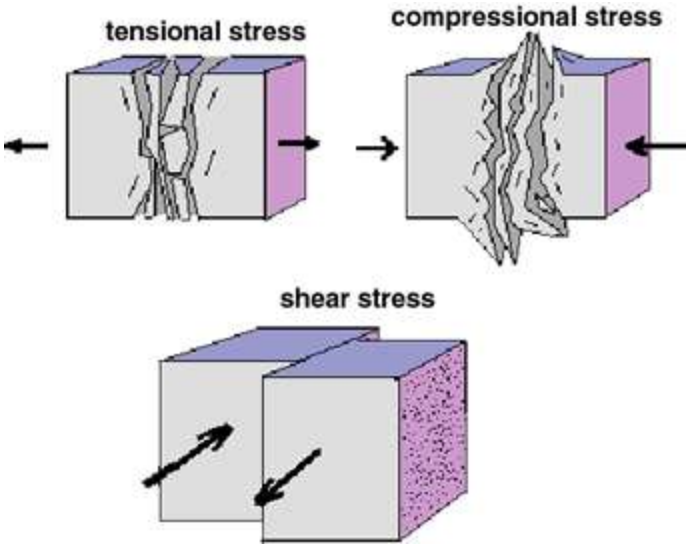
MOUNTAINS AND SEAS IN NC
FAST FACTS

NC Landforms from the Mountains to the Sea

- North Carolina has three main physiographic provinces: Blue Ridge Mountains, the Piedmont, and the Coastal Plain, which contains an area called the Tidewater, which is influenced by the Atlantic Ocean's tides.
- The same geological processes that are shaping the earth now, have also shaped it in the past. This is an application of James Hutton's Law of Uniformitarianism, eg., "the present is the key to the past." But sometimes, we cannot observe geologic changes in our lifetime.
- NC's physiographic provinces determine what type of geologic hazards to expect such as earthquakes, volcanoes, landslides, or flooding. In steep mountain areas, landslides are a risk. There also tend to be more earthquakes in the mountains of North Carolina. The Coastal Plain is relatively flat, and severe flooding, especially due to hurricanes, is a hazard there.
- Although we have volcanic rocks in NC, we do not have any active volcanoes.
- NC experiences earthquakes, but they do not tend to be intense or frequent.
- North Carolina includes many landforms including mountains, ridges, hills, valleys, river basins, several types of wetlands (bogs, swamps, marshes), and estuaries where fresh and salt water mix.
- These landforms were made by plate tectonic processes that caused uplift of higher elevations, and weathering, erosion, and deposition in lower elevations.
- Interstate 40 connects many cities and towns across NC. It also crosses NC's Physiographic Provinces.
- Plate Tectonics Theory states that the earth has a thin layer of brittle continental and ocean crust that slides around on the molten layer called the mantle, which has convection currents in magma that drive the plates to break apart and move.
- The Appalachian Mountains were formed when North America and Africa collided. The impact caused folding of the continental crust, which made the Blue Ridge Mountains and foothills of the Piedmont of North Carolina.
- The Atlantic Ocean formed when rifting occurred in the ocean crust, where it split apart at a seam called the Mid Atlantic Ridge, where new continental crust is being formed.
- The Durham Triassic Basin was formed as the Atlantic Ocean began tearing apart.
- The Blue Ridge Mountains in NC very likely used to be as tall as the Himalayans are now, but because our mountains are so old, they have been eroded down and carried away by NC's rivers to form the sediments of the Coastal Plain.
- The Piedmont contains rolling hills and mostly clay soils. It ranges in elevation from 300 feet to about 1500 feet in elevation.
- Sometimes scientists have new ideas that seem extreme. Alfred Wegener noted that continents conveniently fit in puzzle-like shapes on maps. He considered additional evidence that continents themselves moved. He noted that fossils of the small mesosaurus lizards, which were not great swimmers, were found in both South America and Africa. Other evidence included similarities between mountains in the United States and Great Britain. There were also tropical plant fossils found in Antarctica. Wegener inferred that continents moved and called his theory "Continental Drift." Although his evidence supported that continents must move, nobody could explain exactly how it happened. Then, Harry Hess observed the Mid-Atlantic Ridge where the ocean floor was splitting apart like a zipper with new oceanic crust being formed. Hess called the concept Sea Floor Spreading. A combination of observations and ideas led to Plate Tectonic Theory.

- There are three types of stress that deform or change the surface of the Earth are Compressional Stress, Shear Stress, and Tensional Stress. These stresses are the process that forms mountains, faults and earthquakes, volcanoes, and rift valleys.

https://earthquake.usgs.gov/learn/glossary/images/stress_types.gif

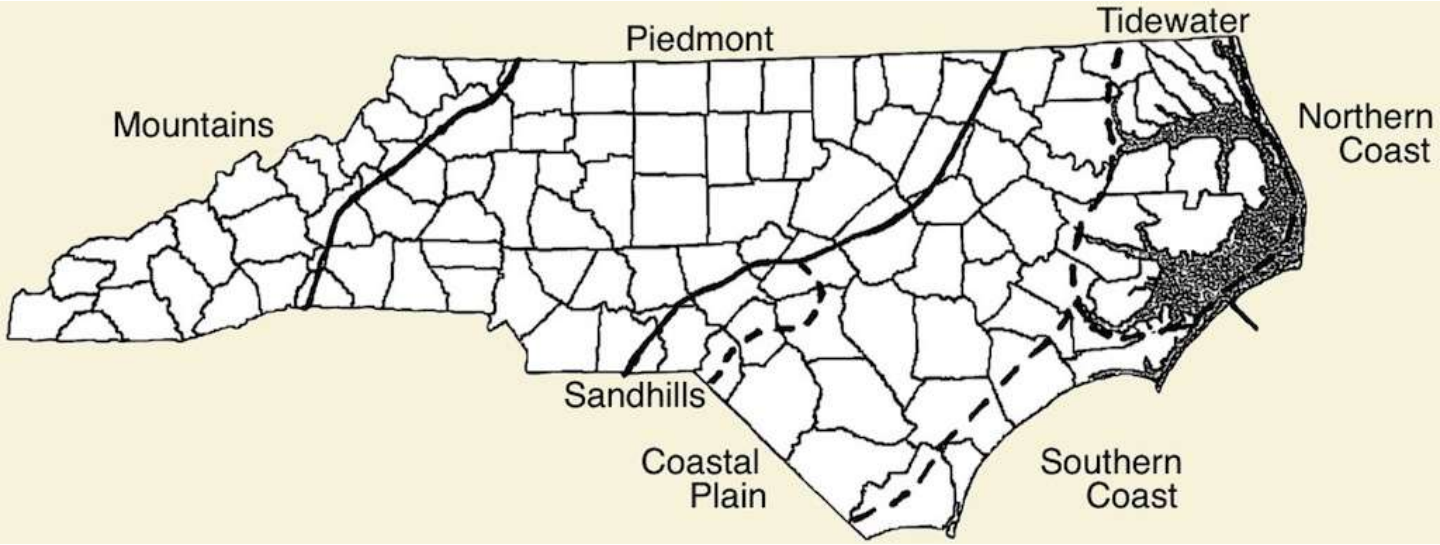


1. Compressional Stress: When plates collide, compression causes folding. In landforms, folding shows up as mountains and rolling hills and faults from where earthquakes occur. Compression formed mountains like the Himalayans. Compression also happened in NC when North America and Africa collided together, thus crunching and folding the continental crust. This compressional stress formed the Appalachian Mountains, of which the Blue Ridge is part. Mount Mitchell is the highest point of elevation in NC at 6484 feet. But our mountains may once have been as tall as the Himalayans, which are 29,000 feet. Where did the Appalachian Mountains go? Over millions of years, wind, rain, and rivers eroded and carried away the mountains to form the sediments of our coastal plain.

2. Shear Stress: When plates slide past/move past each other, the shear stress causes earthquakes and faults, like the San Andreas Fault. In NC, as the Appalachian Mountains formed, chunks of land called terranes shifted and sheared off/past each other. They formed faults from earthquakes that we can still find near Brevard and in parts of the Piedmont. https://pubs.geoscienceworld.org/gsa/geology/article-abstract/16/10/915/204586/location-and-geometry-of-alleghanian-dispersal?redirectedFrom=PDF
3. Tensional Stress: Tensional stress causes rifting or tearing. Magma and lava seeps up through the thinning, opening in the crust, which then cools to form brand new crust. In NC, the Atlantic Ocean is still rifting and tearing apart, which is moving us about 2 centimeters farther away from Europe and Africa each year. This is approximately the rate that a person's fingernails grow. https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Divergent/Mid-Atlantic-Ridge

NC's Physiographic Provinces

https://www.ncpedia.org/geography/landforms



https://projects.ncsu.edu/cals/plantbiology/ncsc/EE/images/nc_map.jpg

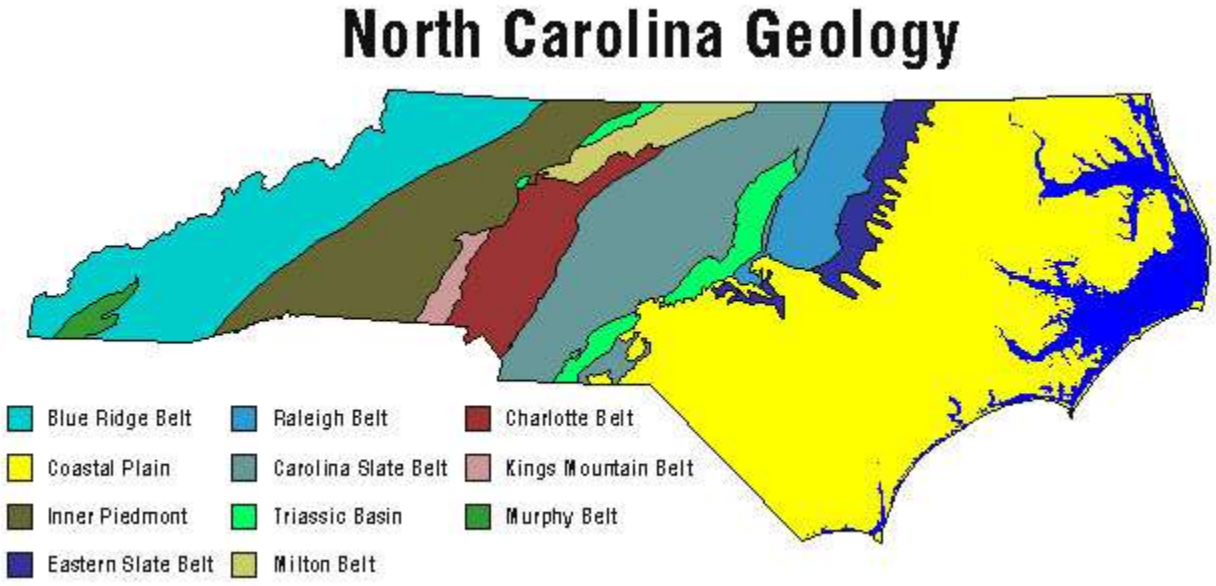
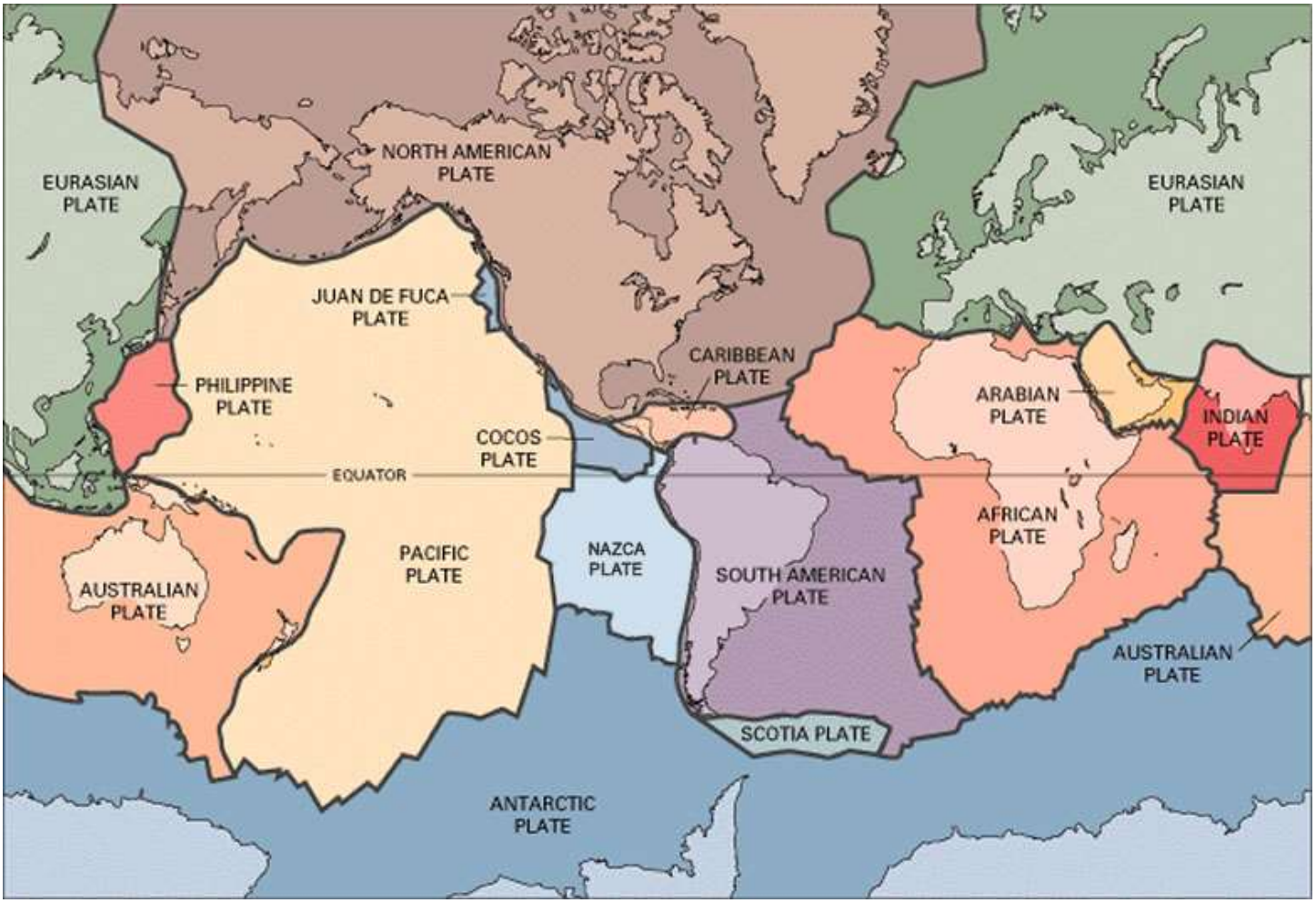


Plate Boundaries Map



https://geology.com/plate-tectonics.shtml

Science Vocabulary

- Landform: a name used to describe the topography of an area.
- Hill: a gently sloping, rounded landform.
- Mountain: a steep-sided landform that is usually dramatically higher than the surrounding area, often with a steep ridge of rock across the top.
- Basin: A low area, usually where sediment collects, like the bottom of a bowl.
- Piedmont: The rolling hills of Central North Carolina ranging from about 300 to 1500 feet above sea level.
- Coastal Plain: the gently sloping, nearly flat area on the Eastern part of North Carolina that is where sediments are deposited by rivers and the sea.
- Tidewater: The outermost region of the Coastal Plain that is influenced by tides
- Uplift: Processes that cause the earth to be elevated, usually with folding and faulting.
- Erosion: Wind, rain, water, and gravity weathering away rock and transporting it away
- Deposition: Sediment/particles of rock and soil that settles out due to gravity.
- Physiographic Province: A description of landforms and soils that result from geologic processes.
- Slope: How steep an area is. The steeper the slope, the more at risk it is for landslides.
- Margin: The edge of a plate.
- Plate: The brittle outer layer of the earth called the lithosphere that is divided into oceanic and continental crust
- Continental Plate: These less dense but thick layers of crust tend are the land areas.
- Oceanic Plate: These dense, but thinner layers of crust are underneath Earth's oceans.
- Convergent Plate Boundary: The edge where plates collide.
    - Continent to Continent: Mountains form through folding and faulting, which causes earthquakes. These mountains are not volcanic inside them. Our Blue Ridge Mountains are examples of continent to

continent convergence. The Himalayan Mountains are another example. The Himalayas are much taller than our mountains. Unlike NC's eroding mountains, the Himalayas are still growing because the Indian continental plate is still colliding with Asia.
    - Ocean to Continent: The denser oceanic crust is subducted or forced underneath the less dense continental crust, which then melts and rises up to form volcanic mountain chains like the Andes Mountains in South America. There are also earthquakes associated with this type of boundary. An example of where subduction occurs is the Pacific Ring of Fire, where most of the earth's earthquakes and volcanoes are found.
    - Ocean to Ocean: Generally, one of the oceanic crusts will subduct underneath the other one, which can form a volcanic island arc.
    - Subduction Zone: wherever one plate is forced underneath another one and melts, forming volcanic mountains.
- Divergent Plate Boundary: Rifting or tearing apart of a plate occurs. Then new magma fills the opening, which then cools to form new crust. In the center of the Atlantic Ocean, rifting is taking place at the Mid-Atlantic Ridge, which stretches from Greenland down to Antarctica. Iceland is sitting right on top of the seam, which is one of the reasons why it can use geothermal energy for electricity there.
- Hot Spot: Sometimes a very large plume of hot magma melts the crust and forms volcanoes. Two locations of hotspots are Yellowstone National Park and the Hawaiian Islands.
- The source of heat for convection currents in the mantle is radioactive energy deep within the core of the earth.

Printable Handouts

1. (optional): Compilation of Continental Drift and Plate Tectonics: https://www.fusd1.org/cms/lib/AZ01001113/Centricity/Domain/883/Evidence%20for%20Continental%20Drift.docx
2. Plate Boundaries handout
3. Mountains to the Sea in NC Lab Parts 1 – 3.

Kid-Tech Spot: Supplemental interactive websites and games

1. The City of Asheville's Planning Department has an interactive map for determining the slope of a property. Click on any property to see if it is too steep to build on. http://www.mapwnc.org/
2. University of California at Berkley's Museum of Paleontology: Background on plate tectonics https://ucmp.berkeley.edu/geology/tectonics.php
3. Plate tectonics animation: https://www.youtube.com/watch?v=Cm5giPd5Uro
4. More detailed (6th grade and up) plate tectonics animation https://www.youtube.com/watch?v=aaL-S88hZys
5. Short video on landforms: https://www.youtube.com/watch?v=FN6QX43QB4g

More Resources, just in case

1. Here's a catchy tune about Alfred Wegener: https://www.youtube.com/watch?v=T1-cES1Ekto

Resources for Teachers:

1. Detailed look at NC's physiographic provinces: https://www.arcgis.com/apps/MapSeries/index.html?appid=1316f4eb4e3349298c3bd0063ab8fb89
2. The natural history of North Carolina: https://www.britannica.com/place/Appalachian-Mountains/Plant-and-animal-life
3. Descriptions of NC's geography: https://www.ncpedia.org/geography/landforms http://www.ereferencedesk.com/resources/almanac/north-carolina.html
4. A geologic map of NC: https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Geological%20Survey/NC_Generalized_Geologic_Map_Description.pdf

In the News

1. English/Language Arts Extensions for Middle to High School age participants:
    a. Fracking and the Triassic Basins in NC: https://carolinapublicpress.org/27699/27699/
    b. Interstate 40 closures due to landslides: https://www.charlotteobserver.com/news/local/article226795249.html

c. Interstate 40 closures due to flooding: https://www.wral.com/weather/video/17867335/
d. Projections for impacts of sea level rise on coastal communities: https://sealevelrise.org/states/north-carolina/

On the Road

1. Carolina Field Trips Magazine: https://carolinafieldtrips.com
2. Raleigh/Durham Area: NC Museum of Natural Sciences https://naturalsciences.org
3. Outerbanks: Aurora Fossil Museum https://www.aurorafossilmuseum.org
4. Charlotte Area: https://www.schielemuseum.org/
5. Statesville/Winston/Hickory: https://www.emeraldhollowmine.com/
6. Asheville Museum of Natural Sciences: https://www.ashevillescience.org

Other Lessons and Reference Materials Used to Develop this Unit

1. https://www.ncpedia.org/geography/landforms
2. https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Geological%20Survey/NC_Generalized_Geologic_Map_Description.pdf
3. https://earthref.org/ERDA/download:2058/
4. https://data-ncdenr.opendata.arcgis.com/datasets/physiographic-provinces-of-nc?geometry=-86.063%2C33.908%2C-71.341%2C37.038
5. https://geology.com/plate-tectonics.shtml
6. https://www.britannica.com/place/Appalachian-Mountains/Recreation-and-tourism
7. https://www.fusd1.org/cms/lib/AZ01001113/Centricity/Domain/883/Evidence%20for%20Continental%20Drift.docx
8. https://www.famousscientists.org/alfred-wegener/
9. https://www.youtube.com/watch?v=T1-cES1Ekto
10. https://sealevelrise.org/states/north-carolina/
11. https://www.globalchange.gov/browse/multimedia/projected-sea-level-rise-and-flooding-2050
12. https://earthquake.usgs.gov/learn/glossary/?term=compressional%20stress
13. http://www.explorevolcanoes.com/Platetectonics.html
14. https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Divergent/Mid-Atlantic-Ridge
15. https://oceanexplorer.noaa.gov/explorations/05galapagos/background/mid_ocean_ridge/mid_ocean_ridge.html
16. http://academic.brooklyn.cuny.edu/geology/grocha/plates/platetec21.htm
17. https://pubs.geoscienceworld.org/gsa/geology/article-abstract/16/10/915/204586/location-and-geometry-of-alleghanian-dispersal?redirectedFrom=PDF
18. http://www.mapwnc.org/
19. https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geoscience-education
20. https://projects.ncsu.edu/cals/plantbiology/ncsc/EE/lecture1.htm
21. https://geology.com/plate-tectonics.shtml#boundaries
22. https://geology.com/articles/mohorovicic-discontinuity.shtml
23. https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Geological%20Survey/Geoscience%20Education/Earthquake%20Workshops%202014/Earthquakes%20and%20Tectonics.pdf
24. https://www.ncpedia.org/geology
25. http://www.ereferencedesk.com/resources/almanac/north-carolina.html
26. https://www.ncpedia.org/geography/landforms
27. https://www.ncpedia.org/fall-line
28. https://projects.ncsu.edu/cals/plantbiology/ncsc/EE/images/nc_map.jpg