NOCKAMIXON STATE PARK, BUCKS COUNTY

ROCKS AND JOINTS

Nockamixon State Park is located in northern Bucks County within a belt of rolling hills and bouldery ridges that geologists call the Triassic Lowland, a name derived from the fact that the rocks underlying the area date mainly from the Triassic Period, approximately 200 million years ago. Major topographic features within or immediately adjacent to the park are Nockamixon Lake, a 1,450-acre man-made lake that floods a portion of the Tohickon Creek valley, and Haycock Mountain (elevation 965 feet), the high point on a rugged semicircular "trap" rock ridge that forms the northwestern boundary of the park.

Nockamixon Lake and Haycock Mountain.

The Rocks

Cropping out within the park is a stratigraphic sequence that includes sedimentary, igneous, and metamorphic rocks. The sedimentary rocks consist chiefly of red shale and siltstone (Brunswick Formation) and gray argillite and shale (Lockatong Formation) that formed from mud and silt layers on river floodplains and in shallow lakes, respectively. The igneous rock, diabase, or "trap" as it is commonly known, is a dark-gray, medium crystalline rock composed predominantly of the two minerals labradorite (a gray feldspar) and augite (a black pyroxene). Originally, the diabase was a hot and molten liquid (magma) that was intruded into the preexisting sedimentary rocks at considerable depth beneath the surface of the earth. As the magma was emplaced, it forced the sedimentary layers apart and baked the adjacent shales and argillites into a tough, maroon to dark-gray metamorphic rock called hornfels. Thermal alteration of the rocks was most intense within several hundred feet of the diabase sheet (producing a dark-gray hornfels), but mild metamorphic effects are noticeable nearly a mile away (maroon hornfels).

The various rock units form successive bands along the length of the park. These bands trend northeast-southwest throughout most of the park, but curve to a north-south direction east of Haycock Mountain. This simple outcrop pattern reflects the gentle northwestward inclination (8 to 15 degrees) of the rock layering in the main park area, and the similarly gentle westward inclination in the extreme northeast. The broad warping of the rock layers that is indicated by this change in trend and inclination may be related to intrusion of the diabase sheet that underlies Haycock Mountain and the hilly area to the southwest.

The topography of Nockamixon State Park and the surrounding countryside is largely due to the structural configuration briefly described above and to the erosional resistance of the rock units. Generally, the red shales and siltstones are only moderately resistant to erosion and tend to underlie relatively low terrain. The harder, gray argillite and hornfels, on the other hand, form distinct ridges;

especially notable is the well-defined ridge along the southeastern side of the park, the crest of which is followed by Ridge Road from Perkasie to Elephant. Diabase is the most resistant of all the rock units and forms Haycock Mountain and the rocky hills in the northwestern portion of the park.

Joints

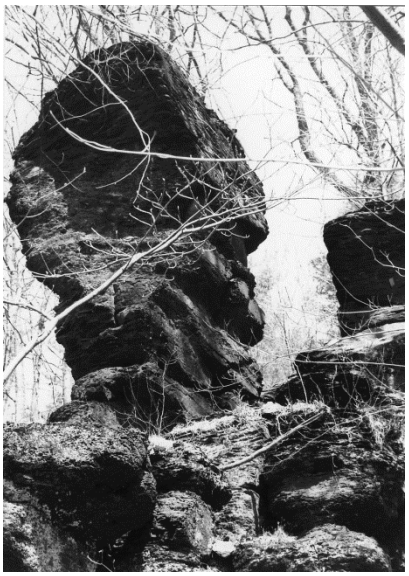
Joints, or naturally occurring, mostly planar fractures, are extremely well developed in the rocks underlying Nockamixon Park. Several distinct groups, consisting of near-vertical fractures that repeat at regular intervals, are present at most outcrops. The overwhelming majority of the joints, however, trend northeast-southwest and are inclined very steeply to the southeast. Generally, they are spaced less than 12 inches apart in the sedimentary rocks and hornfels and 12 to 48 inches apart in the diabase. Along with layering and numerous irregular curved fractures, the joints control the gross physical break-up of the rock masses by allowing the infiltration of air, water, and soil and the penetration of roots.

Joints in Lockatong argillite.

Features of Special Interest

Sentinel Rock (1)

Sentinel Rock is an erosional pinnacle of Brunswick red shale and siltstone located in the gap of Tohickon Creek about 1,000 feet downstream of the crest of Nockamixon Dam. This striking feature was formed by differential weathering along planar joints and irregular curved fractures. Opening of the joints and curved fractures was probably initiated by frost wedging and solution (the rock is slightly limy) and accentuated by soil wedging and gravitational creep. Gradually, zones of more closely spaced joints and fractures were worn away, leaving areas of widely spaced joints, such as Sentinel Rock and other nearby ramparts, to stand out as erosional remnants. Various stages in the development of isolated pinnacles can be observed in ledges north and south of Sentinel Rock.



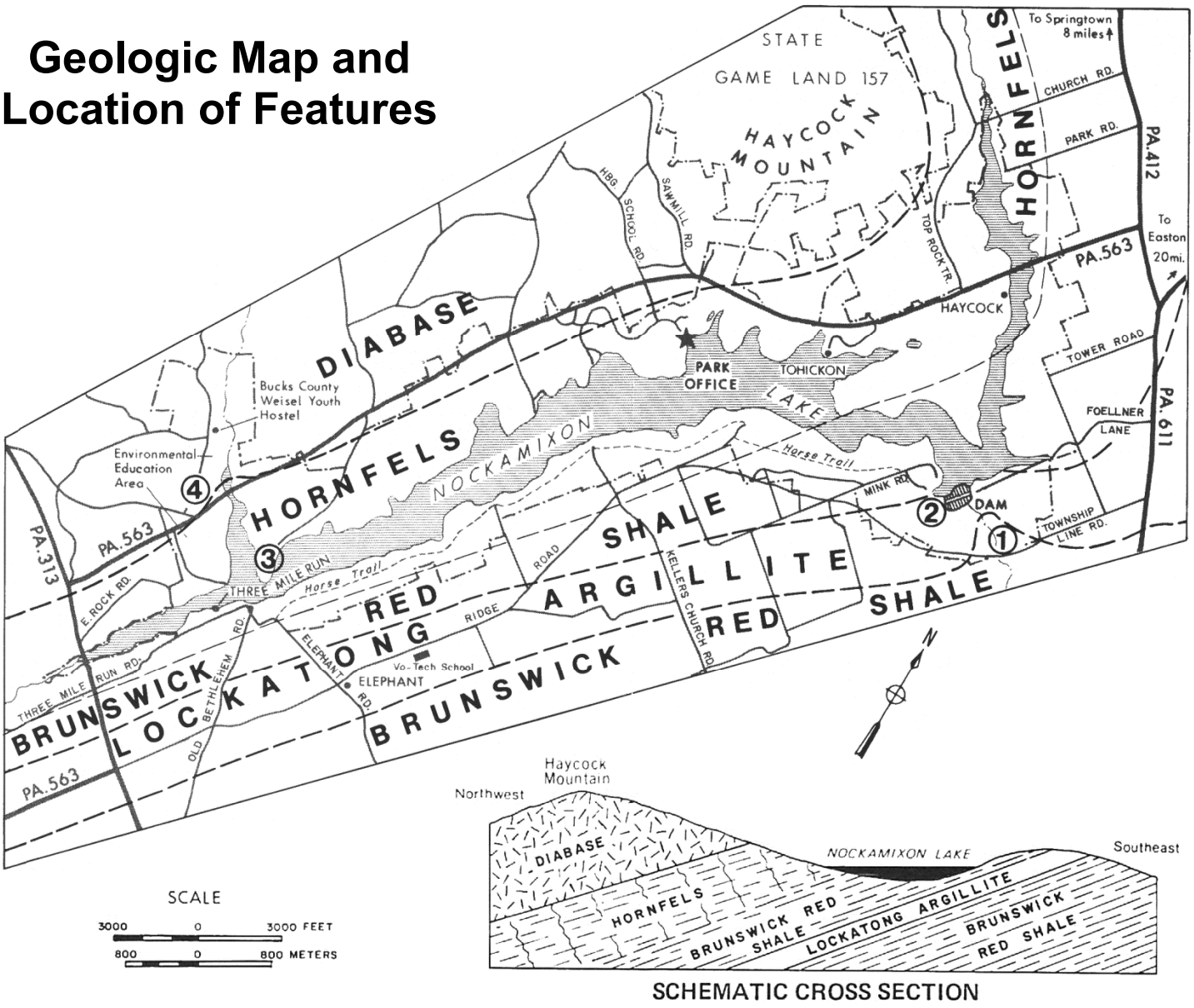
Sentinel Rock.

Emergency Spillway of Nockamixon Dam (2)

The emergency spillway of the large earth-rock dam that impounds Nockamixon Lake is excavated in gray argillite and shale of the Lockatong Formation. Particularly evident in the spillway cut are the gentle northwestward inclination of layering and the splendid development of subvertical joints. About 365,000 cubic yards of rock were removed from the spillway, much of the excavated material being used in rock-fill portions of the dam. Excavation of the rock was greatly facilitated by its intense natural jointing.

Lockatong argillite, such as that exposed in the spillway and in roadcuts on Legislative

Geologic Map and Location of Features



SCHEMATIC CROSS SECTION

Emergency spillway of Nockamixon dam.

Route 386 immediately to the south, is a very tough, commonly limy rock that is highly valued as construction stone in southeastern Pennsylvania. A large quarry in this same belt of argillite is located at Harrow, about one mile northeast of the park.

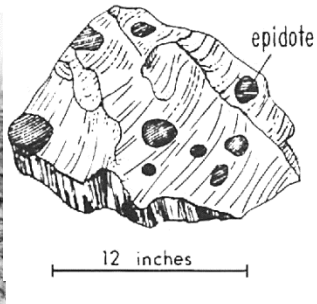
Tohickon Quarry (3)

From 1936 until 1972, hornfels obtained from a large quarry just north of a right-angle bend in Tohickon Creek was used for a variety of construction purposes, including roadstone. When the land was acquired by

the State, the steep walls of the quarry were graded to a moderate angle as a safety precaution. All that remains to remind us of this once-thriving operation is a large, partially flooded amphitheater on the hillside adjacent to Nockamixon Lake.

The hornfels in the quarry is a tough, dark-bluish-gray, fine-grained rock that preserves its sedimentary layering despite intense thermal alteration by the nearby diabase sheet. One of the most interesting mineralogical features of the few ledges that are still exposed at the quarry site is the occurrence of large spherical nodules of olive-green epidote, a calcium-aluminum-iron silicate. These nodules, some of which are more than 2 inches in diameter, formed through chemical reactions between clay minerals and calcium carbonate during metamorphism of the original limy shale or argillite.

Tohickon quarry (1973). Note joint fractures.



Epidote in hornfels.

Good exposures of typical hornfels may be examined on the shore of Nockamixon Lake, just southwest of the old quarry area.

Diabase Ledges and Boulders (4)

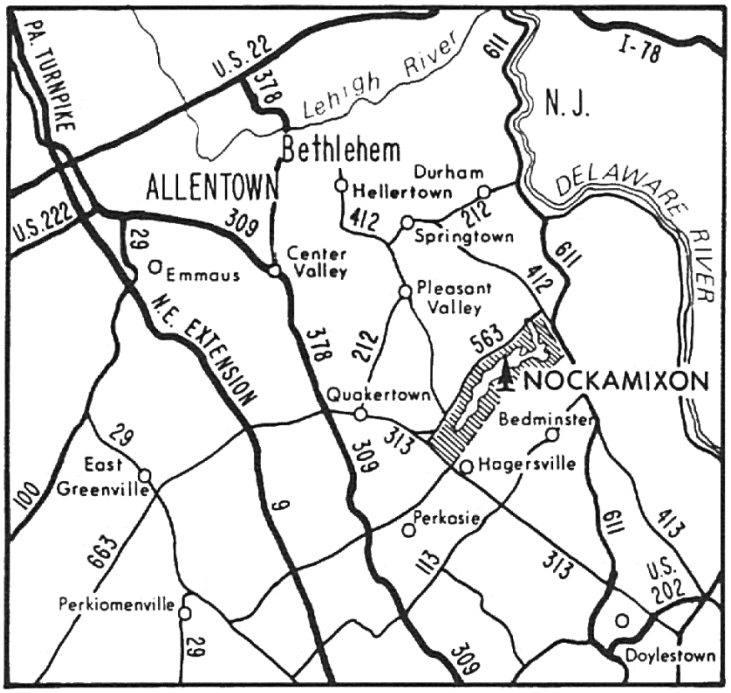
The massive ledge of diabase that crops out on the northwestern side of Pa. Route 563 in the Environmental Education area is part of the same diabase sheet that forms Haycock Mountain. The wild, rather foreboding appearance of this outcrop is due not only to the dark color of the diabase, but also to irregular blocky fragmentation along widely spaced joints, many of which have been opened by frost action and root wedging. Some of these joints appear to be crude columnar joints, i.e., fractures that form perpendicular to the upper and lower surfaces of a thick sheet of cooling igneous rock. Strongly jointed diabase ledges also create a low falls in Tohickon Creek about 1,000 feet southeast of the Youth Hostel.

Columnar joints in diabase ledge.

The northwestern edge of the park is typical of diabase terrains, in that the hillsides are strewn with large boulders that are formed by the chemical and mechanical weathering of blocks bounded by joints. Frost action and the expansion of hydrated clay minerals (derived from the weathering of the original igneous minerals) result in the peeling off of concentric sheets from the rock surfaces and the consequent formation of rounded boulders. Such boulders caused a great deal of difficulty during construction of the roads and parking areas in this portion of the park; they may be seen at numerous places along Pa. Route 563 between Haycock Mountain and the southwestern end of the park.

Because of its graininess and extreme toughness, diabase is probably an even better quarry stone than hornfels and argillite. The active diabase quarry at Rock Hill, about 2 miles southwest of the park, is one of the largest crushed-stone operations in Bucks County.

—Jon D. Inners, Geologist
Pennsylvania Geological Survey
1980



Note: Numbers along roads are Pennsylvania route numbers unless otherwise indicated.

LOCATION MAP

Nockamixon State Park
1542 Mountain View Drive
Quakertown, PA 18995
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PREPARED BY

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