6th Grade Earth Science Unit

Grade Level: 6th Unit: Earth's Structure, Processes and History (Part A &B)

Time Frame:15-17 wks

Unit Essential Questions:

Part A:

- What information does the analysis of a rock's properties allow us to infer about the history of that rock?
- How can rock forming processes be investigated using simulations?
- How do earth materials relate to landforms?

Part B:

- How are geologic events and features explained in light of the plate tectonic theory?
- How have changes in Earth's magnetic field provided evidence in support of plate tectonic theory?
- How is evidence used to discern earth history?

Big ideas: Rocks, minerals and soil; land formations and plate tectonics, Earth's magnetic field, and Earth's history.

Essential Concepts/Skills/
GLCE's:

Solid Earth

E.SE.06.11 Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.**

E.SE.06.12 Explain how waves, wind, water, and glacier movement, shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas. **

E.SE.06.13 Describe how soil is a mixture made up of weather eroded rock and decomposed organic material. **

E.SE.06.14 Compare different soil samples based on particle size and texture.**

E.SE.06.41 Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.

E.SE.06.51 Explain plate tectonic movement and how the lithospheric plates move centimeters each year.**

E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions. **

E.SE.06.53 Describe layers of the Earth as a lithosphere (crust and upper mantle), convecting mantle, and dense metallic core.**

E.SE.06.61 Describe the Earth as a magnet and compare the magnetic properties of the Earth to that of a natural or manufactured magnet.**

E.SE.06.62 Explain how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.**

Earth in Space and Time

E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the Earth (timelines and relative dating, rock layers).**

E.ST.06.41 Explain how Earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.**

E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.**

NGSS:

Earth's Place in the Universe

MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

Earth's Systems

MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Earth and Human Activity

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Vocabulary

- geology
- rock cycle
- igneous
- metamorphic
- sedimentary
- earth processes
- erosion
- weathering
- abrasion
- thermal expansion /contraction
- deposition
- rock layers
- relative dating
- geological history
- timelines
- geological events
- glaciers / glacier movement
- earthquakes
- volcanic eruptions
- mountain building
- plate tectonic
- lithospheric plates
- natural resource
- organic material
- minerals
- soils
- sediments
- gravel
- sand
- silt
- clay
- lithosphere
- crust
- upper mantle
- convecting mantle
- metallic core
- fossils
- rocks
- particle size
- magnetic field
- poles
- navigation
- environmental conditions
- inferences
- identifying
- recognizing
- diagnosing and identification
- analyzing
- classifying
- comparing
- describing
- differentiating
- gradual
- formation
- Pangea
- Richtor scale
- lava
- magma
- tremor
- vibrations
- seizmograph
- magnitude

PRE-PLANNING CONSIDERATIONS

Misconceptions that need to be addressed:

Rocks and Minerals

- Students may confuse the use of geologic terms in everyday language versus scientific communication. (Rock, mineral, crystal, clast)
- Students may think that the size of rocks and minerals are important when classifying them. A

consideration of the many common terms used to describe rocks of various sizes (rock, stone, pebble, gravel, boulder, and so on) illustrates why students may consider size to be of utmost importance, while a geologist does not.
- They may think that all rocks are the same, and it's hard to tell how they originated and/or that rocks and minerals are the same thing.
- Students may also think that humans can fabricate rocks and minerals; artifacts are the same as rocks and minerals.

The Rock Cycle

- One common misconception is that layered rocks are always sedimentary; in fact, many metamorphic rocks are layered, and even a few igneous rocks can have layers.
- Some students mistakenly assume that one type of rock can only change to another type; for example, that igneous can only change to sedimentary or metamorphic rather than melting again and changing to another type of igneous rock.
- Students may think that metamorphic rocks are a "little melted" when, in fact, if there is melting, then the process is igneous.
- Students may think that metamorphic rocks require both heat and pressure, when there are cases of metamorphism that are just heat or predominantly pressure.
- Students may assume that any amount of pressure or heat will cause a rock to metamorphosize, when there are specific amounts; some pressure may just make a sedimentary rock, while too much heat will melt a rock, resulting in an igneous process.

Soil Composition

- http://www.learner.org/courses/essential/earthspace/session1/ideas.html

Weathering and Erosion

- Students tend to view the earth as static, stable, and unchanging. They often have difficulty believing that rocks can change or be worn down through the process of weathering. Students also tend to confuse weathering (the physical or chemical breakdown of rock) with erosion (the process of transporting sediments).
- Even once students understand the concepts of weathering and erosion, they tend to have difficulty conceptualizing the long time frames needed for these processes to occur.
- Many science lessons focus on the negative aspects of erosion (soil loss, ecosystem destruction, sediment buildup in water sources) and lead students to believe that erosion is always bad. However, teachers should stress that erosion does have positive aspects as well. Delta areas, like the Mississippi and the Nile, were created by the deposition of eroded sediments carried downriver. Without erosion, these rich, fertile farming areas would not exist.

Plate Tectonics

- One misconception that more students may have is that lithosphere and athenosphere can be used interchangeably with crust and mantle. Crust and mantle refer to the makeup of the different layers of the Earth, while lithosphere and athenosphere refer to how the composition of the Earth responds to the stress "caused by the differences in temperature."
- Students may think that tectonic plates are always neatly divided along continental lines, but the lines are not so neat. For example, the North American plate includes the North American continent, Greenland, half of Iceland, and part of Eurasia. All six of the Earth's large continental plates contain a continent and a large section of oceanic crust. Some of the 10 other small tectonic plates contain only oceanic crust.
- http://serc.carleton.edu/NAGTWorkshops/intro/misconception_list.html

Supplies to gather or things that need to be done prior to starting the unit:

Part A -

- Rocks and minerals samples (provided by teacher and solicited from student personal experiences / environment)

- Magnifying glasses
- dilute HCl (1 molar solution), streak plates
- Salol, Alum, Salt or Sugar or soda for growing crystals.
- Metal teaspoons and microscope slides.
- Ziploc bags to sort and distribute rocks (and soils) of various types
- Plastic / glass jars with lids and beakers
- Materials for Rock Cycle Simulations
    - Crayons (at least 2 colors), aluminum foil, heat source
    - Jelly beans (at least 2 colors), aluminum foil, heat source
- Composting materials (organic materials such as yard waste / grass clippings, fruit or vegetable scraps, cardboard, newspaper strips, egg shells, nut shells, etc.)
- An area outside of school for composting piles (can include bins such as chicken wire enclosure, wooden box, etc.) and a shovel to turn the pile weekly.
- Sedimentary layers models: round, flat-bottomed bowl – approximately 12 inches, a beaker, small enough to fit inside the bowl, leaving a large enough track to conduct the simulation; aquarium, bottle with lid, beach sand, pea gravel, silt or clay.
- Geologic Time Scale and the Denver Basin: copies of Animal Fossil Cards, copies of Denver Basin rock formation cards, envelopes for Animal Fossil Cards, dopy of Geologic Time Scale and the Denver Basin Handout, copies of mailing labels with Denver Basin Formations, one per student or team.
- Weathering and Erosion simulation materials: 8 effervescent antacid tablets, 1000 ml beaker (filled with hot tap water), 250 ml beaker, stopwatch, thermometer, graph paper, plaster of Paris (available at art or hobby supply stores, or from your art department), a small balloon, two empty pint milk cartons (bottom halves only), freezer.
- Stream table materials: stream table pan filled with 2 quarts of "standard mix" sand, four "drip" containers (with 1⁄8," 31⁄16", 5⁄16", and 3⁄32" holes), ruler, two 1"x2" blocks to prop up the stream table, "wood angle" scraper, water pitcher, basin to catch water flowing out of the stream table pan, inquiry starter station activity cards.
- Soil samples (provided by teacher and solicited from student personal experiences / environment)
- Fast growing seeds (e.g. beans, radishes, mustard greens, cress, melons all germinate in about five to six days) and cups or small pots to plant them.

Part B -

- Maps from the Discovering Plate Boundaries website: http://plateboundary.rice.edu/, clipboards and colored pencils.
- Exploring magnetism: 4-10 inch bar magnet to hang from the ceiling by a fishing string.
    - Session 1: 1 magnetic compass per student, 2 Alnico bar magnets, sevearl sheets of white paper, 4-5 paper clips, a wooden or plastic ruler, and a pencil, 1 salt shaker of iron filings, copper or aluminum wire, 1 cow magnet, 1 small/medium sized bottle (clear plastic or glass), 2 tablespoons of iron filings, 1 manila envelope, 1 roll of scotch tape (duct tape would be fine too), 1 piece paper or tissue paper.
    - Session 2: 1 "boombox" stereo with audio speakers (optional), 1 pair of wire cutters (in most cases scissors will do the trick), spool of copper wire (covered with an insulating enamel), small patch of sand paper for removing wire enamel at connection points, 3 insulated wires with alligator clips, 3 Batteries (D-cells, 9-volt, etc.) with optional battery holders, 1 AC to DC adapter with variable

voltage, 1 knife switch, 1 Ammeter or Galvanometer

- Modeling Plate Boundaries / Sea floor spreading: large batch of shoe boxes (with approximate dimensions 6.5" x 13" by 5" deep), glue sticks, scissors, box cutters, digital camera
- Seismic Eruption Software: www.geol.binghamton.edu/faculty/jones (scroll down to Seismic Eruption and download the self extracting file)
- Cards with geologic events (first six slides of a PowerPoint file in handout mode, six slides per page), index cards, colored pencils.
- Modeling geologic time: 4 different colors of yarn, meter sticks, preprinted events on ½" x 1 ¾" mailing labels or as copies that students can cut out as strips and tape onto the timeline, tape, markers, scissors.
- Model of a geologic basin: Small plastic containers with straight sides, one for each group of four students (small, clear, disposable, Gladware-type square containers work well because of their straight sides and affordability), Play dough or plasticene modeling clay: multiple colors (models must be made in advance and refridgerated), rolling pin, flour, colored pencils (if you are providing this item), roll of painters' tape, clear 10 – inch, 0.25 diameter drinking straws – enough so each group has ten pieces when straws are cut in half, permanent marking pen, pictures of the Boulder Flatirons and horizontal sedimentary rock outcrop (in curriculum guide), small ½" x 1 ¾" mailing sticker labels (each group will need 18), box of straight pins, eight small self-sealing baggies, white copy paper.

Additional Resources:

Part A:
Rocks and Minerals Flipchart:
https://drive.google.com/file/d/0B9Nh_z4RdgdKZl9fcmIxSGZwcjA/edit?usp=sharing

3 types of rock- a science song: https://www.youtube.com/watch?v=jPgE74Vltdc

The Rock Cycle Flipchart:
https://drive.google.com/file/d/0B9Nh_z4RdgdKOTFoM2xrc05rTUk/edit?usp=sharing

Sedimentary Stories Flipchart:
https://drive.google.com/file/d/0B9Nh_z4RdgdKVlNfU3QwdUh4ZDQ/edit?usp=sharing

Igneous Rocks Video:
https://drive.google.com/file/d/0B9Nh_z4RdgdKcUo0bVdjYnZrVnc/edit?usp=sharing

Metamorphic Rocks Video:
https://drive.google.com/file/d/0B9Nh_z4RdgdKczVNbF80ZG9mQVk/edit?usp=sharing

Sedimentary Rocks Video:
https://drive.google.com/file/d/0B9Nh_z4RdgdKd2ljai1aUUFBQzg/edit?usp=sharing

The Rock Cycle Video with simulation:
https://drive.google.com/file/d/0B9Nh_z4RdgdKd2ljai1aUUFBQzg/edit?usp=sharing

Composting in Schools: http://compost.css.cornell.edu/schools.html and

http://cwmi.css.cornell.edu/TrashGoesToSchool/Best.html

The Paleontology Portal (click on Exploring Time and Space):
http://www.paleoportal.org/index.php

40 Common Minerals and Their Uses:
http://www.nma.org/publications/common_minerals.asp
Rock and Mineral Uses: http://www.rocksandminerals.com/uses.htm

Part B:
Completed Maps – Fitting the Continents Together (for teacher use). Atlas URL:
http://oaklandk12.rubiconatlas.org/links/Science_6/Science_Gr_6_Plate_Tectonics_I/Completed%20Maps%20-%20Fitting%20the%20Continents%20Together.docx

This Dynamic Planet – a USGS pamphlet on plate tectonics: http://pubs.usgs.gov/gip/dynamic/
The Global Distribution of Mountain Ranges" (a short article to model the presentation of a line of evidence). Atlas URL:
http://oaklandk12.rubiconatlas.org/links/Science_6/Science_Gr_6_Plate_Tectonics_I/Global%20Distribution%20of%20Mountain%20Ranges.docx

Promethean Flipchart about Plate Tectonic Theory (98 pages):
http://www.prometheanplanet.com/en-us/Resources/Item/148991/theory-of-plate-tectonics#.U-res-NdWSo

http://www.prometheanplanet.com/en-us/Resources/Item/36004/continental-drift-and-plate-tectonics#.U-ro0uNdWSp

Smithsonian Institute Interactive Website on Plate Tectonics and Volcanoes:
http://www.prometheanplanet.com/en-us/Resources/Item/163114/the-dynamic-earth#.U-rhmuNdWSo

Exploring Magnetism Manual:
http://cse.ssl.berkeley.edu/SEGwayed/lessons/exploring_magnetism/Exploring_Magnetism/Exploring_Magnetism.pdf

Teacher background on how paleomagnetism lead to plate tectonic theory – video: Secrets in Stone:
http://216.11.99.113/VBP/Oakland%20Schools/Secrets%20in%20Stone.wmv (or here:
http://vimeo.com/28203736)

Background on sea floor spreading and Harry Hess: http://pubs.usgs.gov/gip/dynamic/

Flipbook Activity Description from Dr. Larry Braile:
http://web.ics.purdue.edu/~braile/edumod/flipbook/flipbook.htm

Sea Floor Spreading and Subduction Model
http://pubs.usgs.gov/of/1999/ofr-99-0132/

LEARNING CYCLE INSTRUCTIONAL MODEL FOR SCIENCE
Part A: Learning Cycle 1 - Understanding Rocks and Minerals (4 - 5 weeks)

ENGAGE (Choose 1 or 2)
Whole Group
Activity 1 – Our Personal History with Rocks (One class session)
Promethean Flipchart: FCS-RocksandMinerals
Introduce and begin Activity 7: Soil Engineering with a Compost Pile (One class session)

EXPLORE (Inquiry) Choose 1 or 2
Part
Promethean Flipcharts: FCS-RocksandMinerals, FCS - Rock Cycle
Activity 2: Understanding Petrology (1-2 class sessions)
Activity 3: Simulating Rock Forming Processes (3 class sessions)
Activity 4: Where Rock Types Occur (One class session)

EXPLAIN (Choose 3-4)
Part
Promethean Flipcharts: FCS-RocksandMinerals, FCS - Rock Cycle
Activity 4: Where Rock Types Occur (This activity could be used in either the Explore or Explain component of the learning cycle.) (1-2 class sessions)
Activity 5 – The Rock Cycle Game (One class session)
Rock Cycle Animations: http://ees.as.uky.edu/educational-materials (part of activity 5)
Activity 6 – Sedimentary Stories (One class session)

ELABORATE
(Engineering Challenge)
Whole class introduction & then Part
Activity 7: Advertising Rock and Mineral Resources (3-4 class sessions)
Activity 8: Soil Engineering with a Compost Pile (This activity should be introduced and started at the beginning of the unit and continued throughout the unit.) (3-5 class sessions)

EVALUATE
Whole
Activity 9: Rock Cycle Quiz (One class session)
Activity 10: Historical Fiction of a Rock's Life (1-2 class sessions, ELA connection)

LEARNING CYCLE INSTRUCTIONAL MODEL FOR SCIENCE
Part A: Learning Cycle 2 - (Approx. 4 weeks)

ENGAGE (Choose 1 or 2)
Whole Group
Activity 1 – What is Weathering? (One class session)

EXPLORE (Inquiry) Choose 1 or 2
Part
Activity 2 – Breaking it Down (Two class sessions)
Activity 3 – Weathering Simulations (One class session)

Activity 4 – Modeling Natural River Systems Using a Stream Table (Three class sessions)
EXPLAIN (Choose 3-4) *Part* Activity 5 – Michigan Glacial Geology (One class session)
ELABORATE (Engineering Challenge) *Whole class introduction & then Part* Activity 6 – The Importance of Soil (Five class sessions) Activity 7 – Soil Engineer (Five class sessions)
EVALUATE *Whole*

LEARNING CYCLE INSTRUCTIONAL MODEL FOR SCIENCE ***Part B: Learning Cycle 1 -***
ENGAGE (Choose 1 or 2) *Whole Group*
EXPLORE (Inquiry) Choose 1 or 2 *Part*
EXPLAIN (Choose 3-4) *Part*
ELABORATE (Engineering Challenge) *Whole class introduction & then Part*
EVALUATE *Whole*

LEARNING CYCLE INSTRUCTIONAL MODEL FOR SCIENCE ***Part B: Learning Cycle 2 -***
ENGAGE (Choose 1 or 2) *Whole Group*
EXPLORE (Inquiry) Choose 1 or 2 *Part*
EXPLAIN (Choose 3-4) *Part*
ELABORATE (Engineering Challenge) *Whole class introduction & then Part*
EVALUATE *Whole*

Notes: