For additional reading (technical)

Miller, J.M.G., 1994, The Neoproterozoic Konnarock Formation, southwestern Virginia, USA; Glaciolacustrine facies in a continental rift, *in* Deynoux, M[ax], Miller, J.M.G., Donnack, E.W., Eyles, N., Fairchild, I.J., and Young, G.M., eds., Earth's glacial record: New York, Cambridge University Press, p. 47–59.

Rankin, D.W., 1993, The volcanogenic Mount Rogers Formation and the overlying glaciogenic Konnarock Formation—Two Late Proterozoic units in southwestern Virginia: U.S. Geological Survey Bulletin 2029, 26 p.

Rankin, D.W., Miller, J.M.G., and Simpson, E.L., 1994, Geology of the Mt. Rogers area, southwestern Virginia Blue Ridge and Unaka belt, *in* Schultz, Art, and Henika, Bill, eds., Fieldguides to southern Appalachian structure, stratigraphy, and engineering geology: Virginia Polytechnic Institute and State University Department of Geological Sciences Guidebook no. 10, p. 127–176.

Cover: Buzzard Rock, a shoulder of Whitetop Mountain, from near the peak of Whitetop Mountain; volcanic rocks are in the foreground. Photograph by Sandra H.B. Clark, U.S. Geological Survey.

For more information online

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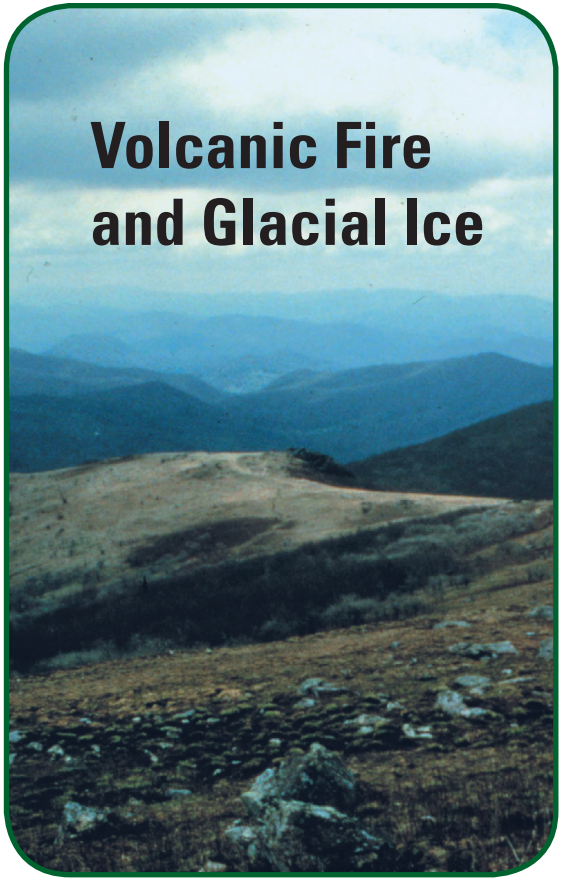

Volcanic Fire and Glacial Ice

Geologic Wonders
of the George Washington and Jefferson National Forests

No. 4 in a Series

Mount Rogers National Recreation Area

USGS science for a changing world

U.S. Department of the Interior
U.S. Geological Survey

in cooperation with

U.S. Department of Agriculture
Forest Service
Southern Region

2007

In addition to containing the highest point in Virginia (Mount Rogers, elevation 5,729 feet), the Mount Rogers National Recreation Area (NRA) of the Jefferson National Forest is a window on the history of ancient volcanic eruptions and glacial movement.

How do we know there were volcanoes in the Mount Rogers NRA?

Although volcanic activity ended long ago, volcanic rocks form the high mountains in the Mount Rogers NRA, which are Mount Rogers, Whitetop Mountain, and Pine Mountain. The volcanic rocks are predominantly light-colored, fine-grained, high-silica (SiO_2) rocks (rhyolite) of the Mount Rogers Formation (Rankin, 1993).

The Mount Rogers volcanic center was the site of different types of eruptions; some eruptions released lava that flowed like a very thick, hot liquid, whereas other eruptions were explosive like the dramatic and destructive 1980 eruption of Mount St. Helens in Washington (fig. 1). Explosive eruptions from Mount Rogers produced hot, high-density, fast-moving flows of volcanic ash that formed a sheet of volcanic rock more than one-third of a mile thick.

Figure 1. Pumice and ash eruption at Mount St. Helens, Wash. Some eruptions at Mount Rogers probably looked like this. U.S. Geological Survey photograph by Austin Post, May 18, 1980; for more photographs, see http://vulcan.wr.usgs.gov/Photo/framework.html.

Textures of volcanic rocks provide information on the type of eruptions that formed them. For example, many volcanic rocks on Whitetop Mountain (elevation 5,520 feet) are fine grained and generally featureless, but some rocks have rounded, mineral-filled holes indicating where bubbles of volcanic gases once escaped (fig. 2*A*). Other rocks have fine laminations that formed as layers of hot volcanic ash cooled and ash grains welded together (fig. 2*B*). In other rocks, you can see angular, broken volcanic fragments enclosed in a fine-grained rock that was once molten lava (fig. 2*C*).

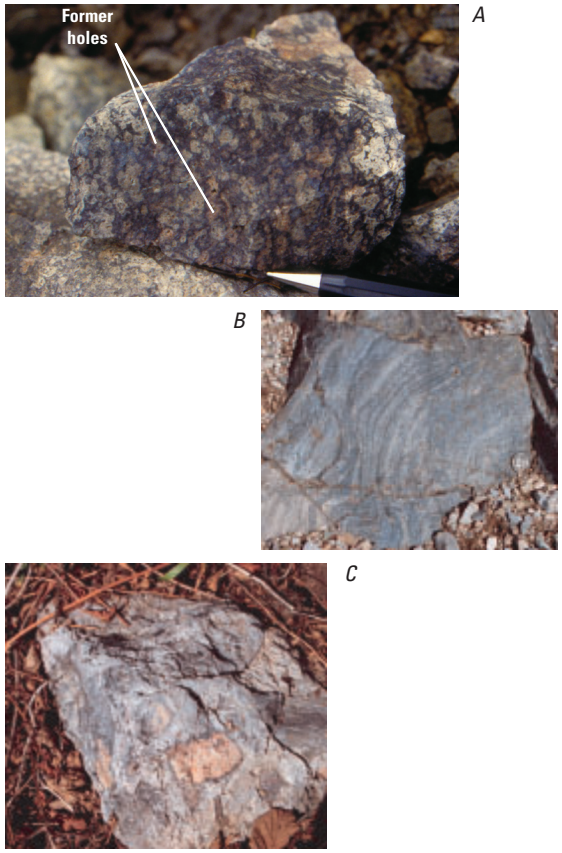

Figure 2. Textures of volcanic rocks from Whitetop Mountain. *A*, Rock containing rounded, mineral-filled holes formed by escape of gas bubbles. *B*, Fine laminations formed as ash grains welded together. *C*, Angular volcanic fragments enclosed in a fine-grained rock. Photographs by Sandra H.B. Clark, U.S. Geological Survey.

Are further eruptions expected?

The volcanoes were active about 760 million years ago during Late Proterozoic time, when the crust of an ancient supercontinent was heated and stretched by forces deep within the Earth. Much later, as the stretching continued, fractures formed and the supercontinent broke into pieces that slowly drifted away from each other. Because volcanic rocks in the Mount Rogers area are thousands of miles from where they originated, future eruptions in this area are extremely unlikely.

Were there other active volcanoes in the Southeast?

The Mount Rogers NRA is partly in the Blue Ridge physiographic province and partly in the Valley and Ridge. To the east, is the Piedmont province. These provinces contain evidence of volcanic activity that took place at different times.

The Blue Ridge province contains many rocks formed from volcanic activity 570 to 600 million years ago; they are younger than the Mount Rogers volcanic rocks (760 million years old) and formed in different settings. Many rocks in the Blue Ridge formed during eruptions from basaltic lavas that were less explosive than most of the lava eruptions that formed Mount Rogers. The basaltic lavas generally flowed to form sheets rather than mountains. The basalts were buried by younger sediments and later metamorphosed (changed by heat and pressure) to dark-green rocks known as greenstones. Such greenstones are common in the Blue Ridge where basaltic magma intruded along fractures in the Earth's crust that led to the breakup of the supercontinent.

The Piedmont province contains volcanic rocks that are about 500 to 650 million years old. These rocks are probably remnants of volcanic islands that then were close to Africa and that were later attached to the North American continent before the collision of Africa and North America.

Are there any valuable minerals in the volcanic rocks?

Some volcanic rocks of the Piedmont province contain gold deposits; the Ridgeway, Brewer, and Barite Hill deposits in South Carolina are examples. Many gold, silver, and copper deposits in the Western United States are found near volcanic centers. However, no valuable mineral deposits are known in the Mount Rogers volcanic rocks.

How do we know there were glaciers and lakes in the Mount Rogers NRA?

Two types of rocks in the Konnarock Formation (Rankin, 1993) of the Mount Rogers area tell the story of ancient glaciers and lakes that formed after the volcanic activity. One rock type, diamictite, formed from a jumbled mix of pebbles and mud that was deposited beneath glaciers (tillite) or was carried by glacial meltwater into channels or a lake. A second rock type, rhythmite, formed from fine sediments deposited on a lake bottom. Pebbles that dropped from floating glacial ice into soft lakebeds are found in rhythmite (fig. 3); larger stones that fell from the floating ice are called dropstones.

Figure 3. Rhythmite containing pebbles dropped from floating glacial ice. Sample from beside Route 603 near its junction with Route 600. Photograph by Sandra H.B. Clark, U.S. Geological Survey.

Were the glaciers part of the most recent ice age?

The Konnarock glaciers were much older than the most recent ice age. Many ice ages have taken place throughout the history of the Earth, and they have been recorded in rocks. The best known is the most recent ice age that began a million or more years ago and covered parts of North America with thick ice sheets; it ended about 10,000 years ago. Although the Mount Rogers area experienced local effects of that ice age, the continental ice sheets did not extend as far south as Virginia.

The exact age of the Konnarock glacial deposits in the Mount Rogers area is not known, but the age can be bracketed between the ages of rocks above and below them. The Konnarock Formation overlies the Mount Rogers Formation, which is 760 million years old (Late Proterozoic) and underlies rocks that are 540 million years old (Cambrian); thus, the Konnarock glacial deposits formed between 760 million and 540 million years ago. It is not known whether the Konnarock glaciation was part of a widespread glacial advance or a local glaciation restricted to high elevations.

Where can you see the volcanic rocks and glacial deposits?

Mount Rogers, Whitetop Mountain, and Pine Mountain are mountains of volcanic rock—remnants of an ancient volcanic field. You can see volcanic rocks nearly anywhere you look along roads and trails in these mountains. In contrast, the glacial and lake deposits that solidified into rock can be found in the valleys and on the lower slopes north, south, and west of Whitetop Mountain.

To see volcanic and glacial rocks near roads, take Route 16 south from the Mount Rogers National Recreation Area headquarters (fig. 4) for 11 miles to the intersection with Route 603 in Troutdale. Turn right on Route 603, which goes through outcrops of rhythmite (maroon and green lakebed deposits) with dropstones (evidence of floating ice from glaciers). Deposits of rhythmite can be seen in outcrops about 7.7 miles from Troutdale on the right side of Route 603 just beyond a bridge. Rhythmite containing pebbles dropped from floating glacial ice can be seen at the east end of a roadcut on Route 603 about 0.1 mile east of its intersection with Route 600 (fig. 4).

At the junction of Routes 600 and 603, turn left (south), stay on Route 600, and go about 6.5 miles to Route 89; turn right (sharp turn). Follow Route 89 to parking at its end near the summit of Whitetop Mountain. Several kinds of volcanic textures can be seen in rocks near the parking area and along Route 89 on the mountain slope.

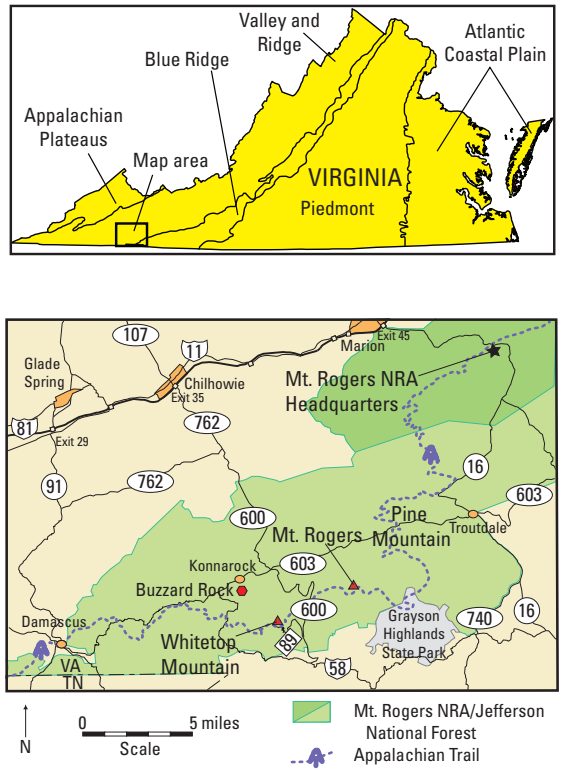

Figure 4. Routes to localities where you can see volcanic, glacial, and lake deposits in the Mount Rogers National Recreation Area (NRA), Jefferson National Forest, southwestern Virginia. Index map shows simplified physiographic provinces in Virginia.