Building the Blue Ridge

The rocks that underlie Nelson County contain clues to a long and complex geologic history. When we study these rocks, we are uncovering the geologic history of the Blue Ridge and western Piedmont, as we know them today. Blue Ridge geologic history is characterized by multiple cycles of tectonic plate **collisions**, **rifting** or pulling apart, then **drifting**. This cycle has repeated itself at least twice in the last one billion years.

About one billion years ago as the supercontinent Rodinia was formed, crustal plates **collided** and formed great mountains (the Grenville Mountains) where the Blue Ridge would eventually stand. These mountains were the ancestors of our present Blue Ridge. With the heat and pressures caused by burial beneath huge mountains, molten masses of rock formed and began to rise upward through the earth's crust. Some of this molten material may have risen all the way to the surface and poured out as volcanic lava. But much of it crystallized deep beneath the surface, forming large blobs or **plutons** of granite. These granites are exposed at the surface today in central and western Nelson County, from Lovingston to Three Ridges Mountain.

For the next 300 million years or so, the ancient great mountains were slowly eroded by the action of wind, water and ice. At about 700 million years ago, the crust of what is now North America began to **rift** apart into a series of fault-bounded basins. The sediments that were deposited into these basins are preserved today as sandstones and conglomerates of the Lynchburg Group, exposed in a wide belt of rocks in eastern Nelson County. Sediments of a similar origin are also found in the western part of the county (Swift run Formation).

As the crust continued to **rift** apart, about 600 million years ago an ocean basin called Iapetus began to form about where the Atlantic Ocean is today. Landward of Iapetus, in today's Nelson County, lava flowed out on the surface of the earth both above and below the water. Today we find this rock, called the Catoctin Greenstone, in eastern Nelson between Schuyler and Howardsville, and on the Blue Ridge at Wintergreen.

For the next 300 million years, ancestral North America drifted close to the equator and sediments collected on top of these old lava flows. During much of this time, what is now eastern North America was covered by a shallow epi-continental sea similar to what surrounds today's Bahama Islands. The sandstones, shales and limestones that formed as sediments at the margins and bottom of these seas are now found at the very eastern and western margins of the Nelson (Unicoi and Candler Formations).

The Iapetus Ocean slowly closed as its ocean floor was consumes at subduction zones and recycled deep in the earth. At about 300 million years ago, the African continent **collided** with North America, forming Pangaea, a subcontinent that included all the existing continental masses worldwide. One result of this collision was the creation of a massive fold called the Blue Ridge Anticlinorium. As did earlier ancient mountain ranges, the forces of wind, water and ice slowly wore down the Blue Ridge fold. The resulting sediments are found on the coastal plain to our east and in far western Virginia. As the mountains erode, the crust slowly rebounds, just as a barge rises in the water as its contents are off-loaded. This process of uplift is called isostacy. The Blue Ridge that we know today is the eroded remnant of that much larger, ancient structure.

About 200 million years ago, the crust began to **rift** apart once4 again into a series of elongate basins, as the Atlantic Ocean began to form. One of these basins was located in the vicinity of what is now Howardsville, where rocks composed of ancient basin sediments and cobbles are now well-exposed.

Today the east coast of North America is tectonically quiet, the only tectonic activity occurring far from its coast in the Mid-Atlantic Ridge where new ocean crust is being formed. Once again, North America is adrift, slowly coursing to the west, many degrees north of the equator. The second cycle is thus completed.

Description of rocks:

Rock#1 Granite…These two rocks are the oldest in the exhibit at about 1800 million years. They were originally sedimentary and volcanic rocks that were metamorphosed later as deep burial and tectonic forces created high temperatures and pressures. (Metamorphism results in a change in the appearance and composition of a rock as a result of pressure and /or temperature changes as well as, in many instances, exposure to circulation fluids.) These rocks may have formed on the margin of a very early or proto-North American plate. Granulite or granulite gneisses are part of what we call the Blue Ridge Basement Complex. Notice the "foliation" or layering resulting from the alternation of bands of light minerals (quartz and feldspar), and dark minerals (especially pyroxene). The banding and recrystallization of the minerals are hallmarks of high-grade metamorphism.

2-11 Granite…There are several examples of granite or granite-like rocks in the exhibit. Granite is an igneous rock that forms as hot molten magma rises in the crust with the heat generated by a mountain building event. The mountain building even in this case was called the Grenville Orogeny, which occurred as an early supercontinent, Rodinia, was formed about 1100 million years ago. The masses of molten rock (plutons) cooled slowly deep within the crust, allowing time for large crystals of quartz, feldspar and dark minerals to develop. These plutons" intruded" or rose into the granulites that we saw at the beginning of the exhibit. After millions of years of erosion, the granites and the granulites, called the Blue Ridge Basement Complex, have become exposed at the surface where we see them now.

5 Roseland Anorthosite…You may have seen this white rock, when crushed, on and beside many of our roads in Nelson County. It is a unique type of granite composed of white feldspar with varying amounts of blue quartz. When pure white, the anorthosite (also called aplite) maybe used in the ceramic industry. The blue in the quartz is the result of light rays bent by tiny crystals of rutile, a mineral containing titanium.

6 Nelsonite…Named for Nelson County, this rock is composed of minerals that contain the element titanium. Nelsonite was an important commercial source of titanium several years ago. Titanium is a metal that is noted for its strength, lightness and toleration of high temperature. Nelsonite is an igneous rock that is found around the community of Bryant.

8 Soapstone…Originally what would become soapstone was an igneous rock. Later it was metamorphosed to a rock, which contains the mineral tale giving it its characteristic soapy feel. Soapstone is so soft that it can be sawed and then fashioned into various objects. It has excellent heat-retaining properties making it useful in the manufacture of counter tops, stones and bowls. It has been used as a dimension stone in the building industry. Schuyler was the center of a large soapstone industry earlier in the 20th century. Now, soapstone is primarily used in the craft industry.

9 Unakite…When granite is recrystallized or metamorphosed by heat and "briney" fluids, its minerals are changed to those we see here. Look at the beautiful greens (epidote), reds (alkaline feldspars) and blues (quartz) of the crystals in this rock. The metamorphosis of the granite to unakite frequently occurs adjacent to molten rock such as a basalt that supplies the heat and fluids that cause the recrystallization.

12 Rockfish Granodiorite… Just as granites rise into the crust with the heat produced by mountain building (orogeny), granite-like rocks called granodiorites my rise into the crust with heat produced by rifting or stretching of the tectonic plate. Chemical analysis of these rocks shows characteristic compositions that point to an anorogenic process. Anorogenic means "not mountain building" or in this case rifting. The granodiorites indicate that a rifting process was beginning as Rodinia began to disassemble.

13, 14, 15 Swift Run Formation and Lynchburg Group…For 500 million years, from 1100 to 600 million years ago, the granites and granulites of the mountains and the highlands to the west of this site were exposed to weathering and erosion. Stream-born sediments collected in the lowlands between the granitic hills (Swift Run Formation). At around 700 million years ago, a series of fault-bounded basins developed as Rodinia began to rift apart, the sediments which were shed into these basins are exposed at the surface today in eastern Nelson County as metamorphosed sandstone, siltstones and conglomerates of the Lynchburg Group.

16 Amphibolite…Notice the salt and pepper appearance, the result of the dark mineral, an amphibole and the lighter mineral feldspar. Amphibolite commonly occurs as dikes, which originate as thin seams of molten rock that cut through surrounding rock as they rise through cracks and fissures toward the surface of the crust. These dikes may have been the feeders or channels via which lava reached the surface 570 million years ago.

17, 18, 19, 20 Catoctin metabasalts or "greenstones" …570 million years ago as the supercontinent Rodinia was rifted apart, lava came up through the fissures and cracks in that fractured crust. A dozen or more separate lava flows flooded the landscape, each cooling quickly on exposure to air or water. This rifting eventually allowed development of the Iapetus or the proto-Atlantic Ocean. Later, the minerals in the basalt were recrystallized (metamorphosed) to chlorite, epidote and actinolite producing the green color characteristic of "greenstone".

Here we see many varieties of rocks included in the Catoctin formation. There are "vesicular" rocks with gas bubbles later filled with white minerals (rock#20). There are "brecciated" rocks made up of angular fragments of rock that formed as lava flows bulldozed underlying rocks and churned their way across the surface of the earth (rock#20). Also note the rock with the large light colored crystals (feldspar), a hallmark of an unusual cooling history (rock#19). The pistachio-green rock called epidosite (rock#17) is composed of the metamorphic mineral epidote which formed as briney seawater percolated through extruded basalts on the floor of the opening ocean basin (rock#17).

21 Unicoi or Weverton sandstones and conglomerates…During the Cambrain Period about 550 million years ago, as the Iapetus Sea widened, rift basins and the coast of proto-North America received sedimentary deposits of gravel, sand and mud from the eroding Grenville mountains to the west. The Unicoi Formation includes those coarse sediments that collected near the base of steep cliffs that were produced by the rifting or pulling apart of the crust.

22 Candler Formation…Like the Unicoi Formation that rests on the western flank of the Blue Ridge anticlinorium, the Candler Formation occupies a similar position on the eastern flank of the anticlinorium. Muddy sediments have been metamorphosed to the phyllites, some of which contain small grains of the metamorphic mineral choritoid. Quartzites, limestones and marbles are also present within these sediments, as would be expected in a marine depositional environment.

23, 24 Limestones…As the Iapetus Sea expanded westward over ancestral North America in Cabrian time, 550 million years ago, many new forms of life proliferated in the warm, shallow tropical epi-continental sea. Organisms similar to our present-day clams, snails, corals and crabs used calcium as they built shells to protect their softer parts. When these animals died, their shells eventually became the limestones found in the Candler Formation in Nelson County and the limestones and dolostones of the Shenandoah Valley to our west.

25 Conglomerate…In the Triassic Period about 200 million years ago, the supercontinent Pangaea began to rift apart just like Rodinia had 400 million years before that. With stretching of the crust, rift valleys or basins formed, one of which was to widen to become the Atlantic Ocean. These rift valleys filled with mud and coarse rocky fragments washed down from surrounding cliffs. This particular rock came from one of those basins called the Scottsville Triassic Basin. In a similar basin near Culpeper dinosaur tracks and fossils of many animals have been found. In East Africa today, we can see the development of a similar rift valley that may, with time, become a sea splitting the continent.

26 Diabase…This black rock, which contains the minerals plagioclase and pyroxene, rose or “welled up” through cracks in the crust as rifting occurred with the formation of the Atlantic Ocean 200 million years ago. Diabase, like amphibolite is often found in dikes that cut crustal rock as they rise toward the surface.

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