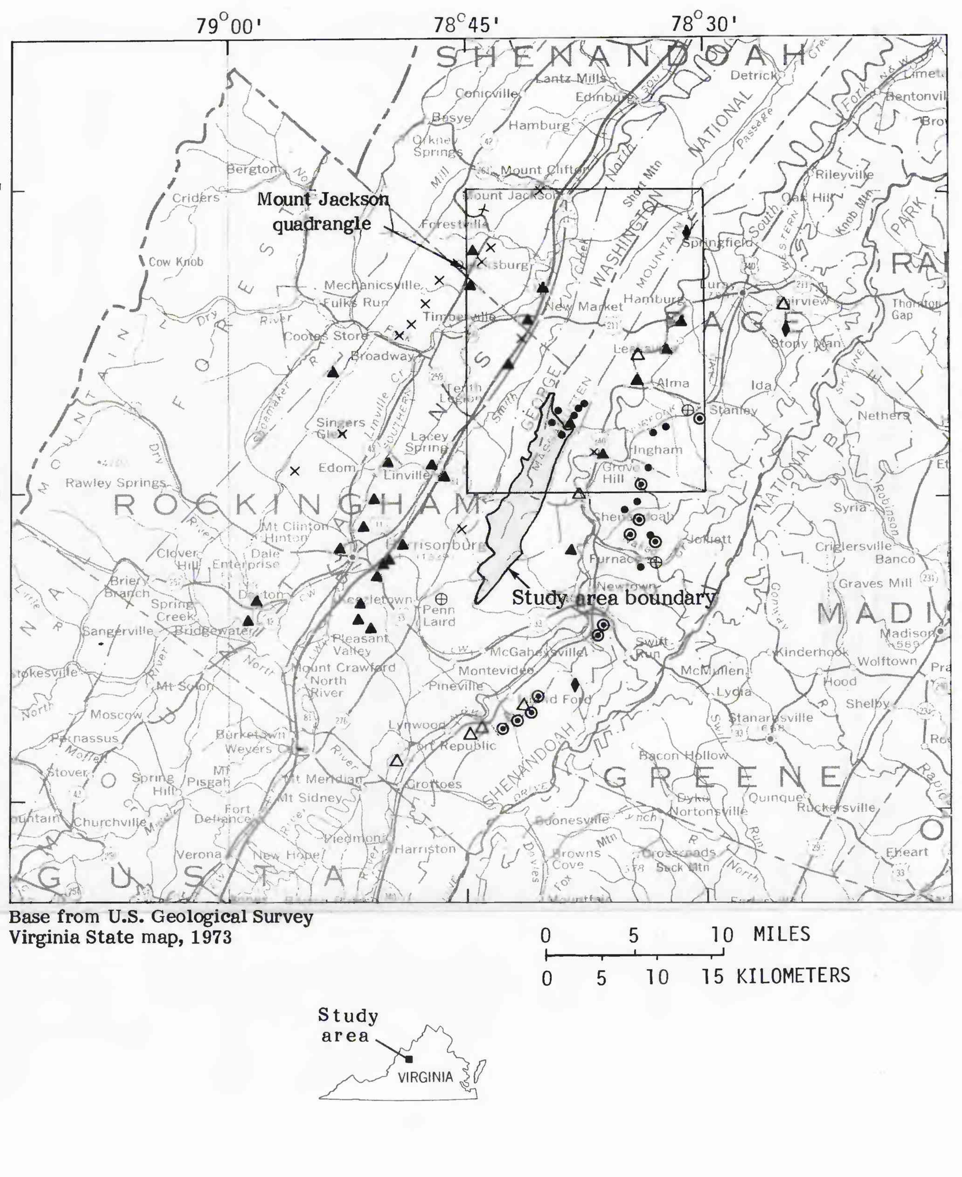
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF–1527–D
PAMPHLET ACCOMPANIES MAP



EXPLANATION

- Iron mine or prospect
- Limestone or dolomite quarry
- Manganese–iron mine or prospect
- Sand and gravel pit
- Zinc mine or prospect
- Ocher mine or prospect
- Sandstone quarry

Figure 1.—Index map showing location of Southern Massanutten Roadless Area (shaded) and some mines, prospects, and quarries in the region. (Mines, prospects, and quarries from Allen, 1967; Brent, 1960; and Herbert and Young, 1956.)

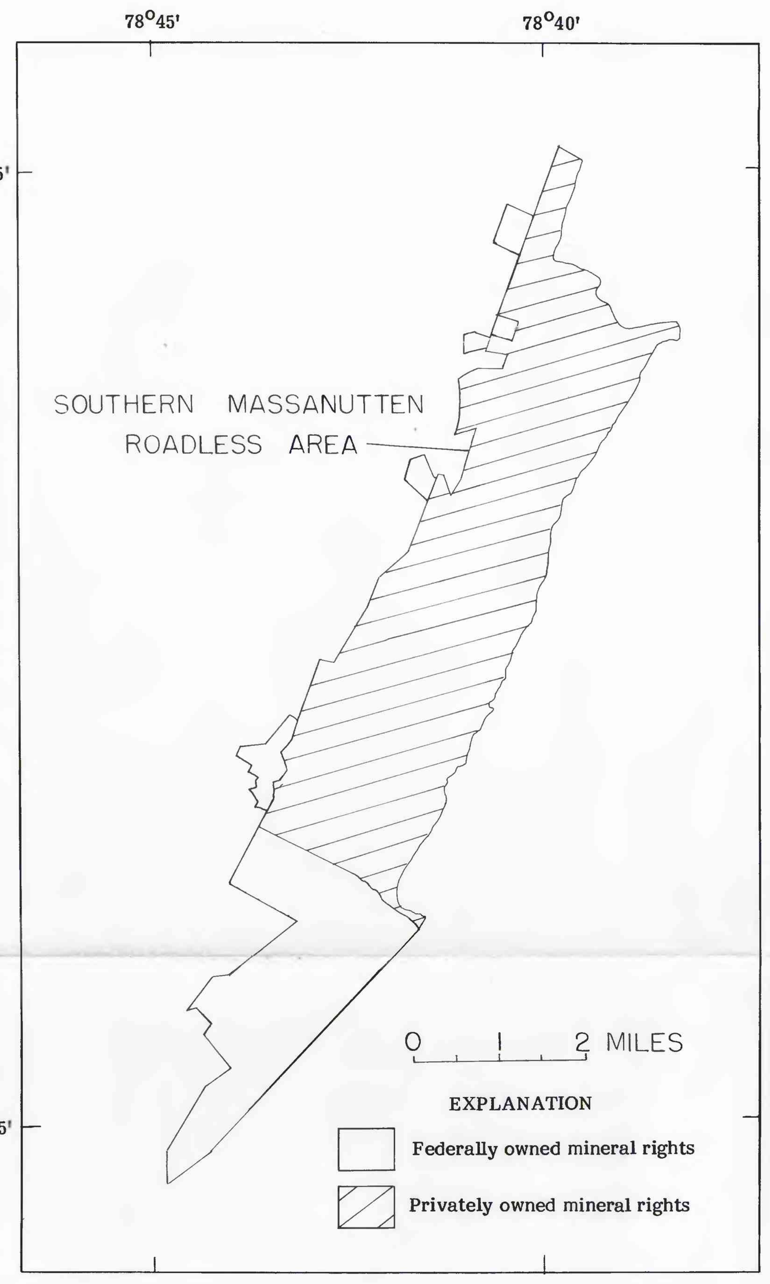


Figure 2.—Mineral-rights ownership map, Southern Massanutten Roadless Area.

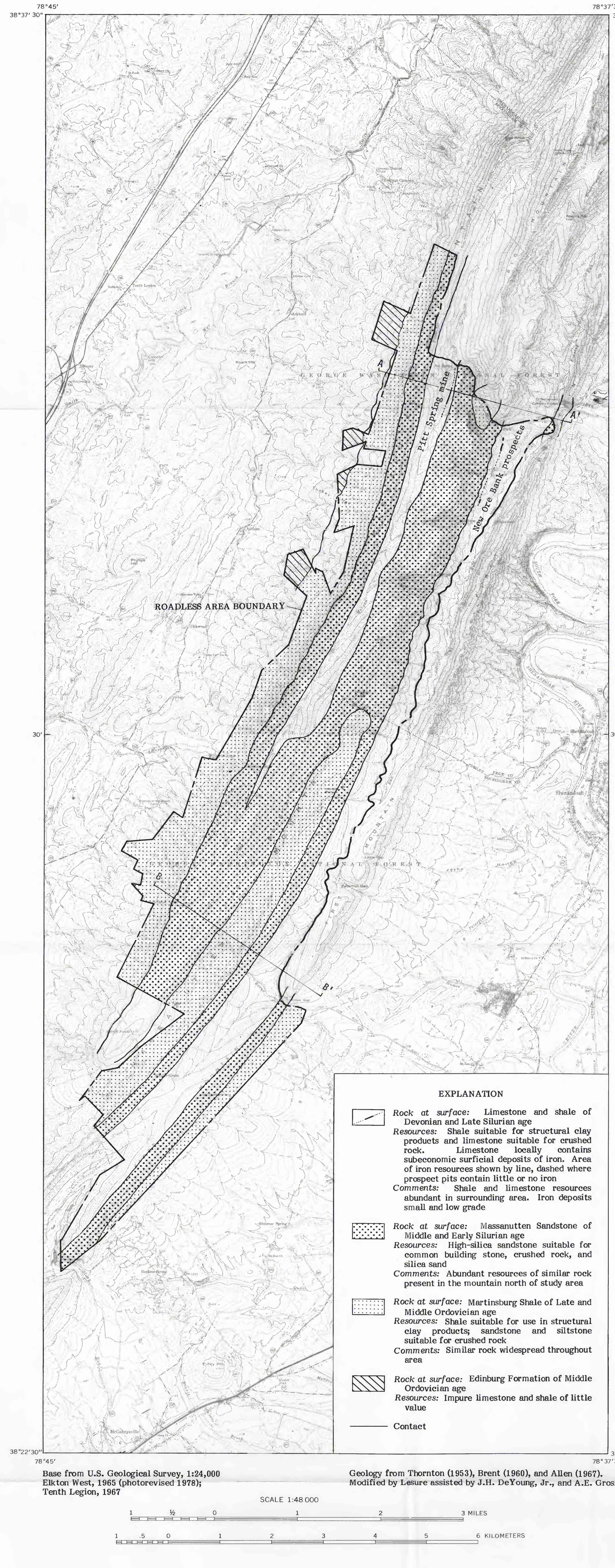


Figure 3.—Map showing distribution of sandstone, shale, and iron resources in the Southern Massanutten Roadless Area.

MINERAL RESOURCE POTENTIAL MAP OF THE SOUTHERN MASSANUTTEN ROADLESS AREA, PAGE AND ROCKINGHAM COUNTIES, VIRGINIA

By
Frank G. Lesure, U.S. Geological Survey
and
Mark L. Chatman, Paul T. Behum, and Thomas J. Wawro, U.S. Bureau of Mines
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STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral resource potential survey of the Southern Massanutten Roadless Area (08-175) in the George Washington National Forest, Page and Rockingham Counties, Va. The Southern Massanutten Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

The Southern Massanutten Roadless Area is in the George Washington National Forest in the Valley and Ridge physiographic province of Page and Rockingham Counties, Va. The Federal Government owns all surface rights and the mineral rights on about 30 percent of the land. No mining, mineral leasing, or prospecting currently involves any of the roadless area, but a small amount of iron ore was mined in the area more than 70 years ago.

The area contains folded sedimentary rocks of Paleozoic age exposed in two long narrow synclines and an intervening anticline. These rocks have extensive resources of high-silica sandstone and inferred subeconomic iron resources of 120,000 long tons of clayey and sandy limonite containing 40 percent metallic iron. Other mineral resources include various shale deposits suitable for making brick, and limited amounts of limestone suitable for crushed stone and agricultural lime. Sandstone, shale, and limestone resources in the area are of limited value because of relative inaccessibility as compared with large, accessible resources of these materials outside the area.

The potential for commercial accumulations of oil or natural gas in the area is unknown, but is probably low.

INTRODUCTION

The Southern Massanutten Roadless Area contains about 11,800 acres (4775 ha) in the George Washington National Forest in the Valley and Ridge physiographic province of west-central Virginia. The area, which is 13 mi (21 km) long and 1-2 mi (1.5 -3 km) wide, is in Page and Rockingham Counties on the eastern side of the Shenandoah Valley of Virginia between the North and South Forks of the Shenandoah River. The north end is 11 mi (18 km) southwest of Luray and the south end is 7 mi (11 km) east of Harrisonburg (fig.1).

The U.S. Government owns all surface rights within the area. Most of the acreage was acquired from the Alleghany Ore and Iron Co. between 1912 and 1915. Other tracts were bought from individual landowners. A right-of-way easement in the southern end of the area and a power line across the northern end constitute the only surface restrictions.

The Federal Government owns the mineral rights on 3,395 acres (1374 ha), about 30 percent of the total area. Allegheny Ore and Iron Co.,now a subsidiary of Lukens Steel Co., Coatesville, Pa., holds the mineral rights on the remainder in perpetuity (fig. 2).

GEOLOGY

The Southern Massanutten Roadless Area consists of two narrow asymmetric synclines and an intervening anticline in which are exposed Middle Ordovician to Middle Devonian sedimentary rocks (Lesure, in press). The oldest rocks are dark shaly limestone beds of the Edinburg Formation of Middle Ordovician age, poorly exposed on the lower western slopes of Fourth Mountain along the western boundary of the area. Overlying these beds are 1,000 to 4,000 ft (300 to 1200 m) of dark shale, siltstone, and limestone of the Martinsburg Shale of Middle and Late Ordovician age exposed on the east slope of First Mountain, in the valley between Second and Third Mountains, and on the western slope of Fourth Mountain. The Martinsburg Shale is also exposed in the core of the anticline along Pitt Spring Run at the north end of the study area.

Overlying the Martinsburg Shale is the Massanutten Sandstone of Early and Middle Silurian age. This unit is 500 to 800 ft (150-240 m) thick and is a white, fine- to coarse-grained crossbedded quartz sandstone that is resistant to erosion. The sandstone forms much of the bedrock in the study area. It crops out along the crests of all the ridges and supplies large quantities of coarse boulders which effectively conceal much of the less resistant formations on the lower slopes. Good exposures of the Massanutten Sandstone are present along Cub Run just east of Catherine Furnace, along Pitt Spring Run east of Pitt Spring, along the road in Runkles Gap, and along the trail in Fridley Gap.

The Silurian and Devonian formations above the Massanutten Sandstone are poorly exposed along the axes of the synclines between First and Second and between Third and Fourth Mountains. These rocks include in ascending order about 200 to 340 ft (60-100 m) of red shale, siltstone, and sandstone of the Bloomsburg Formation and 35-50 ft (10-15 m) of thin-bedded limestone of the Tonoloway Limestone, both of Late Silurian age. Above this sequence is 80 ft (24 m) of light-gray, coarse-grained limestone of Late Silurian to Early Devonian age, the Catherine Limestone of Thornton (1953). The youngest formation preserved in the area is the Romney Shale of Middle Devonian age, which includes 100 ft (30 m) of grayish-green shale at the base, correlated with the Needmore Shale, and an unknown thickness of black fissile shale above, correlated with the Millboro Shale.

Although no major faults are exposed in the study area, a zone of major flat-lying thrust faults is present at a depth of 2 to 5 mi (3-8 km) below the surface (Milici, 1980, sheet 1). The rocks exposed in the study area have been moved westward many miles along these faults.

GEOCHEMICAL SURVEY

Reconnaissance geochemical sampling in the Southern Massanutten Roadless Area was designed to test for indistinct or unexposed mineral deposits that might be recognized by their geochemical halos (Lesure and Forn, in press). Similar geochemical surveys based on trace-element analyses have been credited with the discovery of many types of mineral deposits (Hawkes and Webb, 1962). The only metallic mineral deposits known in the area are the low-grade iron deposits at the Pitt Spring mine and New Ore beds prospects; no evidence of other metallic deposits was found. Traces of zinc (0.2-0.3 percent) in the clayey limonite from the Pitt Spring mine (Lesure and Forn, in press), are similar to amounts found in other iron deposits of this type (Lesure and others, 1978; Lesure, 1982) and are not considered to be of economic importance.

MINERAL RESOURCES

Identified mineral resources of sandstone suitable for common building stone, crushed rock and high-silica sand, and shale suitable for common brick, tile and lightweight aggregate, are in the study area (fig. 3), but are subeconomic at this time. Small medium-grade limonitic-iron deposits worked more than 70 years ago have inferred subeconomic resources[1] of 120,000 long tons of limonitic material containing as much as 40 percent metallic iron. The area has essentially no potential for accumulations of either oil or natural gas because the rocks have been heated to temperatures at which oil and natural gas are unstable (Epstein and others, 1977; Harris and others, 1978), and the structural setting of the Massanutten Synclinorium is unfavorable for oil and gas accumulation. Potential for oil or natural gas in sedimentary rocks below the Pulaski thrust fault, which underlies the area at a depth of 2 to 5 mi (3-8 km), is unknown. There are no identified resources of other commodities in the area; the probability for the occurrence of undiscovered resources of other mineral commodities is small.

Sandstone

The Massanutten Sandstone, present in large amounts in the roadless area, represents a subeconomic resource. It is a potential source of large amounts of stone suitable for common building stone, crushed rock, and high-silica sand. A quarry on Massanutten Mountain, 12.5 mi (20 km) northeast of Catherine Furnace, supplied building, wall, and coping stone as late as the 1960's (Allen, 1967, p. 64; Harris, 1972, p. 4).

Analyses of representative samples (Wawro and others, 1982, p. 18; Lesure and Forn, in press) suggest that the Massanutten Sandstone is suitable for low quality glass products without beneficiation. Because the Massanutten Sandstone consists of nearly pure silica sand, it could possibly be used for refractory sand, abrasive material, or silica for chemical and metallurgical uses (Murphy, 1960; Ries, 1949). Complete evaluation for the special silica uses requires additional testing of physical characteristics. Because this formation and others contain adequate silica resources outside the roadless area and closer to main highways and transportation, the sandstone in the study area is subeconomic.

Shale

Several samples of Martinsburg Shale from the study area have been tested and found suitable for common brick, tile, and lightweight aggregate (Calver and others, 1961, p. 102-105, 128-144; Wawro and others, 1982, p. 15). The most accessible part of the shale resources in the Martinsburg Shale are along the flanks of the mountain generally outside the study area.

Silurian and Devonian shales in the synclinal valleys of the study area were subjected to preliminary ceramic testing, which shows a potential use for structural clay products (Wawro and others, 1982, p. 15). One sample of shale from the Upper Silurian Bloomsburg Formation was also found to be suitable for lightweight aggregate (Wawro and others, 1982, p. 15), but this rock unit is predominantly a sandstone in the study area and does not contain significant shale beds.

Preliminary testing results do not represent a complete resource analysis, and extensive sampling and testing are necessary before commercial development consideration. Shale is usually a low-unit-value material, and its development depends on market proximity. No attempt has been made to develop shale deposits in or near the study area, and the probability for such development is presently low.

Iron

Deposits of medium-grade clayey and sandy limonitic iron are common in this part of west-central Virginia where they have been called Oriskany iron ores (Holden, 1907, p. 408-410). These ores formed during a long period of weathering during which groundwater dissolved iron from pyrite in the Romney Shale and precipitated iron hydroxides as supergene replacement and cavity filling in the underlying Lower Devonian limestone. In general these deposits are near-surface features; the iron ore grades into unreplaced limestone within a hundred feet (30 m) or less of the surface. In the Clifton Forge iron district 70 mi (110 km) southwest of Massanutten Mountain the larger iron deposits occur where the limestone beds dip 20 to 75 degrees (Lesure, 1957, p. 94). Only a few deposits form in steeply dipping or overturned beds such as those prevalent in the study area.

In the study area, structure is apparently a major factor limiting iron replacement to the coarse-grained Upper Silurian and Lower Devonian limestones above the Tonoloway Limestone. Iron deposits are found in discontinuous zones parallel to the axes of the synclinal valleys along Pitt Spring Run, Cub Run, and Roaring Run where the formations dip less than 75 degrees. The iron deposits are on both limbs of the syncline along Roaring Run Valley, but only on the west limb to the south in Cub Run Valley. At the Pitt Spring mine, the ore is apparently developed only on the eastern limb of the syncline, where the rocks dip about 45 degrees to the northwest. On the western limb of the syncline, the beds are overturned, with the result that the coarse-grained limestones are topographically above the iron-rich shale source beds, restricting the possibilities for mineralization. Limonite fracture fillings, however, do occur in calcareous gray shale along Pitt Spring Run. Other iron deposits may be concealed by the thick cover of Massanutten Sandstone colluvium. Exposures of massive but porous limonite 3 to 10 ft (1-3 m) thick are in the two large open cuts at the Pitt Spring mine, but most of the material consists of limonite stringers, veins, and pods in a matrix of soft, ferruginous clay and shale. The massive limonite has a brecciated porous texture and contains numerous vugs coated or partly filled with manganese oxides, white clay, or, rarely, specular hematite. The Pitt Spring ore zone probably does not extend much beyond the southern pits of the Pitt Spring mine. The limestone and shale formations along this eastern limb of the syncline have been removed by erosion not far south of the Pitt Spring mine, and beyond this area only the Bloomsburg Formation and possibly the Tonoloway Limestone are present.

Parallel iron-bearing zones have been mined or prospected in Roaring Run Valley, immediately north of the study area and to the south in the study area along the western limb of the syncline along Cub Run Valley at least as far as the area between Lokey and Koontz Hollows. This western limb of the easternmost syncline is steeply dipping to overturned south of Koontz Hollow and was probably not favorable for significant iron deposition to the south.

Iron resources

Iron resources in Oriskany-type deposits are difficult to estimate without extensive trenching and drilling, which was not done during this study. In the area of the Pitt Spring mine, iron resources are probably restricted to the area of past mining or prospecting. The lack of significant amounts of limonite on the dumps of the small pits between the two large cuts and on strike beyond the cuts suggests that ore-grade material was found only in the area of the large cuts. The shape of the cuts indicates that ore was in tabular masses 5 to 15 ft (1.6-5 m) thick. The southern cut may have had 15 ft (5 m) of material that was mined; the northern cut is narrower and probably had 5-10 ft (1.6-3 m) of minable material. An ore grade of 40 percent iron, as given by Holden (1907, p. 433), probably represents the average grade of material mined. A tonnage factor of 13 cu ft per long ton[2] for rock in place (Morrison and Grosh, 1950, p. 13) is a reasonable estimate for this type of iron ore. The total length of open cut is about 500 ft (150 m) and the distance between the cuts is 500 ft (150 m). An additional 800 ft (240 m) along strike has been prospected but only the pits for 300 ft (100 m) northeast of the northern cut have much limonite on the dumps.

Assuming 200 ft (60 m) of strike length, 15 ft (5 m) of thickness, and 100 ft (30 m) of downdip extension for the southern ore body, and 300 ft (100 m) of strike length, 10 ft (3 m) of thickness, and 100 ft (30 m) of downdip extension for the northern ore body, we can calculate 600,000 cu ft (17,000 m^3) of ore-zone material. An additional 400,000 cu ft (11,000 m^3) of mineralized rock may be assumed in the area between the two large cuts and for 300 ft (100 m) northeast of the northern cut. Dividing by the tonnage factor (13 cu ft per long ton) yields inferred subeconomic resources of 80,000 long tons of limonitic material containing as much as 30,000 long tons of iron at the Pitt Spring mine.

The prospecting on the east slope of Third Mountain extends for a mile southwest of Pitt Spring Run, but only a few pits covering 1000 ft (300 m) or so of this distance have significant amounts of limonite on the dumps. Inferred resources in this area calculated for 1000 ft (300 m) of strike length, an average thickness of 5 ft (1.6 m), and a possible 100-ft (30-m) extension downdip amount to 500,000 cu ft (14,000 m^3) of rock or approximately 40,000 long tons of subeconomic iron resources containing 16,000 long tons of iron. The small size and shallow depth of the pits in this area and the lack of much limonite on the dumps of many of the pits suggest, however, that no mass of mineralized rock large enough to justify mining was discovered.

There is currently no market for Virginia's Oriskany-type iron resources, which occur in relatively small and discontinuous deposits of nonuniform grade. Modern blast furnaces require large tonnages of uniform-grade iron ores. Average phosphorous content of the Pitt Spring deposit is about 0.6 percent. Values exceeding 0.1 percent phosphorous are considered high for modern steel manufacturing. Consequently, the iron resources of Southern Massanutten Roadless Area are unlikely to be utilized in the foreseeable future.

Oil and gas resources

The probability that undiscovered resources of oil and natural gas occur in the Southern Massanutten Roadless Area is low. Based on the data available it would appear that no commercial quantities of gas or oil occur in the area because the rocks have been heated to temperatures at which oil and natural gas break down (high thermal maturation) and the structural setting is unfavorable for the accumulation of oil or gas (Wallace de Witt, Jr., USGS, 1981, written commun.).

Although the area has source beds for oil and gas, these occur only in the near-surface rocks. Reservoir rocks with original intergranular porosity and permeability are rare and appear to be present only in the near-surface beds that generally crop out on Massanutten Mountain. The general synclinal structure of the mountain favors migration of light fluid hydrocarbons to outcropping reservoir rocks rather than forming traps capable of retaining oil or gas. Zones of open fracture porosity may exist at depth associated with buried thrust faults and splay faults (Milici, 1980). High levels of thermal maturation of both source beds and reservoir rocks at the surface and probably at depth below the Pulaski thrust fault (Harris and others, 1978) preclude the existence of oil or commercial quantities of natural gas in the study area. The thermal maturity of the lowermost sedimentary rocks below the zone of thrust faulting (Harris, 1979, p. 529) is unknown, but this unit of rocks is probably thin and is an unlikely source of oil or gas (Wallace de Witt, Jr., USGS, 1981, oral commun.).

Other mineral commodities

Limestone in the Upper Silurian and Lower Devonian sequence is a potential source of crushed stone. The valley area surrounding Massanutten Mountain, however, is a major source of aggregate from much more extensive deposits of limestone and dolomite of Late Cambrian to Middle Ordovician age. Consequently the limestone in the study area is subeconomic.

Zinc sulfides sporadically occur as disseminations or fracture fillings in Cambrian- and Ordovician-age carbonates throughout the Shenandoah Valley (Herbert and Young, 1956). Some lead occurrences are also known. Several zinc prospects are located near the study area (fig. 1). Similar deposits may occur in the study area in these same formations at depths probably greater than 4,000 ft (1,200 m), but the cost of locating them would probably exceed the value of metals in them.

Manganese was mined with iron at localities in the Shenandoah Valley near the study area. Iron-rich materials sampled in the study area contain low concentrations of manganese, and no deposits of predominant manganese mineralization were observed.

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[1] Inferred resources are estimated extensions of a mineral deposit into areas for which there is geologic evidence of its continuity, beyond the points at which the resources were "demonstrated" or directly observed. Subeconomic resources are those which cannot be extracted with any certainty of a profit (U.S. Bureau of Mines and U.S. Geological Survey, 1980, p. 2).

[2] One long ton (2240 lbs) is nearly equal to one metric ton (2204.6 lbs).

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