

Instructor: Andrew Urquhart School: Kalkaska High School

Subject: Earth Science Grade(s): 9th

Instructional Materials: _____

Month	Topics	Time Spent (weeks)	MCF Benchmarks, or Grade Level Content Expectations (GLCEs)
September	Organizing Principles of Earth Science -Topographic Maps		E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
			E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.
			E2.3c Explain how the nitrogen cycle is part of the Earth system.
			E2.3 Biogeochemical Cycles The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different states and chemical forms; they move within and between the geosphere, atmosphere, hydrosphere, and biosphere as part of the Earth system. The movements can be slow or rapid. Elements and compounds have significant impacts on the biosphere and have important impacts on human health.
			E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life) within Earth systems and how those forms can be beneficial or harmful to humans.
			E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.
			E3.3B Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that results from their increased density.

Rock Forming processes

Resources and Environmental Challenges

- E3.1A Discriminate between igneous, metamorphic, and sedimentary rocks and describe the processes that change one kind of rock into another.
- E3.1B Explain the relationship between the rock cycle and plate tectonics theory in regard to the origins of igneous, sedimentary, and metamorphic rocks.
- E3.1c Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.
- E3.1d Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.
- E2.1e Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.

- E2.2B Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.

- E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.
- E2.2e Explain how energy changes form through Earth systems.
- E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.
- E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).
- E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.
- E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.
- E2.4c Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.
- E2.4d Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.
- E4.3C Describe severe weather and flood safety and mitigation.
- E5.3A Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).

Discerning Earth's History

- E5.3B Explain the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.
- E5.3C Relate major events in the history of the Earth to the geologic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.
- E5.3D Describe how index fossils can be used to determine time sequence.
- E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.
- E5.3f Explain why C-14 can be used to date a 40,000 year old tree but U-Pb cannot.
- E5.3g Identify a sequence of geologic events using relative-age dating principles.

Plate Tectonic and Volcanoes

- E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
- E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.
- E2.2A Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).
- E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.
- E3.3A Explain how plate tectonics accounts for the features and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.
- E3.3B Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that results from their increased density.
- E3.3C Describe the motion history of geologic features (e.g., plates, Hawaii) using equations relating rate, time, and distance.
- E3.3d Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.
- E3.r3e Predict the temperature distribution of the lithosphere as a function of distance from the mid-ocean ridge and how it relates to ocean depth.

December	Plate Tectonic and Volcanoes		<p>E3.4 Earthquakes and Volcanoes Plate motions result in potentially catastrophic events (earthquakes, volcanoes, tsunamis, mass wasting) that affect humanity. The intensity of volcanic eruptions is controlled by the chemistry and properties of the magma. Earthquakes are the result of abrupt movements of the Earth. They generate energy in the form of body and surface waves.</p> <p>E3.4A Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.</p> <p>E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.</p> <p>E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.</p> <p>E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.</p> <p>E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.</p>
January	Earthquakes and Earth's Interior		<p>E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.</p> <p>E3.2A Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.</p> <p>E3.2B Explain how scientists infer that the Earth has internal layers with discernable properties using patterns of primary (P) and secondary (S) seismic wave arrivals</p> <p>E3.2C Describe the differences between oceanic and continental crust (including density, age composition).</p> <p>E3.2d Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.</p> <p>E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.</p> <p>E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.</p> <p>E3.4f Explain why fences are offset after an earthquake using the elastic rebound theory.</p>

February

Hydrogeology

-River Systems

-Glaciers

- E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.
- E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).
- E4.1A Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative size as Earth's freshwater reservoirs and the dynamics of water movement (inputs and outputs, residence times, sustainability).
- E4.1B Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g., the past 100 years) qualitatively using the concepts of recharge, residence time, inputs and outputs.
- E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.

Oceans and Climates

- E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
- E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.
- E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.
- E2.2e Explain how energy changes form through Earth systems.
- E4.2A Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the Earth, changes in water temperature and salinity in high latitudes, and basin shape.
- E4.2B Explain how the interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climatic zones, and the ocean as a major CO₂ reservoir.
- E4.2c Explain the dynamics (including ocean-atmosphere interactions) of the El Nino-Southern Oscillation (ENSO) and its effect on continental climates.
- E4.2d Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.
- E4.2e Explain the differences between maritime and continental climates with regard to oceanic currents.
- E4.2f Explain how the Coriolis effect controls oceanic circulation.

Climate Change

- E2.1A Explain why the Earth is essentially a closed system in terms of matter.
- E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
- E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.
- E2.2e Explain how energy changes form through Earth systems.
- E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.
- E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life within Earth systems and how those forms can be beneficial or harmful to humans).
- E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.
- E5.4A Explain the natural mechanism of the greenhouse effect including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).
- E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the Earth, meteorite impacts).
- E5.4C Analyze the empirical relationship between the emission of carbon dioxide, atmospheric carbon dioxide levels and the average global temperature over the past 150 years.
- E5.4D Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (including the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).
- E5.4e Based on evidence from historical climate research (e.g., fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climate system.
- E5.4f Describe geological evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).
- E2.1A Explain why the Earth is essentially a closed system.
- E5.4g Compare and contrast the heat trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat trapping capacity.

Severe Weather

- E2.2A Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).
- E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.
- E2.2D Identify the main sources of energy to the climate system.
- E4.3A Describe the various conditions of formation associated with severe weather (thunderstorms, hurricanes, floods, waves, and drought).
- E4.3B Describe the damage resulting from and the social impact of thunderstorms, tornadoes, hurricanes, and floods.
- E4.3C Describe severe weather and flood safety and mitigation.
- E4.3D Describe the seasonal variations in severe weather.
- E4.3E Describe conditions associated with frontal boundaries that result in severe weather (thunderstorms, tornadoes, and hurricanes).
- E4.3F Describe how mountains, frontal wedging (including dry lines), convection, and convergence form clouds and precipitation.
- E4.3g Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.

Cosmology and Earth's Place in the Universe

- E5.1A Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.
- E5.1b Describe how the Big Bang theory accounts for the formation of the universe.
- E5.1c Explain how observations of the cosmic background radiation have helped determine the age of the universe.
- E5.1d Differentiate between the cosmological and Doppler red shift.
- E5.3 Earth History and Geologic Time The solar system formed from a nebular cloud of dust and gas 4.6 Ga (billion years ago). The Earth has changed through time and has been affected by both catastrophic (e.g., earthquakes, meteorite impacts, volcanoes) and gradual geologic events (e.g., plate movements, mountain building) as well as the effects of biological evolution (formation of an oxygen atmosphere). Geologic time can be determined through both relative and absolute dating.
- E5.3A Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).

June	The Sun and Other Stars		E5.2A	Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).
			E5.2B	Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power disturbances.
			E5.2C	Describe how nuclear fusion produces energy in the Sun.
			E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
			E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
			E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycle of stars.
			E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
			E5.2h	Compare the evolution paths of low, moderate and high mass stars using the H-R diagram.

Frequent Standards

E2.1A 2
E2.1B 4
E2.1C 4
 E2.2A 2
E2.2C 5
E2.2e 3
 E2.3A 2
 E2.3B 2
 E2.3d 2
 E3.3B 2
 E3.4B 2
 E3.4C 2
 E4.3C 2
 E5.3A 2

