Rocks Trip

Pre-Trip Student Reading Materials

CLIMBE 2009
Montreat College

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Linville Gorge

A **gorge** is a deep valley between cliffs often carved from the landscape by a river. Most gorges were formed by a process of long-time erosion from a plateau level. The cliffs form because harder rock strata that are resistant to erosion and weathering remain exposed on the valley walls. The age of a gorge is easily distinguished by its valley shape. A young valley is denoted as a **V-shaped valley** because the river that formed the valley cut through the earth's surface quickly and its primary force of direction was down. After a while the river widens and flattens the floor of the valley creating a **U-shaped valley**.

Named for William Linville, an explorer who lived nearby and was killed by the Cherokees in 1766, the 12,000 acre Linville Gorge Wilderness is one of the original components of the National Wilderness System.

The centerpiece attraction – the Linville River – is also the chief architect of this wilderness sculpture. The river begins as a trickle high on the southwest slope of nearby Grandfather Mountain and enters the Gorge at Linville Falls, an impressive 90 foot multilevel cascade known as a cap-rock fall. Geologists believe that millions of years ago Linville Falls was on the Blue Ridge escarpment, about12 miles south of where it is now. But thanks to a quirk of geology, this area is distinguished by a hard, erosion-resistant layer of rock that overlays younger, softer rocks. These softer rocks erode more quickly, undercutting the hard layer and forming a precipice (the cap) that eventually collapses of its own weight. Through this process of undermining and collapsing, Linville Falls has gradually migrated north, leaving the gorge in its wake.

After leaving the falls, the Linville River drops almost 2000 feet over the next 14 miles as it weaves a serpentine path around the spiny ridges of the adjacent mountains before spilling into Lake James at the entrance to the piedmont. Nearly vertical rock outcroppings several hundred feet high border the river throughout much of the Gorge. One peninsula, the 400 foot high Babel Tower, stands above the river like the turret on a medieval castle. Blocked from its southward course, the river detours and surrounds the peninsula, nearly forming a moat.

No wonder the Cherokees called the river "Eeseeoh," "a river of many cliffs." Today, these cliffs attract scores of rock climbers. Short-off Mountain and Table Rock, on the east rim of the Gorge, are two of North Carolina's premier climbing destinations.

Finally, the Linville Gorge is known for the Blue Ridge Escarpment. The gorge is placed on the eastern edge of the Blue Ridge Mountains, and if one were to look west, they would see something completely different than from looking east. Westward, the mountains stretch farther and farther, rising and falling. The east levels out towards the piedmont and coasts. This phenomenon is known as the Blue Ridge Escarpment.

The Rock Cycle

The vast array of rocks found on Earth can be categorized into three types: igneous, sedimentary, and metamorphic. As magma from the core of the Earth rises to the surface, it cools and crystallizes to form igneous rock. **Igneous rock** is a cooled molten rock and the most commonly found is granite. When existing rock weathers and erodes it forms sediment. Sediment may undergo a process known as lithification, compacting and binding the sediment together into **sedimentary rock**. Examples of sedimentary rock include sandstone and limestone (used in the formation of caves). When exposed to extreme temperatures and pressure, existing rock "morphs" into **metamorphic rock**. Metamorphic literally means "changed in form," and includes rocks such as marble and slate.

Diagram R1: The Rock Cycle

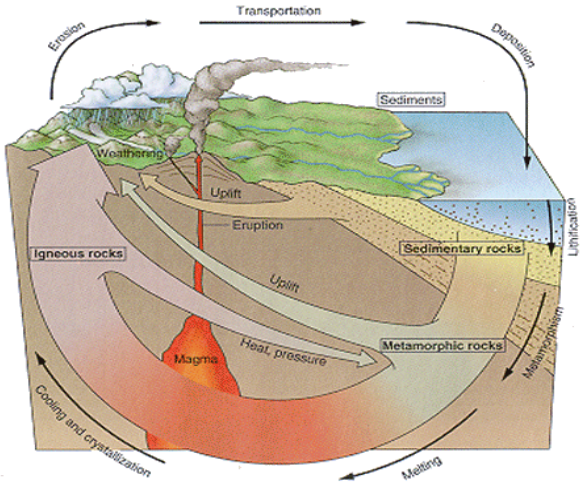


Plate Tectonics

When molten magma rises to the earth, it cools and forms igneous rock to compose the **lithosphere,** or crust. But if this continued to happen, the surface of the earth would rise farther and farther into the atmosphere. So why isn't this happening? The earth is recycling its crust through the process of **plate tectonics**. Plate tectonics is a theory that describes the earth's crust as being divided into a number of moving plates which are fueled by the convection of magma beneath the surface. These plates are continually floating and moving over the magma.

The earth's plates move on a finite plane (a sphere), which means that they all interact in certain ways. A **diverging plate boundary** is one whose plates are moving farther and farther away from each other, opening the crust and allowing more magma to flow through to form new crust. A **converging plate boundary** is one whose plates are moving closer together. If the converging plates occur between land and ocean, the ocean plate will sink creating an ocean trench. If converging plates occur on land, they are likely to form new mountains through a process known as crumpling, or folding.

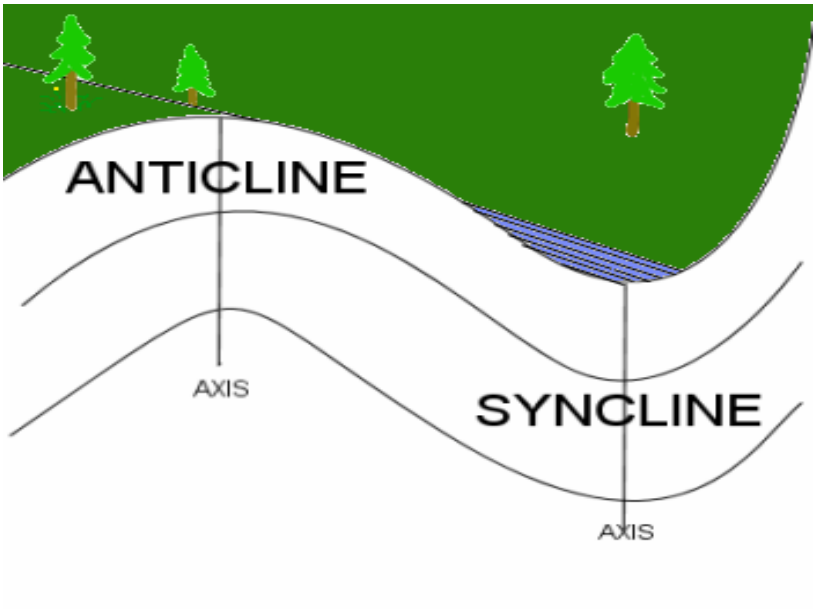
Mountain Formation

The crumpling and folding of the land that forms continental mountains are exactly the processes by which the Appalachian Mountains were formed. There are two types of mountain forming process: **volcanism** and **diastrophism. Volcanism**, the process by which molten magma rises and breaks the earth's surface, is unlikely to be found in the middle of a continent. These mountains are found around oceanic-oceanic converging plate boundaries. The Pacific Ocean is a major oceanic-oceanic converging plate boundary and is respectfully noted as the Pacific Ring of Fire due to its numerous volcanically formed mountains. The Cascades of Washington belong to the ring of fire and are all volcanic.

Unlike volcanism, **diastrophism** is a process by which the earth's crust is compressed and forced into a mountainous landscape. There are three types of diastrophic mountain formations, but the process of **folding** is one that is significant to our area. The Appalachian Mountains were formed by folding, which is nothing more than the forcing of two ends

together causing some areas to rise and fall. This can easily be demonstrated with a sheet of paper. The two distinguishable characteristics of a folded landscape are anticlines and synclines. **Anticlines** are the up-folds in the earth and the **synclines** are the down-folds.

Diagram R2: Anticlines and Synclines



Weathering

Once the mountains of converging plates are formed, they are exposed and susceptible to environmental conditions known as weathering. **Weathering** is the natural process of breaking down rocks chemically and mechanically. **Chemical weathering** involves chemical break down of rock and may result from acid rain or organic chemicals from plants. In contrast, **mechanical weathering** involves the physical breaking down of rock. Mechanical weathering includes the freeze-thaw effect (when water seeps down into the cracks of rocks and freezes, forcing the rock to break apart as it expands); heating; wind- and water-borne sediments; and the impacts of humans like walking. As rock is broken down, the gateway to succession is opened.

Ecological Succession

Succession is the long-term process of natural vegetative communities changing from one to another. **Primary succession** is succession beginning with bare weathered stone that attracts the growth of lichen, a composite organism consisting of a **symbiotic** association of a

fungus and a photosynthetic partner, usually a green algae. **Symbiosis** is a close and often long-term interaction between different species in which both organisms benefit from each other. In lichen, the fungus provides shelter and protection for the growth of the algae and the algae, through photosynthesis, provides both species with food. Because lichen have no vascular tissue (xylem and phloem), they absorb moisture directly from the atmosphere. By doing so, they take in any molecular particles attached to the moisture, such as pollutants; therefore, making lichen a **biotic weather indicator.** Biotic weather indicators inform us of the quality of the air in the atmosphere.

Once the lichen slowly breaks down the rock, they turn the broken pieces into nutrients, allowing the growth of moss. Mosses feed on the lichen and continue the process of breaking down the rock, this time into nutrient rich soil, paving the way for plant seeds to germinate and grow. Grasses, ferns, shrubs, and trees will then begin to grow. **Secondary succession** is succession that takes place in areas that have been scarred by fire or disturbances such as plowing. This type of succession is much quicker because the soil has already been formed with nutrients and contains pre-existing seeds.

For a better understanding of ecological succession, view this brief Youtube video: http://www.youtube.com/watch?v=J1_jy2lxl54.

Cliff Face Ecology

A **cliff** is a significant vertical, or near vertical, rock exposure, and are common on coasts, in mountainous areas, escarpments and along rivers.

The flora of cliffs is always very distinct from the flora of surrounding level-ground habitats. Often, cliffs are the sites for species that are rare elsewhere for a variety of reasons, including their lack of competitive ability on level ground, their intolerance of disturbance, or their status as glacial relics. Thus, all cliffs can be described as habitats with minimal disturbance by humans and animals that are colonized by non-competitive, disturbance-sensitive plants that grow slowly.

Virtually all inland cliffs and man-made cliffs support a sparse vegetation of lower plants including mosses, lichens, and algae. Annual plants are very rare leaving grasses and sedges the

most commonly found flora. However, shrubs and trees that do appear on cliffs have been noted to grow very large in comparison to their lower ground counterparts and often in deformed and twisted fashions. They also grow at a much slower rate.

Environmental groups and rock climbers are always at loggerheads because of the impact of rock climbing on the environment. There have been numerous instances, wherein rock climbers are accused of venturing into secured natural territories, and mistreated the organisms and rocks that are there. However, with the changing times, rock climbers are conscious and carry out minimal climbing.

Rock climbers hammer bolts on climbing routes and in the process deface the nature of rocks. In addition, climbing activity also has an effect on the animals and plants situated near the climbing area. The plants and small shrubs growing near the base of rocks are trampled on and cut back, lichens and fungi growing on the rock are spoilt, and the animals living in the climbing area are forced to displace, whenever humans are around.

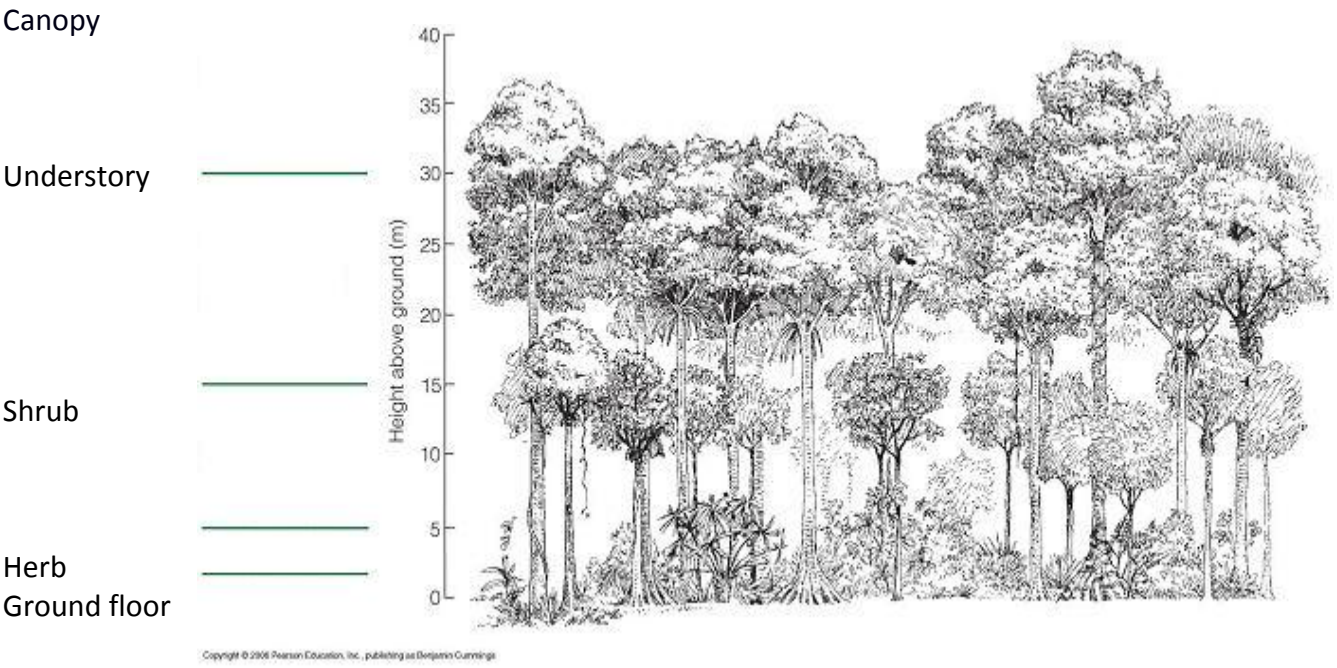
While this may be true, rock climbers have understood the significance of wildlife plant and animal preservation and related issues and therefore make provisions to minimize impact in climbing areas.

Forest Communities

Forests communities occur at the later stages of succession and are subdivided into a number of different categories. The two types of forests found in this region are the deciduous and the coniferous. **Deciduous forests** are temperate biomes composed of broad-leaved trees that shed once per year. Examples of deciduous trees include oaks, maples and beeches. What is the advantage to shedding leaves every autumn? Without its leaves, a tree will not transpire (or lose water) and conserve it energy for photosynthesis in the spring. Another distinguishing characteristic of the deciduous forest is vertical stratification. **Vertical stratification** is the clear-cut subdivision of the forest from top to bottom. The following diagram explains these subdivisions in greater detail, while Diagram R3 visualizes these concepts:

Division	Location	Characteristic
Canopy	Top	Primary photosynthesizers
Understory	Beneath the canopy	Hardwoods; photosynthesis
Shrub Layer	Blow understory	Provides shelter and camouflage for certain animals; shrubby plants and trees
Herb Layer	Just above the ground	Provide food
Ground floor	Bottom	Primary decomposers

Diagram R3: Forest Stratification



In contrast with the deciduous forest, the **coniferous forest** is composed of needle and scale like leaf-bearing trees as well as broadleaved evergreens such as spruces, firs, redwoods, and cedars. Many of these trees bear cones as a means of reproduction. Coniferous forests are typically found at higher elevations (above 5,000 feet) in comparison to deciduous trees. They

also have a much simpler stratification composed of a canopy and understory, and some may have an herby ground floor.

The southern Appalachian Mountains experience these two types of forests and are further divided into differing types of forest communities. The first of these is the Oak-Hickory forest, a deciduous forest found below 3500 feet on the south and east-facing slopes. These warm and dry forests generally include, but are not limited to red, black, scarlet, white and chestnut oaks, pignut hickory, shagbark hickory, dogwoods and mountain laurel. The Cove Hardwood forest is found between 1500-4500 feet in damp coves on the north and east facing slopes of a mountain. These plants require plenty of moisture and include plants such as yellow, and sweet birch, American beech, maples, and white ash.

An interesting community found in our area is the Heath Bald. These exposed rocky ridges are found between 3500 and 5500 feet, and consist of few large trees. The dominant vegetation has adapted to dry and shallow acidic soils and high winds. The most common plants include rhododendron, mountain laurel, and high-bush blueberry. Lastly, the Spruce-Fir forest, a coniferous forest, is one of the most unique and beautiful mountain ecosystem found about 5500 feet. These forests are similar to the forests in southern Canada and are adapted to extreme cold, high winds and high precipitation. They are also highly susceptible to acid rain, being at such high altitudes, and are one of the most endangered communities in the Southern Appalachians.

Krum-Holtz

Once at the peak of a mountain, one may observe familiar vegetation of unusual shapes and sizes. These plants, due to the harsher weathering conditions of higher elevations, have adapted to maximize their photosynthesis by growing more horizontally than vertically. This process is known as the **Krum-Holtz Effect**. Trees are stunted and are capable of growing in rocky soils.

A variation of the Krum-Holtz Effect is the flag tree. The harsh winds of higher elevations kill branches on the windward side, giving the tree a characteristic flag-like appearance. Where

the lower portion of the tree is protected by snow cover, only the exposed upper portion may have this appearance. Flag trees are good indicators of dominant wind direction of an area.

Geological Window

If you were to take a guess as to where the oldest rock of the mountain would be (bottom or top) where would you place it? If you said the bottom of the mountain you would be correct, but how is this so? Wouldn't the oldest rock continually be pushed upward from the surface of the earth? It would, but since the environmental conditions at the peak of the mountain are so harsh, it is weathered away revealing the younger rock beneath. Therefore, from an aerial standing point, the oldest rock would surround the youngest. This is known as the **geological window**, because the oldest rock "frames" the younger. Many scientists have found sediment from the peaks of the Appalachian Mountains as far as the coastline and have used these particles to help age our mountains.

Fire Ecology

Fire ecology is concerned with the processes linking fire behavior and ecological effect. Campaigns such as "Smokey Bear" in the USA have molded public opinion to believe that wildfires are always harmful to nature. This view is based on the outdated belief that ecosystems progress toward equilibrium and that disturbance (such as fire) disrupts the harmony of nature. More recent ecological research has shown, however, that fire is an integral component to the function and biodiversity of many communities, and that the organisms within those communities have adapted to withstand and even exploit it. **Fire suppression**, in combination with other human-caused environmental changes, has resulted in unforeseen changes to ecosystem dynamics and species composition and has backfired to create some of the largest, most intense wildfires yet. Land managers are faced with tough questions about where it is appropriate to restore a fire regime and how to do it. These questions are crucial today as we see the consequences of years of fire suppression and the continued expansion of people into fire-adapted ecosystems.

Fire has important effects on the abiotic (non-living) components of an ecosystem, particularly the soil, through both direct contact with the soil and its effects on the plant community using the soil.

A. Temperature

By removing overhead vegetation, fire opens soil up to increased solar radiation and warming during the day. Alternately, the loss of vegetation also allows soils to become cooler and do so more quickly at night.

B. Moisture

Soil moisture does not change predictably with fire, and is a function of fire intensity and soil properties. Fewer leaves left to intercept rain allows more rain to reach the soil's surface and decreased transpiration (the process by which water travels through plants and evaporates through pores in the leaves) because of the smaller leaves of post-fire plants allows the soil to retain more moisture. This overall positive effect on moisture can be counteracted when fires increase the ground's exposure to sunlight and evaporation, and/or when fire creates water-repellent soils. Water-repellent soils may form when fire heats organic matter on the ground into a waxy covering. This can lead to increased erosion.

C. Physical and Chemical Properties

Fire causes nutrient loss through a variety of mechanisms, including oxidation, volatilization, and increased erosion and leeching by water. Temperatures must be very high, however, to cause a significant loss of nutrients, and these nutrients are often quickly replaced by dead organic matter left behind in the fire. Charcoal is able to counteract some nutrient and water loss because of its absorptive properties.

Overall, soils become more basic (higher pH) following fires because of acid combustion. By driving novel chemical reactions at high temperatures, fire can even alter the texture and structure of soils by affecting the clay content and the ability of soil to form **aggregates** (clumps of soil that increase the ground's porosity to water).

Plants have many adaptations to fire. In chaparral communities in Southern California, some plants have leaves coated in flammable oils that foster an intense fire. The heat will cause their fire-activated seeds to germinate and capitalize on the lack of competition in the burnt landscape. Other plants have smoke-activated seeds and/or fire-activated buds. **Serotinous** cones of Lodgepole pine (Pinus contorta) are sealed with resin until fire melts it away and releases the seeds. Many plant species, including shade-intolerant giant sequoia (Sequoiadendron giganteum), require fire to make light gaps in the vegetation canopy. This allows their new seedlings to compete with more shade-tolerant seedlings of other species and establish themselves in a process known as “recruitment”.

Fire behavior is different in every ecosystem and the organisms in those ecosystems have adapted accordingly. One sweeping generality is that in all ecosystems fire creates a mosaic of different habitat patches, with sites ranging from just burned to untouched by fire for years, through a process known as succession. Succession is the progress of site through continuous and directional phases of colonization by and extinction of species populations after a disturbance, such as fire. Ecologists usually characterize succession through vegetation. After a fire, the first species to colonize are those whose seeds are already present or those whose seeds disperse to the burned area quickly. These are generally fast-growing herbaceous plants that need lots of light and are poor competitors in crowded areas. As time passes, more slowly growing, shade-tolerant, and competitive, woody species crowd out the herbaceous plants. These woody plants may be shrubs or trees. Different species of plants, animals, and microbes specialize in exploiting different successional stages, and by creating these different types of patches, fire allows a greater number of species to exist within a landscape

Glossary

- **Anticline**: a ridge-shaped fold of stratified rock in which the strata slope downward from the crest.
- **Chemical Weathering**: involves chemical aspects such as acid rain from the atmosphere and organic chemicals from plants in the soil.
- **Cliff**: a significant vertical, or near vertical, rock exposure.
- **Coniferous Forest**: A forest of trees that bear cones and evergreen needlelike or scale like leaves.
- **Converging Plate Boundary**: plates that are moving closer together.
- **Deciduous**: (of a tree or shrub) shedding its leaves annually.
- **Diverging Plate Boundary**: Plates that are moving away from each other.
- **Freeze-Thaw Effect**: when water seeps down into the cracks of rocks and freezes, forcing the rock to break apart as it expands.
- **Geological Windows**: Old rock on the peaks of mountains is eaten away by the harsher weathering conditions reveling the younger rock underneath. The old rock frames the younger rock from an aerial perspective thus forming a "window."
- **Igneous rock**: having solidified from lava or magma.
- **Krum-Holtz Effect**: Plants due to the harsher weathering conditions of higher elevations, maximize photosynthesis by growing more horizontally than vertically.
- **Lithosphere**: the rigid outer part of the earth, consisting of the crust and upper mantle.
- **Mechanical Weathering**: involves the physical aspects of breaking down rock.
- **Metamorphic**: geology denoting rock that has undergone transformation by heat, pressure, or other natural agencies.
- **Plate Tectonics**: a theory that describes the earth as being divided into a number of moving plates, which are fueled by the convection of magma beneath the surface.

- **Primary Succession**: begins with bare weathered stone that attracts the growth of lichen. Once the lichen slowly breaks down the rock, they turn the broken pieces into nutrients, allowing the growth of moss. Mosses feed on the lichen and continue the process of breaking down the rock, this time into nutrient rich soil, paving the way for plant seeds to germinate and grow. Grasses, ferns, shrubs, and trees will begin to grow.
- **Secondary Succession**: takes place in areas that have been scarred by fire or disturbances such as plowing.
- **Sedimentary**: geology that has formed from sediment deposited by water or air.
- Succession: the process by which a plant or animal community successively gives way to another until a stable climax is reaches.
- **Syncline**: a trough or fold of stratified rock in which the strata slope upward from the axis.
- **Vertical Stratification**: the clear-cut subdivision of the forest from top to bottom.
- **Weathering**: wear away or change the appearance or texture of something by long exposure to the atmosphere.