COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

GEOLOGY OF THE MILLBORO QUADRANGLE VIRGINIA

SAMUEL J. KOZAK

REPORT OF INVESTIGATIONS 8

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
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DEPARTMENT OF PURCHASES AND SUPPLY
RICHMOND
1965

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GEOLOGY OF THE MILLBORO QUADRANGLE, VIRGINIA

By Samuel J. Kozak

ABSTRACT

Within the Millboro quadrangle of west-central Virginia, Upper Cambrian through Upper Devonian sedimentary rocks have an aggregate thickness of approximately 15,000 feet. Cambrian and Ordovician dolomites, limestones, and shales are restricted in outcrop to the southeast part of the quadrangle; Silurian and Devonian rocks are mainly restricted to that part of the quadrangle northwest of North Mountains.

Deformation of rocks in the Millboro quadrangle can be dated only as post-Chemung. Rock strata are more intensely deformed in the southeast part of the quadrangle and faults and folds are common. To the northwest faults are absent, and folds are more open and less overturned than those to the southeast.

Lower to Middle Ordovician dolomite and limestone, and Upper Silurian and Lower Devonian limestone are potential sources for commercial use; and Lower to Middle Silurian sandstone and Lower Devonian sandstone, sources of silica sand. Ordovician and Devonian shales, as well as residual and Quaternary clays, are potential sources of commercially valuable clay deposits.

DESCRIPTION OF AREA

The Millboro quadrangle includes approximately 235 square miles between latitudes 37° 45′ and 38° N., and longitudes 70° 30′ and 79° 45′ W. in west-central Virginia. Parts of four counties, Rockbridge, Bath, Alleghany, and Botetourt, are included within the quadrangle. Major highways include U. S. Highway 60 which follows a sinuous east-west route across the quadrangle, State Highway 42 in the northwest portion, State Road 780 in the northeast portion, and State Highway 251 and State Roads 643 and 672 in the southeast portion of the quadrangle. The Chesapeake and Ohio Railway extends across the

northern part of the quadrangle. Goshen, the largest town in the quadrangle, is in the northeast corner. Other towns include Millboro and Millboro Springs in the north-central part, and Collierstown in the south-central part.

The Millboro quadrangle lies wholly in the Valley and Ridge province of the Appalachian Highlands. In the southeast part of the quadrangle southeast of North Mountains, elevations average about 1400 feet, and the rolling topography has a relief of about 200 to 300 feet. Exceptions to this are Big House Mountain and Little House Mountain where resistant Silurian sandstones rise to elevations of 3640 feet and 3360 feet respectively, towering about 2000 feet above the valley floor. From North Mountains northwestward the topography has a northeast-southwest trending, linear character. Mountain crests range from 2000 feet to 3200 feet in elevation. Topography is strongly controlled by structure. Mountain crests are anticlinal, synclinal, and monoclinal; valleys generally occupy synclinal areas underlain by Devonian shales. Mountains in the quadrangle include, from southeast to northwest, North Mountains, Brushy Mountain, Mill Mountain, Short Mountain, Rough Mountain, and Beards Mountain. The highest point in the quadrangle is Big House Mountain, at an elevation in excess of 3640 feet. The lowest point is along the Cowpasture River where it enters the Clifton Forge quadrangle south of Sharon Church along the western margin of the Millboro quadrangle. Total relief in the quadrangle is approximately 2600 feet.

Only one major river, the Cowpasture River, is present in the quadrangle. Flowing southwestward along the western side of the quadrangle, the Cowpasture River forms a part of the James River drainage system. Numerous creeks drain the quadrangle; largest of these are Colliers Creek, Buffalo Creek, Kerr Creek, Bratton Creek, Simpson Creek, Pads Creek, and Mill Creek. The drainage pattern appears structurally controlled and is predominantly a trellis pattern. Radial drainage is evident about Big and Little House mountains. The Cowpasture River appears to be in part structurally controlled, following the strike of the structure, and in part transverse. Along its course in the Millboro quadrangle the Cowpasture River is an entrenched, meandering stream.

ACKNOWLEDGEMENTS

Field work for this study was carried out primarily during the summers of 1962, 1963, and 1964 under the auspices of the Virginia Division of Mineral Resources. Support from the Division and the cooperation of the residents of the Millboro quadrangle are here acknowledged. Special thanks are expressed to E. W. Spencer and O. S. McGuire who contributed time both in the field and in discussions. James W. Head served as field assistant during the summer of 1963. His comments on the geology of the Kerr Creek area that he mapped during the summer of 1964 are appreciated.

GEOLOGIC FORMATIONS

CAMBRIAN SYSTEM

Conococheague Formation

The only occurrence of the Conococheague Formation mapped in the Millboro quadrangle is in the vicinity of Brushy Hill, Spring Valley, and Dry Hollow. It is conformably overlain by the Chepultepec Formation (Table 1). Exposures are scarce and neither the upper nor lower contacts were observed. The Conococheague Formation is predominantly a fine-grained, medium- to dark-gray dolomite with minor amounts of fine-grained, rusty-weathering sandstones. Wavy laminae of siliceous material stand in relief on weathered surfaces and, along with the sandstone units, serve as identification of the Conococheague.

ORDOVICIAN SYSTEM

Chepultepec Formation

The Chepultepec Formation is nowhere recognized in the Millboro quadrangle; its presence is inferred between the underlying Conococheague Formation and overlying Beekmantown Formation from exposures in the southwestern part of the adjacent Lexington quadrangle (Bick, 1960). The formation as described in the Lexington quadrangle (Bick, 1960) consists of 400 to 600 feet of thick-bedded, fine-grained, dark bluish-gray limestone with only minor amounts of dolomite.

Table 1.—Stratigraphic units in the Millboro quadrangle.

	Map Unit	*Other Stratigraphic Units Included with Map Units*
Devonian	Chemung Formation	
	Brallier Formation	
	Millboro Shale	Needmore Shale
	Oriskany Sandstone	
	Helderberg Group	Licking Creek Limestone New Scotland Formation Coeymans Limestone
Silurian	Keyser Formation	Clifton Forge Member
	Cayuga Group	Tonoloway Limestone Wills Creek Formation McKenzie Limestone
	Clinton Formation	Keefer Member Cacapon Member
	Tuscarora Formation	
Ordovician	Martinsburg Formation	Oswego Sandstone Juniata Formation
	Edinburg Formation	Collierstown Limestone Liberty Hall facies Lantz Mills facies Botetourt Member
	Lincolnshire Formation	Whistle Creek Limestone
	New Market Limestone	
	Beekmantown Formation	
	Chepultepec Formation	
Cambrian	Conococheague Formation	

Beekmantown Formation

The Beekmantown Formation is conformable with the underlying Chepultepec Formation and disconformable with the overlying New Market Limestone and Whistle Creek Limestone. The lower contact was not observed in the Millboro quadrangle; the upper contact is exposed in several localities. The Beekmantown Formation is predominantly a thick-bedded, fine-grained, light to medium blue-gray dolomite. Irregular light-gray chert nodules characterize the formation, and in many places a residue of chert scattered in the soil supplies the only indication of its presence. Thick-bedded, medium bluish-gray limestone units occur sparingly in the formation. Estimated thickness of the Beekmantown Formation is 1500 feet.

New Market Limestone

The New Market Limestone disconformably overlies the Beekmantown Formation and is conformably overlain by the Lincolnshire Formation. Exposures of the New Market Limestone are restricted to the southeast quarter of the Millboro quadrangle. An excellent exposure is located along State Highway 251 and Colliers Creek a few hundred feet east of State Road 644 (long 79° 33′30″ W., lat 37° 46′08″ N.). Detailed descriptions of this section are included in reports by Cooper and Cooper (1946, Section 42) and Edmundson (1958, p. 47-48). The New Market Limestone is composed of massively bedded, aphanitic to fine-grained, medium-gray to dove-gray limestone. In many places crystals of clear calcite about a millimeter in diameter create a "birds eye" appearance. Black chert nodules are present locally. Where the New Market Limestone is present, it may be greater than 120 feet thick. This thickness may be in part a function of the relief of the Beekmantown surface upon which deposition took place. The lower contact locally contains a well-developed conglomerate of Beekmantown boulders in a matrix of New Market Limestone.

Lincolnshire Formation

The Lincolnshire Formation is conformable with the underlying New Market Limestone and is overlain by the Edinburg Formation. A disconformable relationship may exist locally

where the New Market Limestone is absent and the Lincolnshire Formation is in contact with the Beekmantown Formation.

The Whistle Creek Limestone has been recognized as a distinctive unit between the New Market Limestone and the Lincolnshire Formation. Because of lithologic similarities in the Whistle Creek and Lincolnshire in the Millboro quadrangle, the writer could not consistently distinguish between the two formations and has included the Whistle Creek Limestone with the Lincolnshire Formation for mapping purposes.

Exposures of the Lincolnshire Formation in the Millboro quadrangle are restricted to the southeast quarter of the quadrangle southeast of a line connecting Collierstown and House Mountain Church. A complete section of Lincolnshire is exposed along State Highway 251 and Colliers Creek. The lower part of the unit, corresponding to the Whistle Creek Limestone, is characteristically a thin-bedded, medium-grained, medium- to dark-gray to bluish-gray limestone. Black chert nodules are locally very abundant. The upper part of the unit, corresponding to the Murat facies of the Lincolnshire Formation, is characterized by thick-bedded, massive, coarse-grained, light-gray limestone. Interbedded with the Murat-type lithology are units of cherty, medium-grained, medium- to dark-gray limestones similar to limestones in the lower part of the unit.

Thickness of the Lincolnshire Formation in the measured section along State Highway 251 and Colliers Creek is 400 feet; the lower 165 feet comprises the Whistle Creek Limestone, the upper 235 feet, the Lincolnshire Formation (Cooper and Cooper, 1946; Edmundson, 1958). East of State Road 676, the undifferentiated Whistle Creek-Lincolnshire section is 353 feet thick (Edmundson, 1958).

Edinburg Formation

The Edinburg Formation conformably overlies the Lincolnshire Formation and is conformably overlain by the Martinsburg Formation. The lower 10 to 60 feet of the Edinburg, the Botetourt Member, is composed of medium- to corase-grained, reddish-weathering, fossiliferous limestone. Above the Botetourt Member two principal lithologies are interbedded; their stratigraphic relationship differs with geographic location. Fine-grained, dense, black, thin-bedded limestone units separated by

buff-weathering, fissile black shale constitute the Liberty Hall facies. This facies alternates with nodular, fine-grained, black limestone with little or no shale, the Lantz Mills facies. Up to 60 feet of medium- to coarse-grained, medium-gray, slightly argillaceous, fossiliferous limestone, the Collierstown Limestone, overlies the Edinburg Formation proper. Because the Collierstown is relatively thin, lacks geographic continuity, and is lithologically similar to parts of the Edinburg Formation, the unit is included within the Edinburg for mapping purposes. The thickness of the Edinburg within the Millboro quadrangle is difficult to determine because of deformed rocks within the formation. Estimated thickness within the quadrangle is 1000 feet.

Martinsburg Formation

The Martinsburg Formation conformably overlies the Edinburg Formation and is disconformably overlain by the Tuscarora Formation. Locally, along the east side of North Mountains, along State Road 770 between Collierstown and Long Dale Furnace, the Martinsburg may be conformably overlain by the Juniata Formation and Oswego Sandstone. Because of lateral variations in thickness and poor exposure, the reddish shales and greenish sandstones have been included with the Martinsburg Formation for mapping purposes.

The Martinsburg is composed of yellowish-weathering, light-gray, fissile, calcareous shales that are fossiliferous in many places. Fine-grained, medium-gray, thin-bedded limestone units are common. The formation is strongly susceptible to weathering, and good outcrops of the shaly portions of the formation are rare. Although the formation is poorly exposed, its presence can be recognized by the occurrence of distinctive yellowish-weathering shale fragments in the soil. The base of the Martinsburg is taken at the base of the first thick shale unit above Edinburg-type limestone. The top is taken at the base of the first overlying massive gray sandstone unit. Because of poor exposure and the incompetent structural behavior of the Martinsburg, its thickness could not be measured in the Millboro quadrangle. Estimated thickness of the Martinsburg in the adjacent Lexington quadrangle is 1000 to 2000 feet (Bick, 1960).

SILURIAN SYSTEM

Tuscarora Formation

The Tuscarora Formation disconformably overlies the Martinsburg Formation and is conformably overlain by the Clinton Formation. Locally the Tuscarora is underlain by reddish shales and poorly sorted greenish sandstones which have been tentatively correlated with the Juniata Formation and Oswego Sandstone respectively. The base of the Tuscarora is taken at the base of the first massive gray sandstone unit overlying the Martinsburg; the top is taken at the base of the first overlying red sandstone. The Tuscarora is a well-sorted, fine- to medium-grained, strongly cemented, massively bedded, light- to medium-gray to brownish-gray sandstone. Conglomeratic lenses are common near the base. It crops out along the east flank of North Mountains, and generally forms the lowest prominent cliffs. The thickness of the Tuscarora Formation is estimated to range from 40 to 200 feet within the Millboro quadrangle.

Clinton Formation

The Clinton Formation conformably overlies the Tuscarora Formation and may be disconformable with the overlying Cayuga Group. The lower contact is placed at the base of the lowest reddish sandstone or shale unit above the gray sandstones of the Tuscarora; the upper contact is not exposed but is mapped at the top of the uppermost sandstone of the Keefer Member.

Two markedly different lithologies have been recognized in the Clinton Formation within the Millboro quadrangle, but the paucity of exposure has made it impractical to map them separately. The lowermost 200 feet of the Clinton, the Cacapon Member, is composed of shale, siltstone, and sandstone ranging in color from brownish red to maroon, to gray, to green. Thin beds of red, maroon, and reddish-gray hematitic sandstone are common; and where the formation is poorly exposed, fragments of these hematitic units readily indicate the presence of the Cacapon Member. The upper part of the Clinton Formation, the Keefer Member, is a well-indurated, well-sorted, fine- to medium-grained, thick-bedded, gray sandstone. Its separation from the Tuscarora is difficult and accomplished with confidence only where the Cacapon Member can be recognized and the

upper surfaces of beds determined. Thickness of the Clinton Formation in the Millboro quadrangle is estimated to be up to 700 feet.

Cayuga Group

The Cayuga Group may disconformably overlie the Clinton Formation and is conformably overlain by the Keyser Formation. Exposures of the Cayuga Group are sparse, and its presence is inferred only from isolated outcrops of Tonoloway Limestone within and adjacent to the quadrangle. The group includes the McKenzie Limestone, the Wills Creek Formation, and the Tonoloway Limestone, all of which, because of their thin beds, have been mapped as a single unit. Neither the McKenzie Limestone nor the Wills Creek Formation is exposed within the Millboro quadrangle.

Keyser Formation

The Keyser Formation conformably overlies the Cayuga Group and is conformably overlain by the Helderberg Group. The lower contact is taken at the top of the fine-grained, dark-gray, distinctively laminated limestone of the Tonoloway Formation underlying medium- to coarse-grained, medium-gray, nodular limestones of the Keyser. The upper contact is placed at the base of an overlying, very coarse-grained, gray and pink mottled, crinoidal limestone.

Outcrops of the Keyser Formation are scarce within the Millboro quadrangle; however, a complete section has been described along State Highway 42 approximately 7 miles southwest of Millboro Springs (Edmundson, 1958, p. 75). The lower 50 feet of the formation is composed of coarse-grained, light- to dark-gray, medium-bedded, somewhat nodular limestones with a few chert nodules. Overlying these limestones is 70 feet of the Clifton Forge Member that is composed of medium-grained, medium- to thick-bedded, light-gray sandstone with some thin beds of dark-gray shales and dark-gray, fine-grained limestones. An upper limestone member of the Keyser, above the Clifton Forge Member consisting of 25 feet of limestone similar to the lower limestone member but lacking chert, is recognized in the Millboro quadrangle.

DEVONIAN SYSTEM

Helderberg Group

The Helderberg Group conformably overlies the Keyser Formation and is conformably overlain by the Oriskany Sandstone. A three-fold lithologic division can be recognized in the Helderberg Group, but the units are too thin to be mapped separately at the scale of 1:62,500. The oldest of these, the Coeymans Limestone, comprises the lower 10 to 15 feet of the group and consists of a coarse-grained, light-gray to pink mottled, crinoidal limestone. The Coeymans is conformably overlain by the New Scotland Formation, a heterogeneous unit of limestone, arenaceous limestone, and sandstone 20 to 30 feet thick. The upper 145 feet of the Helderberg Group, the Licking Creek Limestone, is composed of dark-gray to dark bluish-gray, medium-grained limestone that is cherty in many places. Exposures of the Helderberg are scarce in the Millboro quadrangle and are virtually restricted to the northern part of the quadrangle in the vicinity of Millboro Springs and along State Highway 42 approximately 7 miles southwest of Millboro Springs, where a structurally deformed, composite section has been described (Edmundson, 1958, p. 74-75).

Oriskany Sandstone

The Oriskany Sandstone conformably overlies the Helderberg Group and is conformably overlain by the Needmore Shale. The lower contact is placed at the base of sandstones overlying the Licking Creek Limestone. The upper contact is placed at the base of the lowest overlying light-gray to olive-drab shale of the Needmore or fissile black shale of the Millboro. Because of the susceptibility to weathering of the overlying shales, the contact is exposed only in a few places, and the presence of the Needmore throughout much of the quadrangle can only be inferred. The Oriskany is composed of medium- to coarse-grained, white, locally calcareous sandstone. In many places weathered surfaces are yellowish brown and extremely friable. A complete section of Oriskany Sandstone exposed along the Chesapeake and Ohio Railway a few hundred feet north of the Millboro quadrangle at the west end of Panther Gap has a thickness of 30 feet.

Millboro Shale

The Millboro Shale is conformably overlain by the Brallier Formation and conformably overlies the Needmore Shale. Because of its relative thinness and lack of exposure, the Needmore Shale is included with the Millboro Shale for mapping purposes. The upper contact is placed at the base of a thick sequence of light-gray to brown to olive-drab shales, siltstones, and sandstones. The lower contact is placed at the base of light-gray to olive-drab shales underlying a thick sequence of fissile black shales.

The Millboro is composed of fissile black shale that bleaches on weathering to a light gray. In a few places large, symmetrical, lenticular concretions of limestone and pyrite are present in the black shale. The thickness of the Millboro is difficult to determine because of its susceptibility to weathering and high degree of deformation in the Millboro quadrangle. Butts (1940) estimated a thickness of about 1000 feet at its type locality in the vicinity of Millboro Springs in the Millboro quadrangle and Pig Run in the Williamsville quadrangle. Estimations made by constructing geologic cross sections indicate that locally it may be 500 feet thick.

Brallier Formation

The Brallier Formation conformably overlies the Millboro Shale and is conformably overlain by the Chemung Formation. The base of the Brallier Formation is placed at the base of a thick sequence of light-gray to brown to olive-drab fissile to subfissile shales, siltstones, and sandstones. The upper contact is not exposed in the Millboro quadrangle and in mapping was approximately located on the basis of float from the overlying Chemung Formation. The Brallier is composed of thin, regularly bedded, fissile to subfissile, micaceous, light-gray to brown to olive-drab shales, siltstones, and very fine-grained sandstones. Locally beds of fissile black shale, similar to Millboro-type shales, occur within the Brallier making identification of small isolated outcrops in structurally deformed areas somewhat questionable. A thickness of about 1700 feet is estimated for the Brallier Formation in the Millboro quadrangle.

Chemung Formation

In areas adjacent to the Millboro quadrangle the Chemung Formation conformably overlies the Brallier Formation, and is conformably overlain by the Hampshire Formation. Its presence is inferred by the occurrence of float on Beards, Rough, and Short mountains in the northwestern part of the Millboro quadrangle. The float is composed of fine- to medium-grained, grayish-green to reddish sandstones and shales containing large fossils that serve to distinguish the Chemung from the Brallier (Butts, 1940, p. 322).

STRUCTURAL GEOLOGY

Deformation appears more intense in the southeastern part of the quadrangle where relatively small overturned folds and low-angle thrust faults dip southeastward. Toward the northwest, overturning is not as widespread and there are few faults. Folds in competent sandstones and limestones are generally larger than those in less competent shales and thinly bedded limestone and shale sequences in a given area. However, lithologically similar units such as the Martinsburg, Millboro, and Brallier shales locally are as intensely deformed in the northwest as in the southeast, although fissility at angles to the bedding is more highly developed in the Martinsburg Formation in the southeast than in either the Millboro Shale or Brallier Formation in the northwest.

Three faults of considerable extent were recognized in the geosyncline which during much of the Paleozoic Era subsided easterly dips. In the southeast the Conococheague, Chepultepec, and Beekmantown are faulted against the New Market, Lincolnshire, and Beekmantown. Bedding locally is steep and overturned. A branch of the Little North Mountain fault, mapped in the Lexington quadrangle by Bick (1960), extends across the Millboro quadrangle along a line from the community of Kerr Creek (Lexington quadrangle) through a point midway between Collierstown and Effinger School to the south boundary of the Millboro quadrangle. Parts of the New Market, Lincolnshire, and Beekmantown have been thrust northwestward over the Edinburg and Lincolnshire. A third fault, previously unmapped, extends northeastward from the south border of the quadrangle along the southeast flank of North Mountains for approximately

5 miles to where it crosses to the northwest flank and can be traced no farther. The Martinsburg, Tuscarora, and Clinton are thrust northwestward over equivalent stratigraphic units.

Folds in the southeastern part of the quadrangle lack continuity, having been truncated by faults, and have little relationship to the present topography. Towards the northwest folds are more continuous. Ridges and mountains generally consist of monoclinal or anticlinal structures in Silurian and Devonian sandstones and carbonates, with the exception of Beards, Rough, and Short mountains which are synclinal. Principal ridge formers are the Tuscarora and Clinton sandstones. Valleys are generally wide and flat bottomed in synclines composed of the Millboro and Brallier shales near the surface. Portions of folded structures recognized by Butts (1940) are in the Millboro quadrangle. The Deerfield anticline bifurcates several miles to the north; the southeast branch, the Panther Gap branch, continues southwestward along Mill Mountain through an area near Sharon. The northwest branch, the Millboro Springs branch, trends southwestward to the west of Millboro Springs forming a low unnamed anticlinal hill immediately to the southeast of the Cowpasture River between Beards Mountain and Rough Mountain. The McClung syncline, a single structural element in the Williamsville quadrangle, extends through the Millboro quadrangle where it becomes divided into a number of subsidiary synclines by the Millboro Springs and Panther Gap branches of the Deerfield anticline.

The Millboro quadrangle lies along part of the Appalachian geosyncline which during much of the Paleozoic Era subsided with respect to adjacent cratonal areas and served as the site of deposition of a relatively thick sequence of sedimentary rocks. Rocks ranging in age from Late Cambrian to Late Devonian occur in the same structural trend and can be dated only as post-Chemung (Late Devonian) on the basis of features observed within the Millboro quadrangle. The intensity of deformation does appear to decrease across strike toward the northwest. Vertical changes in lithology support the concept of periods of orogenic activity separated by periods of relative quiescence, but do not indicate whether these periods of activity are individual orogenic episodes or pulses of a single deformation periodically increasing in intensity.

ECONOMIC GEOLOGY

CARBONATE ROCKS

Carbonate rocks of Cambrian, Ordovician, Silurian, and Devonian age crop out in many parts of the Millboro quadrangle. Edmundson (1958) discusses in some detail the carbonates of the James River district west of the Blue Ridge including the area within the Millboro quadrangle, and interested readers are referred to his work for detailed discussions and chemical analyses of the various units.

The main body of carbonate rocks within the Millboro quadrangle is in the Collierstown-Rapps Mill area (Edmundson, 1958, p. 44-50). A few units aggregating a thickness of 50 to 140 feet of high-calcium limestones are present. The commercial value of these units is, however, minimized by the impure character of strata interbedded with the high-calcium limestones. At the present time no carbonate rocks are being actively quarried within the Millboro quadrangle, although numerous small abandoned quarries give evidence of periodic small-scale operations in the past.

SILICA SAND

The Tuscarora Formation, the Keefer Member of the Clinton Formation, and the Oriskany Sandstone are potential sources of silica sand in the Millboro quadrangle. Each of these units has been mined for silica sand elsewhere in the Valley and Ridge province. One of these is presently being quarried by the Locher Silica Corporation near Goshen (Plate 1). When permission is granted to gain admittance to the quarry, the geologic map in this area may be modified upon examination of the exposures.

CLAY AND SHALE

Calver, Smith, and LeVan (1964) describe the potential use of clay and shale from the general area in and adjacent to the Millboro quadrangle. Samples collected about 2 miles west of Collierstown (R-1670) and about 0.5 mile northeast of Rockbridge Alum Springs (R-1669) are representative of shales that have potential use in brick and tile manufacture. Shale similar to sample R-1669 may be utilized as raw material in the produc-

tion of lightweight aggregate. About 0.7 mile northeast of Lone Star Church is a shale (R-1987) that may have possible use for brick manufacture. Some of the stratigraphic units that were tested include shales from the Millboro, Brallier, and Martinsburg, as well as residual and Quaternary clays. At the present time there are no operations utilizing clay or shale resources in the Millboro quadrangle.

IRON ORE

In the past, a number of iron-ore mines have been operated within the quadrangle, and several of these located along the southeast side of Brushy Mountain and Mill Mountain are reported by Watson (1907) to have had the greatest total production of iron ore of any mines in the State. Except for the Long Dale Furnace commemorated by a State historical marker along U. S. Highway 60, there is little evidence of the former mining activity. No iron ore is being mined at present in the Millboro quadrangle. The iron ore was obtained from mines in the upper part of the Devonian carbonate sequence (Licking Creek Limestone) and from the overlying Oriskany Sandstone. The iron oxide in these ores is thought to have originally been disseminated in the Devonian shales overlying the Oriskany Sandstone and Licking Creek Limestone. As the shale weathered, the iron in solution moved downward and either replaced the carbonates or filled existing cavities. Generally minable quantities of iron ore occurred in the carbonates. Hematitic beds characterize the Cacapon Member of the Clinton Formation and in the past have been mined near Low Moor and near Iron Gate in the Clifton Forge area. Nowhere within the Millboro quadrangle has the writer seen sufficient concentrations of ore to encourage more detailed exploration.

REFERENCES

Bick, K. F., 1960, Geology of the Lexington quadrangle, Virginia: Virginia Division of Mineral Resources Rept. Inv. 1, 40 p.

Butts, Charles, 1940, Geology of the Appalachian Valley in Virginia: Virginia Geol. Survey Bull. 52, pt. 1, 568 p.

Calver, J. L., Smith, C. E., and LeVan, D. C., 1964, Analyses of clay, shale and related materials—west-central counties: Virginia Division of Mineral Resources Mineral Resources Rept. 5, 230 p.

Cooper, B. N., and Cooper, G. A., 1946, Lower Middle Ordovician stratigraphy of the Shenandoah Valley, Virginia: Geol. Soc. America Bull., vol. 57, p. 57-92.

Edmundson, R. S., 1958, Industrial limestones and dolomites in Virginia; James River district west of the Blue Ridge: Virginia Division of Mineral Resources Bull. 73, 137 p.

Watson, T. L., 1907, Mineral resources of Virginia: Lynchburg, Virginia, J. P. Bell Company, 618 p.

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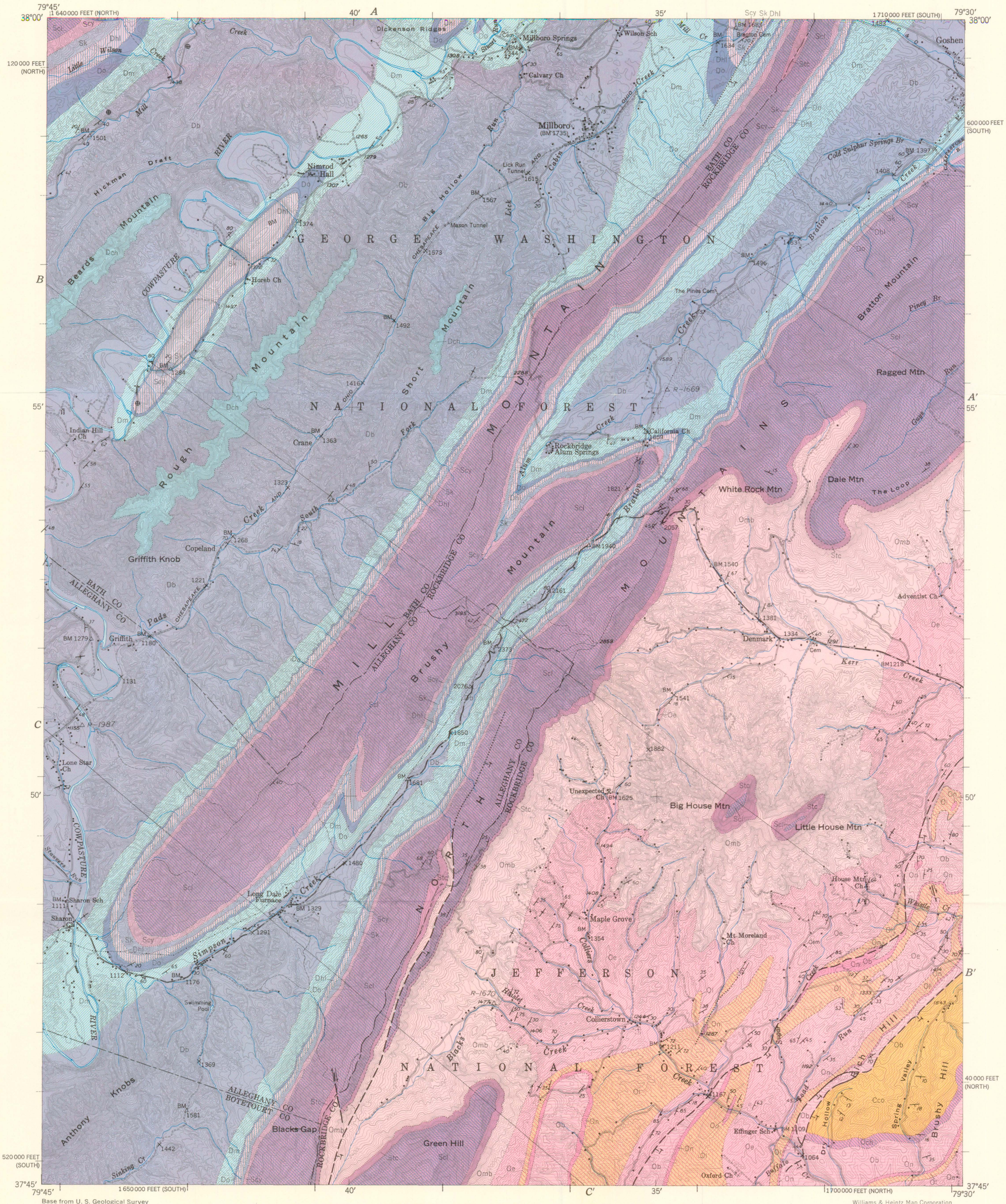
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist

REPORT OF INVESTIGATIONS 8
PLATE 1



GEOLOGIC MAP OF THE MILLBORO QUADRANGLE, VIRGINIA

Geology by S. J. Kozak

Scale 1/62500

1/2 0 1 2 3 4 Miles

1000 500 0 1000 2000 3000 4000 5000 6000 7000 Yards

1000 0 3000 6000 9000 12000 15000 18000 Feet

Contour interval 20 feet

Datum is mean sea level

1965

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EXPLANATION

DEVONIAN
- Dch — Chemung Formation
- Db — Brallier Formation
- Dm — Millboro Shale
- Do — Oriskany Sandstone
- Dhl — Helderberg Group

SILURIAN
- Sk — Keyser Formation
- Scy — Cayuga Group
- Scl — Clinton Formation
- Stc — Tuscarora Formation

ORDOVICIAN
- Omb — Martinsburg Formation
- Oe — Edinburg Formation
- Ol — Lincolnshire Formation
- On — New Market Limestone
- Ob — Beekmantown Formation
- Och — Chepultepec Formation

CAMBRIAN
- €co — Conococheague Formation

CONTACTS
- exposed
- approximate
- covered

FAULTS
THRUST
- exposed
- approximate
- covered
- T—overthrust side

TRANSVERSE
- exposed
- approximate
- Arrows indicate relative movement

ATTITUDE OF ROCKS
- Strike and dip of beds
- Strike and dip of overturned beds
- Strike of vertical beds
- Horizontal beds
- R-1669 △ Clay and shale localities

No Vertical Exaggeration