U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCIENTIFIC INVESTIGATIONS MAP 2830

DESCRIPTION OF MAP UNITS

(Glossary of Geologic Terms on reverse side of map)

Rocks of the Appalachian Plateaus and Valley and Ridge Provinces

- Coarse- to fine-grained sedimentary sequences, limestone, and dolomite (Pennsylvanian to Mississippian)
- Shale, siltstone, and sandstone (Devonian to Cambrian)
- Sandstone and conglomerate (also in the Grandfather Mountain window in the Blue Ridge province) (Ordovician to Cambrian)
- Limestone and dolomite (also in windows in the Blue Ridge province) (Ordovician to Cambrian)

Rocks of the Blue Ridge Province

- Metasandstone, metasiltstone, and marble (light-gray patterned areas) (Cambrian? to Late Proterozoic?)
- Metamorphosed sandstone, siltstone, shale, and conglomerate of the Ocoee basin and Grandfather Mountain window (Late Proterozoic)
- Metavolcanic and metasedimentary rocks of the Mount Rogers area and nearby glacial deposits (Late Proterozoic)

Rocks of the Piedmont Province

- Sandstone, siltstone, and shale deposited in a fault-bounded basin (Triassic)
- Gneiss, schist, and phyllite (Cambrian to Late Proterozoic)—Includes quartzite, metasandstone, and metamorphosed igneous rocks. Includes low-grade metamorphosed sedimentary and volcanic rocks east of Lexington, N.C. Created from offshore sediments, volcanic rocks, and continental material that formed elsewhere and collided with the North American continent

Rocks of the Blue Ridge and Piedmont Provinces

- Rocks of the Brevard fault zone (Ordovician to Permian)—Highly sheared and deformed rocks in a major fault zone
- Granitic plutonic rocks (Permian to Late Proterozoic)—Mostly granite, but locally includes some mafic and ultramafic rocks; some are metamorphosed
- Gneiss, schist, phyllite, metagraywacke, and amphibolite (Late Proterozoic)—Metamorphosed sea-floor sediments and lava flows
- Gneiss (Middle Proterozoic or older)—Fragments of the basement rock of ancestral North America

EXPLANATION OF MAP SYMBOLS

- **Contact**—Boundary between geologic map units
- **Thrust fault**—Trace of surface along which rocks have moved; sawteeth on upper plate of thrust faults
- **Normal fault**—Trace of surface along which rocks on one side dropped down relative to rocks on the other side; bar and ball on downdropped side
- **Blue Ridge Parkway**
- **Interstate route**
- **U.S. route**
- **State route**
- **Cities and towns**
- **Locality shown in photograph**—Photographs are on both sides of this sheet

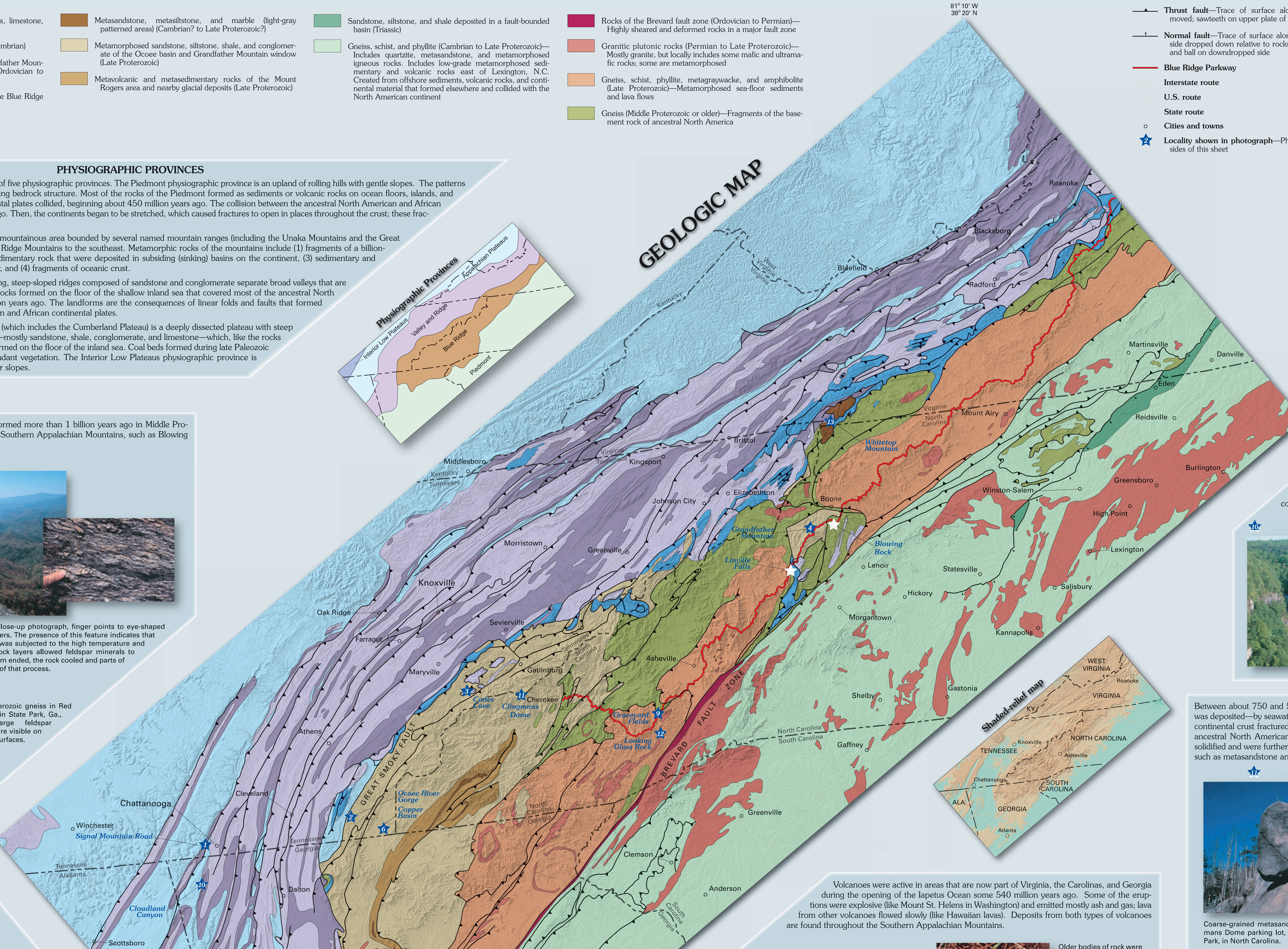
PHYSIOGRAPHIC PROVINCES

The Southern Appalachian Mountains cover parts of five physiographic provinces. The Piedmont physiographic province is an upland of rolling hills with gentle slopes. The patterns of valleys and hills rarely coincide with the underlying bedrock structure. Most of the rocks of the Piedmont formed as sediments or volcanic rocks on ocean floors, islands, and continental plates; igneous rocks formed when crustal plates collided, beginning about 450 million years ago. The collision between the ancestral North American and African continental plates ended about 270 million years ago. Then, the continents began to be stretched, which caused fractures to open in places throughout the crust; these fractures were later filled with sediment.

The Blue Ridge physiographic province is a high, mountainous area bounded by several named mountain ranges (including the Unaka Mountains and the Great Smoky Mountains) to the northwest, and the Blue Ridge Mountains to the southeast. Metamorphic rocks of the mountains include (1) fragments of a billion-year-old supercontinent, (2) thick sequences of sedimentary rock that were deposited in subsiding (sinking) basins on the continent, (3) sedimentary and volcanic rocks that were deposited on the sea floor, and (4) fragments of oceanic crust.

In the Valley and Ridge physiographic province, long, steep-sloped ridges composed of sandstone and conglomerate separate broad valleys that are underlain by limestone, dolomite, and shale. The rocks formed on the floor of the shallow inland sea that covered most of the ancestral North American continent from about 540 to 270 million years ago. The landforms are the consequences of linear folds and faults that formed during the collision of the ancestral North American and African continental plates.

The Appalachian Plateaus physiographic province (which includes the Cumberland Plateau) is a deeply dissected plateau with steep slopes. The plateau is underlain by flat-lying rocks—mostly sandstone, shale, conglomerate, and limestone—which, like the rocks of the Valley and Ridge physiographic province, formed on the floor of the inland sea. Coal beds formed during late Paleozoic time in swamps and deltas during periods of abundant vegetation. The Interior Low Plateaus physiographic province is similar to the Appalachian Plateaus, but has gentler slopes.



Geology modified from Peper and others (2001).
Shaded-relief base map rendered by Natural Scene Designer Pro 4.0 (Natural Graphics, Rocklin, Calif., www.naturalgfx.com)

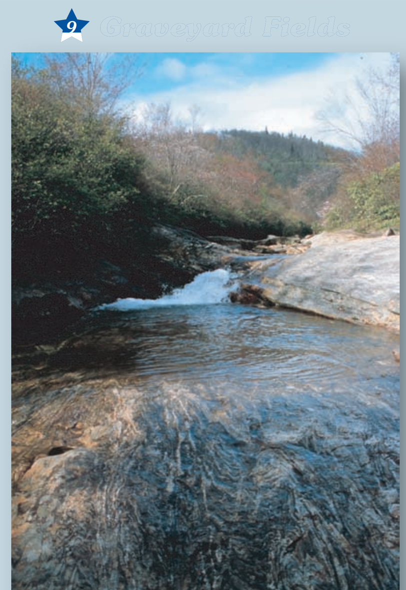
GEOLOGIC TIME SCALE

EON	ERA	PERIOD	Age in millions of years before present (base)
			Present
Phanerozoic	Cenozoic	Quaternary	1.8
		Tertiary	65.5
	Mesozoic	Cretaceous	146
		Jurassic	199
		Triassic	251
	Paleozoic	Permian	299
		Carboniferous: Pennsylvanian	318
		Carboniferous: Mississippian	359
		Devonian	416
		Silurian	444
		Ordovician	501
		Cambrian	542
Proterozoic	Late Proterozoic	none defined	1000
	Middle Proterozoic	none defined	1600
	Early Proterozoic	none defined	2500
Archean			

Remnants of the supercontinent Rodinia, which formed more than 1 billion years ago in Middle Proterozoic time, may be seen at many places in the Southern Appalachian Mountains, such as Blowing Rock and Red Top Mountain.

Middle Proterozoic gneiss at Blowing Rock, N.C. In close-up photograph, finger points to eye-shaped body (augen) of feldspar within the light and dark layers. The presence of this feature indicates that some of the original rock became deformed when it was subjected to the high temperature and pressure of metamorphism. The squeezing of the rock layers allowed feldspar minerals to become separated from the layers. After metamorphism ended, the rock cooled and parts of it recrystallized. The feldspar augen body is the result of that process.

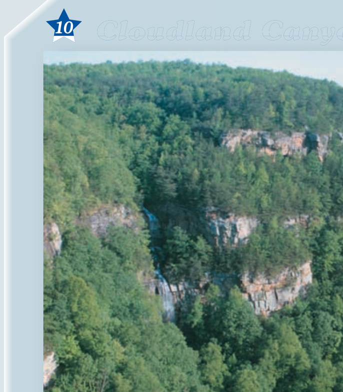
Middle Proterozoic gneiss in Red Top Mountain State Park, Ga., contains large feldspar grains that are visible on weathered surfaces.



View of the Yellowstone Prong of the East Fork of the Pigeon River below Graveyard Fields overlook. An outcrop of folded gneiss may be seen the river bed.

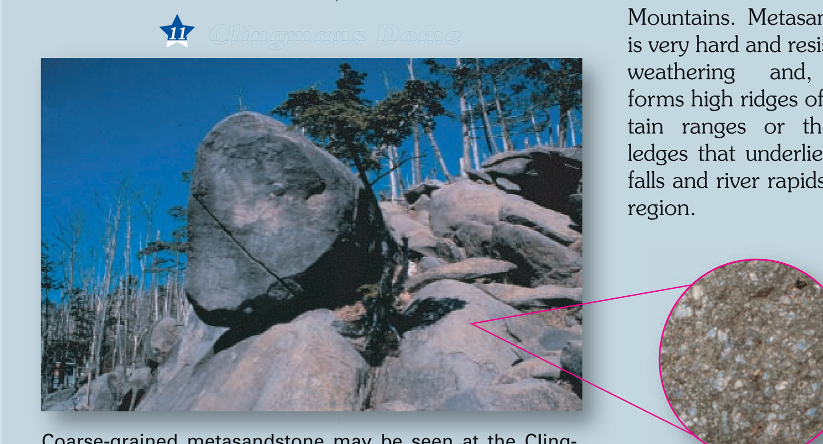
Folds in an outcrop of gneiss. This exposure may be seen across the road from the Graveyard Fields overlook at milepost 418.8 of the Blue Ridge Parkway in North Carolina. The banding and the folds resulted from the tremendous forces of heat and pressure exerted on the rocks by tectonic movements. The temperature was not high enough to melt the rock, but there was enough heat and pressure to deform it. During the deformation, the rock's mineral components separated into bands that flowed like toothpaste because they were not quite solidified. The results are metamorphic rocks with curving and swirling bands.

Long, straight ridges with intervening valleys are characteristic of the Valley and Ridge physiographic province. When the ancestral North American and African continents collided to form the continent Pangea, sheet after sheet of flat-lying rock were pushed to the west. During the collision, the sheets folded and faulted against each other; erosion over millions of years left the valleys and ridges that are visible today.



View of the west wall in Cloudland Canyon State Park, Ga. Nearly horizontal layers of hard and resistant sandstone form the ridges, and softer, more erodable layers of limestone form the valleys in the Valley and Ridge physiographic province.

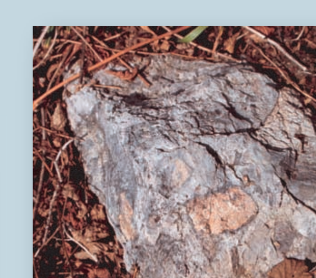
Between about 750 and 540 million years ago, a thick pile of clay, silt, sand, and gravel was deposited—by seawater and rivers—in layers in the Ocoee basin, which formed as the continental crust fractured and was pulled apart by tectonic forces near the margin of the ancestral North American continent. Over hundreds of millions of years, the sediments solidified and were further subjected to tectonic activity. They are now metamorphic rocks, such as metasandstone and slate, which form the bedrock of the Unaka and Great Smoky Mountains. Metasandstone is very hard and resistant to weathering and, thus, forms high ridges of mountain ranges or the rock ledges that underlie waterfalls and river rapids in this region.



Coarse-grained metasandstone may be seen at the Clingmans Dome parking lot, Great Smoky Mountains National Park, in North Carolina.

Volcanoes were active in areas that are now part of Virginia, the Carolinas, and Georgia during the opening of the Iapetus Ocean some 540 million years ago. Some of the eruptions were explosive (like Mount St. Helens in Washington) and emitted mostly ash and gas; lava from other volcanoes flowed slowly (like Hawaiian lavas). Deposits from both types of volcanoes are found throughout the Southern Appalachian Mountains.

Ancient volcanic rocks are exposed on Whitetop Mountain in the Mount Rogers National Recreation Area in the Jefferson National Forest of southwestern Virginia.



Older bodies of rock were sometimes broken apart by a force such as erosion or tectonic activity. The rock fragments were then enclosed by molten lava, which later cooled and solidified. The resulting outcrop shows the angular old rock fragments captured in the cooled lava flow.

The holes (vesicles) in this outcrop formed from bubbles and indicate where gas within the lava escaped. The lava solidified quickly, capturing holes left by the bubbles.

As lava or molten rock flowed, its mineralogic composition might change over time. The resulting solidified rock exhibits thin layers (flow laminations) of different mineral compositions which later became contorted as the rock was subjected to tectonic heat and pressure.

Heat deep within the Earth caused some pre-existing rock to become so hot that it melted. Some molten rock (magma) that rose to the surface erupted as volcanoes. However, some of the magma was trapped deep underground. As it cooled and crystallized, the magma formed plutons—large bodies composed of granite and similar rock. After a long period of time, the overlying rocks eroded away and the plutons became exposed at the Earth's surface. The results are unusual, smooth-sided domes, such as Looking Glass Rock.

View of Looking Glass Rock from the Blue Ridge Parkway in North Carolina.

GEOLOGY OF THE SOUTHERN APPALACHIAN MOUNTAINS

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