrologic cycle is driven by the transfer of energy within the atmosphere and hydrosphere

- foliated versus non-foliated rocks

**geologic resources:** minerals, ores, fossil fuels, metals, aggregates

**surface processes:** weathering, erosion

**internal processes:** melting, crystallization, metamorphism

**economic feasibility:** price, concentration, accessibility, environmental concerns

**exploration methods:** use of geochemical and geophysical data, field work, remote sensing, mapping, drilling

**extraction methods:** open pit versus underground mining, fracking of oil and gas reservoirs, methods of concentrating and refining ore minerals and fossil fuels

**site remediation:** government regulations, failed tailings ponds, acid rock drainage, land reclamation

Plate Tectonic Theory
**heat:** both within the core and from excess radioactivity within the mantle
**plate motion:** contributions of ridge push and slab pull, as well as convection currents within the mantle
**features:** mid-ocean ridges, rift eruptions, volcanic island arcs
**plate boundaries:** Boundaries occur between both oceanic and continental plates.

Atmospheric Science and Climate

**transfer of energy:** conduction, convection, and radiation
**layers:**

- troposphere, stratosphere, mesosphere, thermosphere
- ozone layer

**properties:** temperature, composition, auroras

**composition:** nitrogen, carbon dioxide, pollutants, methane

sources

- Consider the changes in knowledge over time as tools and technologies have developed
- Connect scientific explorations to careers in science
- Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in primary and secondary sources
- Consider social, ethical, and environmental implications of the findings from their own and others' investigations
- Critically analyze the validity of information in primary and secondary sources and evaluate the approaches used to solve problems
- Assess risks in the context of personal safety and social responsibility

**Applying and innovating**

- Contribute to care for self, others, community, and world through individual or collaborative approaches
- Co-operatively design projects with local and/or global connections and applications
- Contribute to finding solutions to problems at a local and/or global level through inquiry
- Implement multiple strategies to solve problems in real-life, applied, and conceptual situations
- Consider the role of scientists in innovation

**Communicating**

- Formulate physical or mental theoretical models to describe a phenomenon
- Communicate scientific ideas, information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-

data and identify trends and patterns.

- Create clouds in a bottle and investigate the conditions required to make a cloud.
- Create a graphic novel to document and explore the different conditions required for the hydrologic cycle to function, including references to phase and energy transitions, temperature, and air pressure, as well as the effects of water on Earth's surface, the formation of glaciers, and subsurface groundwater.
- Research and study a local body of water to determine how local weather is influenced by water:
  - formation of off-shore breezes, water-spouts, and other phenomena
  - lake-effect snowstorms
  - rain shadows and the effect of mountains and other barriers that influence weather patterns
- Produce a timeline that documents the major events that have taken place from the big bang to the present, and relate the events to the evolution of our modern solar system.
- Explore trends and patterns within our solar system, including:
  - average density and suspected internal structure
  - composition of Earth and other planets
  - structure of Earth's and other planets' interiors
  - number of moons
  - spacing of planets and average surface temperatures
  - orbit direction and direction of planetary spin
  - volcanism and evidence of past volcanism
  - mountains and evidence of plate tectonics
- Classify stars in terms of their characteristics (e.g., luminosity, size) and development of the

- First Peoples perspectives and knowledge of ocean processes
- water is a unique resource and is found in many forms on Earth:
  - **fresh water**
  - **salt water**
  - **environmental concerns**
- use of remote sensing and direct observation to determine the properties of the ocean and **ocean floor**
- **ocean currents** are dependent on salinity, temperature, and density
- oceans and lakes influence **local** and **global** climates
- **water sources are affected by climate change**
- First Peoples knowledge of climate change and interconnectedness as related to environmental systems

Earth within the Solar System

- the nebular hypothesis explains the origin of the formation of solar systems:
  - formation of planets and moons
  - composition of planets
  - density of planets
  - spacing of planets
- **Earth is a unique planet** within its solar system
- stars are the centre of a solar system and can be **classified** based on their **characteristics**
- impacts of the **Earth-moon-sun system**
- **application of space technologies** to study changes to Earth and its systems

**evidence of change:** Consider evidence for both historical and recent (i.e., the last 100 years) climate change (e.g., ice core data, deep sea sediments, First Peoples knowledge)

**impacts on the carbon cycle:** both natural and man-made carbon sources/sinks

**weather:**

- air masses
- air pressure
- humidity and dew point
- fronts and frontal systems
- extreme weather events
- local (e.g., on-shore breeze, tornadoes ) and global (e.g., jet stream) air currents
- El Niño and La Niña

**impacts on the energy budget:** Consider both natural and manmade impacts, including:

- greenhouse effect
- albedo
- climate change

Oceanography and the Hydrosphere

**fresh water:** 3% of Earth's water (e.g., rivers, glaciers, ground water)

**salt water:** 97% of Earth's water (e.g., oceans, salt lakes)

**environmental concerns:** aquifer depletion, sea water intrusion, contamination from landfills and industry

**ocean floor:** continental margins, abyssal plain, trench, seamounts

**ocean currents:** both local and global ocean currents (e.g., Gulf Stream)

**local:** on-shore breeze, temperature moderation

**global:** oceans are one of the largest carbon sinks;

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| based arguments and using appropriate scientific language, conventions, and representations<br>• Express and reflect on a variety of experiences, perspectives, and worldviews through place | Hertzsprung-Russel diagram.<br>• Graph tidal data and determine the significance of the moon to Earth's tides.<br><br>**Evaluating:**<br>*Sample opportunities to support student inquiry:*<br>• How do different industries depend on earth materials?<br>• What earth science careers are relied on in finding, processing, and producing earth material resources?<br>• Consider the different interpretations of remediation and restoration requirements of a mining site after a resource has been extracted.<br>• Compare the advantages and disadvantages of various extraction methods, such as open-pit versus underground mining, and fracking of geological oil and gas reservoirs.<br>• Compare and contrast continental drift theory and modern plate tectonic theory<br>• Engage in a group project to research and report on parts of Earth that has experienced the effects of climate change most acutely. Presentations could emphasize:<br>○ causes and effects of climate change<br>○ evidence to link change in the area to climate change<br>○ socio-economic effects of climate change in the area<br>• Debate the benefits of electric vehicles if the local electricity is generated by coal-powered plants.<br>• Create an infographic on one of the world's major oceans, seas, or lakes that explores the role that the body of water has as a:<br>○ maker of weather, and its influence on local climate<br>○ transportation and economic/trade lifeline | | albedo effect<br>**water sources are affected by climate change:**<br>• ocean acidification<br>• changes to ocean currents<br>• loss of glaciers<br>• rising sea levels<br><br>Earth within the Solar System<br>**Earth is a unique planet:** water, life, protective magnetic field, temperature, atmosphere<br>**classified:** white dwarves, red giants, Hertzsprung-Russell diagram<br>**characteristics:**<br>• life cycles<br>• apparent and absolute magnitude<br>• colour<br>• size<br>**Earth-moon-sun system:** tides, eclipses, seasonal variation, albedo, precession, moon phases, solar winds<br>**application of space technologies:** satellites, ISS, probes, telescopes, GPS |

- source of fisheries

- Research the role of oceans as a carbon sink and the impact of rising global temperatures on the ocean.
- Debate the change of Pluto's status from a planet to a planetoid.
- Research the characteristics of Mars, Venus, and Earth to establish the life-sustaining properties offered by Earth in contrast to its neighbours.

**Applying and innovating:**
*Sample opportunities to support student inquiry:*

- How can resource site remediation be improved?
- Research new technologies used in the refining process of ores (e.g., bacteria).
- Investigate building techniques that are resistant to earthquake damage.
- What does it mean for a company to be carbon neutral?
- Why do some governments have a carbon tax?
- Design an action and awareness campaign about the importance of preserving a local body of water.

**Communicating:**
*Sample opportunities to support student inquiry:*

- Research a mining operation or other earth material resource extraction process in your local area and create an infographic or other presentation to illustrate the location (geologic map), formation history, and importance (types of skills, trades, and local businesses) of the operation to the local economy.
- Use a variety of methods (e.g., sculpture, 3D model) to create a scaled model of Earth that illustrates its interior, with various layers and boundaries.

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| | • Create topographic maps of tectonic settings that represent mountain ranges, subduction zones, faults, and past earthquake data.<br>• Produce cross-sections of tectonic settings to illustrate tectonic plate interactions, including collisions and boundaries produced by them.<br>• Create a representation (e.g., model, computer graphic, infographic) that illustrates the properties of the various layers within the Earth's atmosphere (e.g., changes in pressure, clouds, composition, human activity).<br>• Produce a weather broadcast video or presentation that explains the cause and effects of an extreme weather event.<br>• Create 3D models of the ocean floor showing continental slope, continental rise, continental shelf, sea-mounts, ocean ridge, abyssal plain, and canyons, using clay, playdough, or other sculpting materials displayed in a shoebox.<br>• Create a model to relate the distances from the sun and the sizes of various planets, moons, and asteroids. | | |