COMMONWEALTH OF VIRGINIA

VIRGINIA CONSERVATION COMMISSION

VIRGINIA GEOLOGICAL SURVEY

ARTHUR BEVAN, *State Geologist*

Bulletin 66

Industrial Limestones and Dolomites in Virginia: Clinch Valley District

By

BYRON N. COOPER

UNIVERSITY, VIRGINIA
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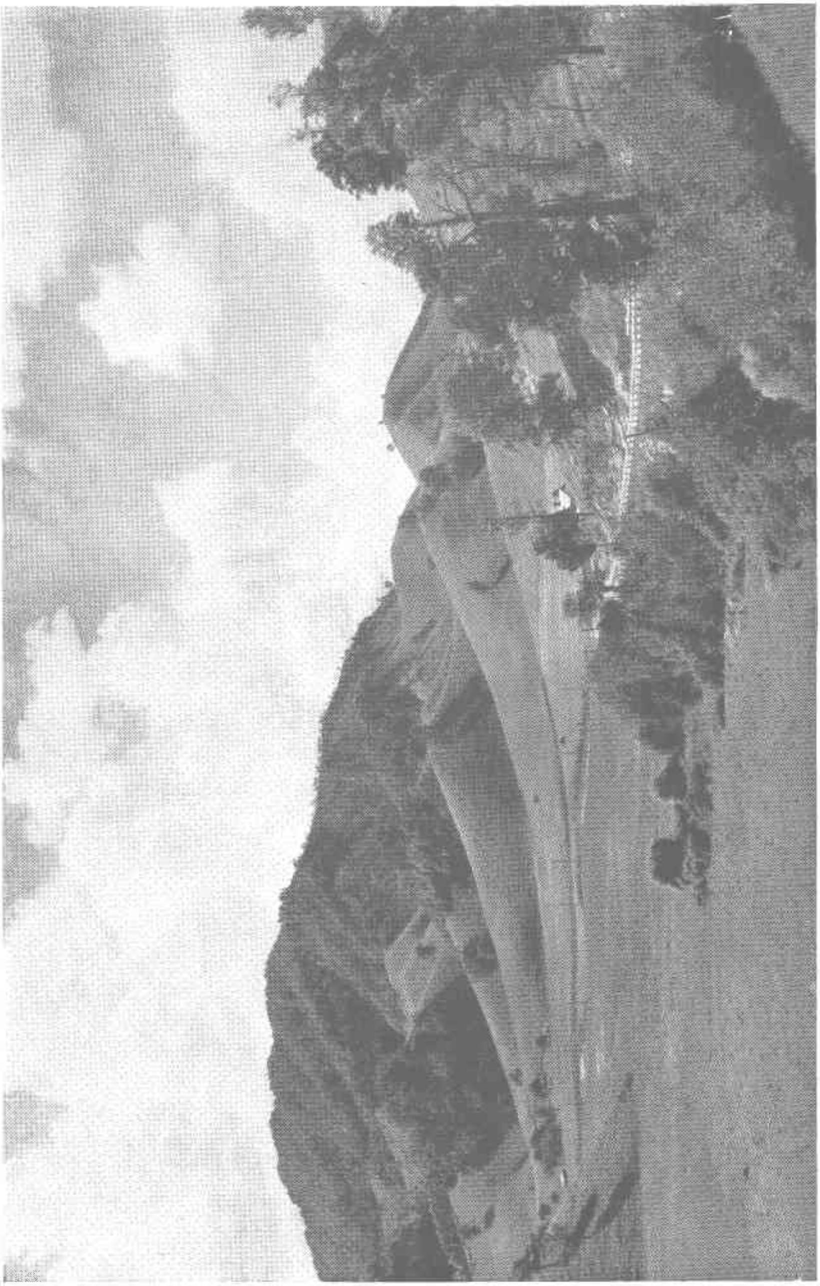
East end of Paint Lick Mountain, near Tazewell, Virginia. Photograph by Bob Harmon.



East end of Paint Lick Mountain, near Tazewell, Virginia. Photograph by Bob Harmon.

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FOREWORD

This report embraces the results of detailed studies of limestones and dolomites of present and potential future industrial importance in Tazewell and Russell counties and a part of Scott County, Virginia. The manuscript and illustrations were submitted to the printer on September 10, 1945, during the administration of Doctor Arthur Bevan as State Geologist. Because of unprecedented difficulties and delays, most of which were beyond the control of the Virginia Geological Survey, this Bulletin was not printed and delivered to us until the date indicated below.

On September 1, 1947, the undersigned was appointed State Geologist of Virginia to succeed Doctor Arthur Bevan who resigned on that date.

WILLIAM M. MCGILL,
State Geologist.

VIRGINIA GEOLOGICAL SURVEY,
Box 1428, University Station,
Charlottesville, Virginia,
August 15, 1951.

LETTER OF TRANSMITTAL

COMMONWEALTH OF VIRGINIA
VIRGINIA GEOLOGICAL SURVEY
UNIVERSITY OF VIRGINIA

CHARLOTTESVILLE, VA., *September* 10, 1945.

To the Virginia Conservation Commission:

GENTLEMEN:

I have the honor to transmit for publication as Bulletin 66 of the Virginia Geological Survey, the text and illustrations of a report on *Industrial Limestones and Dolomites in Virginia: Clinch Valley District,* by Dr. Byron N. Cooper, Associate Geologist of the Virginia Geological Survey.

This report is the third in a series on the limestones and dolomites of present and future industrial value in the State. As the investigations are completed, additional reports in the series will be issued until all of the industrial limestones and dolomites of Virginia have been discussed.

Bulletin 66 contains a discussion of these carbonate rocks in three counties in southwestern Virginia. These counties are Tazewell, Russell, and part of Scott. The geologic data given in the report are primarily those of industrial significance, with sufficient scientific discussion of the stratigraphy and structure of the formations. The measured geologic sections and the chemical analyses of representative field samples are of particular value. The high quality of many of the limestones and dolomites is notable.

Respectfully submitted,

ARTHUR BEVAN,
State Geologist.

Approved for publication:
Virginia Conservation Commission,
Richmond, Virginia, September 11, 1945.
R. A. GILLIAM, *Executive Secretary and Treasurer.*

CONTENTS

PAGE

ILLUSTRATIONS

TABLES

Industrial Limestones and Dolomites in Virginia: Clinch Valley District

By Byron N. Cooper*

ABSTRACT

Clinch Valley, in southwestern Virginia, contains extensive deposits of high-grade limestone and dolomite suitable for industrial use. Some of the thickest occurrences are favorably situated close to a railroad and only a few miles from available supplies of bituminous coal. Considering the quality of the available rock, conditions for quarrying or mining, and the cost of fuel, the cost of producing lime is less in Clinch Valley than in any other section of the Appalachian Valley of Virginia.

Favorable sites for possible industrial development were determined by detailed study of the exposed rocks, by chemical analyses of carefully sampled thicknesses of various rock units, and by tracing and mapping of the geologic formations. The report contains geologic maps showing the distribution of the limestones and dolomites and many geologic sections showing the character, thickness, and chemical composition of the more important units. Tonnage estimates of the amount of rock obtainable by quarrying or shallow mining are given for the most important localities.

Thick occurrences of high-calcium limestone are rather persistent along the northwest base of Clinch Mountain from Elk Garden, Russell County, to the Virginia-Tennessee line. The most favorable areas for large-scale quarryng of high-calcium limestones are along the Norfolk and Western Railway between Pounding Mill and Bluefield, Tazewell County, and along the Southern Railway between Gate City and Speers Ferry, Scott County. In the Copper Creek-Clinch River belt thick bodies of high-calcium limestone are of local extent and represent complex facies variations.

Nearly inexhaustible reserves of high-magnesium dolomite averaging 42 per cent magnesium carbonate and less than 4 per cent of noncarbonates, occur along the Norfolk and Western Rail-

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way in the vicinity of Cedar Bluff and Wittens Mills in Tazewell County and also between Honaker and Carterton in Russell County.

Most of the limestones and dolomites in Clinch Valley could be used for crushed stone and are available in any desired quantity. Suitable sites for obtaining road stone or agstone can be determined from the geologic sections, chemical analyses, and the accompanying geologic maps included in this report.

INTRODUCTION

LOCATION

The Clinch Valley district discussed in this report is situated in the southern Appalachian Valley, northwest of Clinch Mountain, and west of Bluefield, Virginia-West Virginia (Fig. 1). Most of this district is drained by the Clinch River, one of the principal tributaries of the Tennessee. Clinch Valley with an average width of 10 to 12 miles is bordered on the east by Clinch Mountain, the highest ridge in the southern Appalachian Valley, and on the west by the bold east facing escarpment of the Cumberland-Allegheny Plateau (Fig. 1). The mountains bordering the Clinch Valley district have been rather effective barriers to the development of highways and railroads. For example, Clinch Mountain is crossed by only two paved highways between the northeastern end of the mountain and the Tennessee line. U. S. Route 19 follows the broad sag or col in Clinch Mountain south of Hansonville, Russell County. Big Moccasin Gap, southeast of Gate City, Scott County, is utilized by U. S. Routes 23 and 58 and by the Southern Railroad. The Clinchfield Railroad, extending to the coal fields in western Russell County, cuts through Clinch Mountain by a tunnel. The northwestern part of the Clinch Valley district is traversed by the Norton Division of the Norfolk and Western Railway. These railroads connect with main lines serving the Ohio Valley and the Atlantic seaboard. A growing system of paved highways provides access to most sections of the Clinch and Powell valley districts, but the rugged topography still serves to isolate some areas.

FIELD WORK

Most of the field work on which this report is based was done during the summer of 1942. Some additional sections were measured and samples of rock for chemical analysis were collected during the spring of 1944. Use was made of all available published maps, particularly the geologic maps in U. S. Geological Survey folios[14, 15, 16, 17] and the Geologic Map of the Appalachian Valley of Virginia.[3]

Only the purer limestones and dolomites, suitable for large scale industrial use, were studied in detail. Much time was given to the measurement of geologic sections and the collection of samples for chemical analysis, which are the essence of this report. Some of the samples were analyzed by Prof. John H. Yoe of the

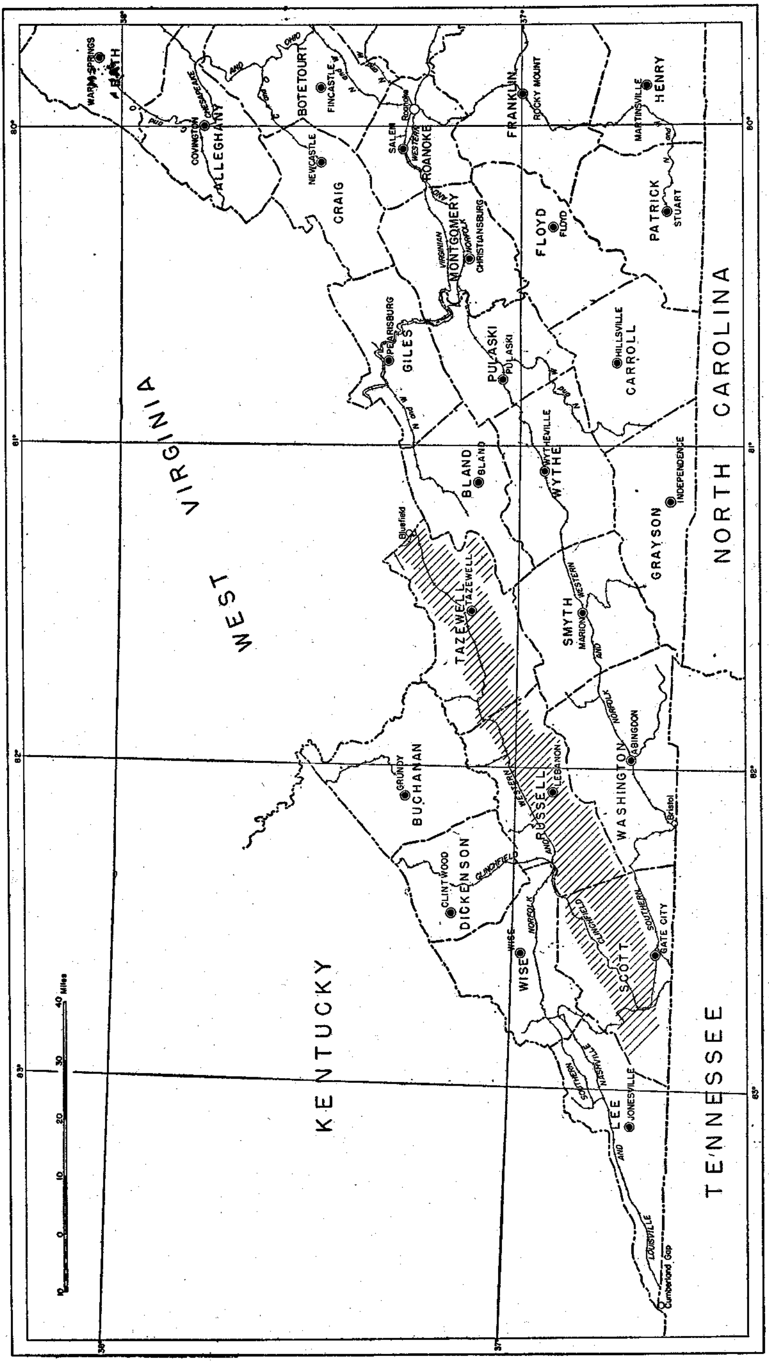


FIGURE 1.—Index map of southwestern Virginia showing location of the Clinch Valley district.

University of Virginia, Survey chemist, others by Froehling and Robertson, Inc., Richmond, and a few were taken from previous reports of the Virginia Geological Survey.[1, 30]

ACKNOWLEDGMENTS

During the field season of 1942, the writer was very capably assisted by R. C. Oburn, who supplied many of the photographs used in this report. R. S. Edmundson, of the Virginia Geological Survey, aided in the field work done in the spring of 1944. The writer is indebted to him also for numerous suggestions during the preparation of the report. Quarry operators and many other local residents rendered assistance and supplied valuable information. In this connection, special thanks are due C. M. Hunter of Pounding Mill, Jack Dunaway of North Tazewell, and to J. B. Connelly of Lebanon. The writer also appreciates the many valuable suggestions and directional guidance given by Arthur Bevan, State Geologist.

RELIEF AND DRAINAGE

The Clinch Valley district is drained chiefly by Clinch River which heads about 10 miles west of Bluefield. The relatively small area to the east of Clinch Valley, shown on Plate 9, is drained by tributaries of New River. Southwest of Hansonville, Russell County, the valley between Copper Ridge and Clinch Mountain is drained by Moccasin Creek, a tributary of the North Fork of Holston River. Southwest of Tazewell, Clinch River flows in a narrow gorge 150 to 400 feet below the broad rolling surface to the southeast. The entrenchment of Clinch River is especially noticeable southwest of Blackford, Russell County. Many segments of the gorge of Clinch River are utilized by the Norfolk and Western Railway and the Clinchfield Railroad.

In eastern Russell and Tazewell counties a rather prominent group of mountainous ridges occurs in the middle of the Clinch Valley district (Pls. 1, 9, and 18). Farther southwest, in Russell and Scott counties, the most prominent topographic feature is a rather broad rolling upland known as Copper Ridge (Pl. 23). This prominence extends northeastward into Tazewell County, where it is known as Kent Ridge. The rather rugged topography of Clinch Valley, produced by the entrenchment of the main drainage, makes exceptionally large quantities of "dry rock" available for quarrying and mining well above the water-

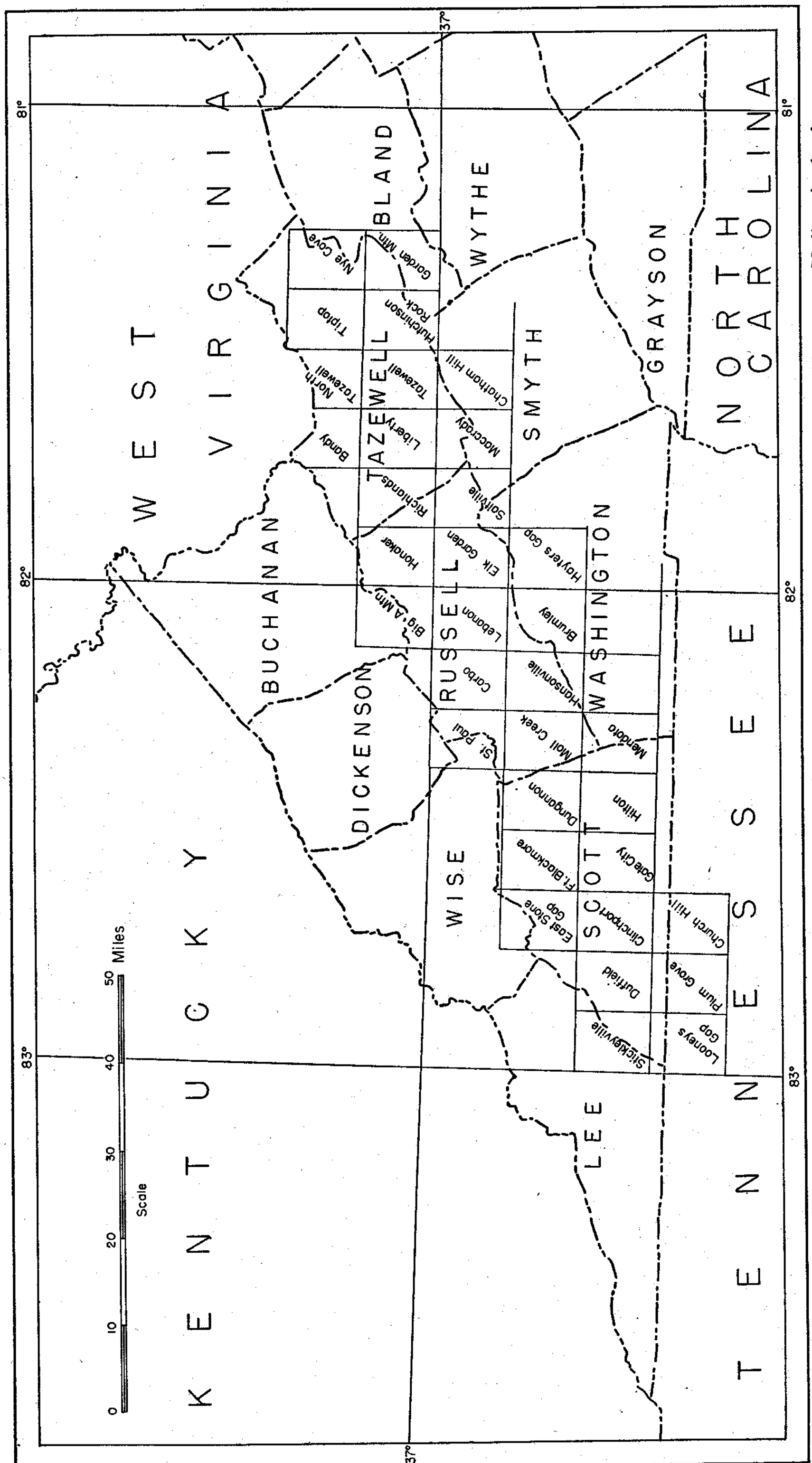


FIGURE 2.—Index map of the Clinch Valley district, showing areas covered by 7½-minute maps of the Tennessee Valley Authority.

saturated zone. Many of these excellent potential quarry sites are located close to railroads.

Practically all of the district described in this report is covered by 7½-minute planimetric maps on a scale of 1:24,000, prepared by the Tennessee Valley Authority. Contour maps of many of these quadrangles are also available. The names and locations of the TVA 7½-minute quadrangle maps covering the Clinch Valley district in Virginia are shown in Figure 2. Much of Tazewell and the eastern part of Russell County are covered by the Burkes Garden, Pounding Mill and Richlands topographic maps on a scale of 1 inch to a mile. A topographic map of Wise County, Virginia, published as a part of Bulletin 24 of the Virginia Geological Survey, shows the topography and distribution of the limestone belts along the Cumberland-Allegheny Front between Big Stone Gap and St. Paul.

GEOLOGY

As shown in Plate 2, the limestones and dolomites of the Clinch Valley district comprise somewhat less than one-third of the total thickness of exposed rocks, which range in age from early Cambrian to Pennsylvanian. These rocks record a lengthy history of the Appalachian region, wholly unlike currently prevailing conditions.

All of the strata except the youngest, coal-bearing formations were laid down in the shallow waters of an ancient inland sea which covered extensive regions of North America during the Paleozoic era. By a gradual subsidence of the sea bottom during deposition, the shallow sea continued to exist for 350 to 400 million years, in the Appalachian trough, during which time more than 30,000 feet of sediment accumulated.

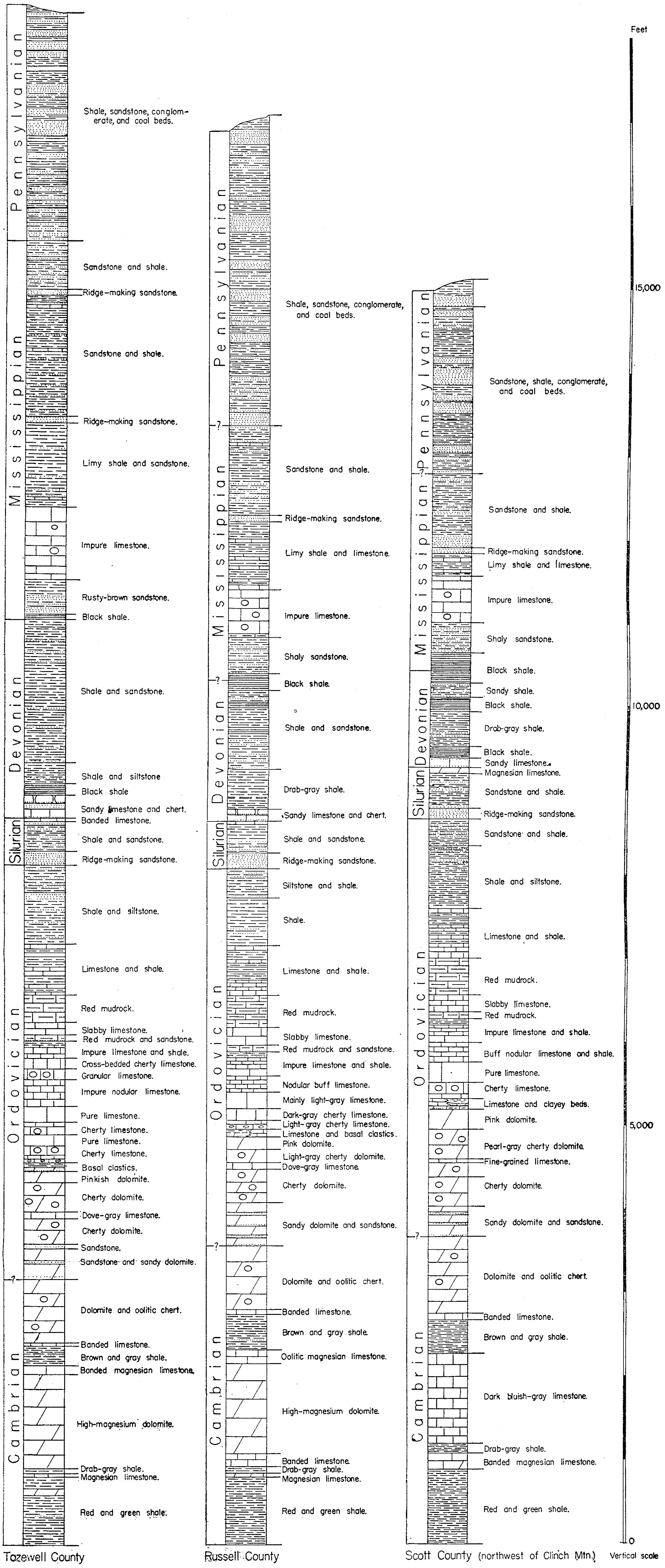
The shallow water marine origin of the strata is attested by such physical characteristics as ripple marks and mud cracks (Pl. 21B), and also by fossil marine invertebrates which are amazingly numerous and well preserved. Some of the purest limestones in this part of the State are almost wholly composed of the fragmental skeletons of extinct marine animals and plants. The marine conditions prevailing in this region during most of the Paleozoic era were gradually supplanted during late Mississippian and early Pennsylvanian time by semimarine and nonmarine environments. The change was brought about by a gradual elevation of the sea bottom and of the land areas to the east of the sea, which caused the strand line to migrate westward beyond the area of Virginia and other sections of the Appalachian province.

The changing geography is read from the Upper Mississippian and Lower Pennsylvanian strata which are largely coarse clastics and contain the remains of terrestrial plants. The environment of deposition of these sediments seems to have been a broad flat coastal plain. Coastal swamps and peat bogs resembling those in the present southern Coastal Plain of Virginia, existed sufficiently long to allow accumulation of great thicknesses of coal-forming material. From time to time these swamps were obliterated by shifting rivers and changes in sea level. This interval of mainly continental deposition immediately preceded the building of the Appalachian Mountains.

Very late in Paleozoic time, the tremendously thick body of sediments which had accumulated in the Appalachian trough was subjected to severe compressive forces. Although most of the deposited sediment had already been lithified by compaction and cementation, the compressive forces were sufficiently great and prevailed long enough to cause the rock layers to bend and crumple. Great folds of the strata arose gradually on the site of the ancient inland sea and the upward swelling mass rose faster than rivers and other erosive agencies were able to cut downward. Thus mountainous land displaced the seas which had prevailed for many geologic ages. This radical and fundamental change in the ancient geography of the Appalachian region is known as the Appalachian revolution. Since late Paleozoic time the Appalachian Valley and the less folded strata in the Allegheny plateaus to the west have been undergoing erosion. The downcutting action of streams and rivers has been regenerated anew from time to time by general, overall uplifts of the land. The exposed rocks attest the long history of deposition; the folds, fractures, and faults in the strata evidence the Appalachian revolution; and the present rather rugged topography (Pls. 1, 17B) is the ever-changing product of erosional forces which have been active since Paleozoic time. The limestones and dolomites and the other mineral resources are truly our heritage from the geologic past.

The eroded ends of upturned, folded beds crop out in linear, northeast-trending belts, some extending for many miles with only minor changes in dip or trend. Because of folding, the various formations are repeated in several belts. Some outcropping belts are terminated by faults, others by the pitch or plunge of folds.

In Tazewell, Russell, and Scott counties, the dividing line between the Appalachian Valley and the Cumberland-Allegheny Plateau is a zone of faults marked by the St. Clair, St. Paul, and Hunter Valley thrusts. Along these faults, the beds are steeply upturned, but a short



Generalized columnar sections for the Clinch Valley district, Virginia.

distance to the northwest they flatten rather abruptly. In most sections of the Cumberland-Allegheny Plateau the beds have a slight regional dip to the west, which locally is modified by broad low folds and minor faults.

In Tazewell and eastern Russell counties, most of the folds are rather broad and open, but farther southwest these folds are dismembered by faulting and the prevailing dip is to the southeast. The main structural features of the Clinch Valley district are shown in the geologic cross sections on Plates 9, 10, 18, and 23.

DEFINITION OF TERMS

In describing the lithology and geologic relations of various types of sedimentary rock, several technical terms are used. *Fine-grained* means that the grains are too small to be distinguished without a magnifier; *coarse-grained* refers to sizes of particles readily distinguished with the naked eye; and *medium-grained* to intermediate or border line textures. The "knit" or packing of the particles in a rock is described as *compact, mealy,* or *crumbly.* Crumbly, medium-grained rocks are described as *saccharoidal.* Some rocks contain small, concentrically banded granules called *oolites,* which are about the size of fish roe.

Carbonate, when used alone, refers to both calcium and magnesium carbonates. The silica, alumina, iron oxide, and alkalies are referred to collectively as *noncarbonates. High-calcium limestone* contains more than 95 per cent calcium carbonate. *Dolomite* refers to varieties of carbonate rocks containing 20 to 46 per cent magnesium carbonate. *High-magnesium dolomite* contains less than 5 per cent noncarbonates and more than 40 per cent magnesium carbonate. *Magnesian limestones* contain 5 to 20 per cent magnesium carbonate. *Impure limestone* denotes a carbonate content of less than 95 per cent. Such rocks may be *sandy, argillaceous* (clayey), *ferruginous* (containing iron oxides), and *siliceous* or *cherty. Primary* signifies formation at the time the enclosing rock was formed; *secondary* denotes an origin subsequent to original deposition of the beds. The color adjectives, unless otherwise designated, refer to the color of freshly broken rock surfaces.

Facies refers to the lithologic aspects of a rock formation particularly to those characteristics which signify the origin or mode of deposition. A limestone grading laterally into and interfingering with a shale is said to change facies. Different facies of the same sedimentary record generally signify different environments of deposition. The term *limestone* embraces a great variety of sedimentary rocks having different origins. Some are composed almost wholly of fossil shells (shell limestones), and others are mechanical or *clastic* deposits. Limestones secreted largely by colonial, reef-building organisms such as corals, bryozoans, and calcareous algae are called *bioherms* (Pl. 14C). Most coarse-grained limestones were deposited mechanically, whereas most of the fine-grained limestones very probably were precipitated as lime muds. Some coarse-grained limestones and probably many coarse-grained dolomites are of *secondary* origin, the coarse textures resulting either from *recrystallization* or *replacement* of originally finer grained material.

USES OF LIMESTONE AND DOLOMITE

Together, limestone and dolomite have a greater number of important uses than other naturally occurring substances, except coal and petroleum.[24] By far the greater part of the annual tonnage of limestone and dolomite produced in Virginia, particularly in the district covered by this report, is used in the form of crushed stone and allied products such as limestone dust, stone sand, and riprap. For crushed stone, the physical properties rather than the chemical composition of the rock are considered most important. With few exceptions, only the pure, premium grades of limestone are suitable for chemical and industrial uses (Table 1).

Because of its greater value and variety of possible uses, high-calcium limestone is among the most important rocks quarried in Virginia. Much of the high-calcium limestone produced in the State is used for fluxing iron ore. Other important uses are as ground limestone for conditioning and neutralizing acid soils; in water purification; in the manufacture of alkalies, calcium carbide, glass, and sugar; and in the tanning industry. High-magnesium dolomite has been used as a fluxing stone and in the manufacture of dead-burned dolomite, magnesia, and finishing limes. High-magnesium dolomite has been used elsewhere during World War II for making magnesium metal.

FACTORS DETERMINING THE RELATIVE VALUE OF LIMESTONES AND DOLOMITES

The quality, quantity, location, and accessibility of a deposit of limestone or dolomite largely determine its value. Other important factors include: (1) present and probable future demands for the raw material and finished products; (2) possible competition with other already well-established industries utilizing the same or similar materials; and (3) quarrying and mining costs for the whole period of operation.

TABLE 1.—*Important chemical uses of limestone and dolomite*

(compiled from Lamar, J. E. and Willman, H. B., "A summary of the uses of limestone and dolomite," Ill. Geol. Survey, Rept. Investigations No. 49, 1938).

USES	High-calcium limestone	Impure limestone	Magnesian limestone	High-magnesian dolomite
Agricultural limestone	x	x	x	x
Alkalies	x			
Aluminum oxide	x			
Ammonia (cyanamide process)	x			
Baking powders	x			
Calcium carbide	x			
Carbon dioxide	x	?	?	x
Coal-mine dust	x		x	x
Dolomite refractories			?	x
Dye works	x	?		
Epsom salts				x
Explosives	x	x	x	x
Fertilizers	x			x
Flux:				
Open-hearth furnace	x			
Blast furnace	x			x
Nonferrous metals	x			
Glass manufacture	x			x
Lime:				
High-calcium lime	x			
Low-magnesium lime			x	
Hydraulic lime		x		
Magnesium metal manufacture				x
Natural cement		x		
Paper:				
Sulphite pulp (Tower system)	x			x
Sulphite pulp (milk-of-lime system)				x
Soda pulp and sulphate pulp	x			
Phenol	x			
Plastics	x			
Portland cement	x	x		
Rock wool	x	x	x	x
Salt refining	x			
Soap purification	x			
Sugar refining	x			
Technical carbonate				x
Whiting substitute	x			x

Although most of the limestones and dolomites in the Appalachian Valley of Virginia meet the physical standards required for crushed stone and allied products, there is a growing tendency to utilize the purer varieties of limestone and dolomite even for these purposes. The freer the rock is from such impurities as iron oxide, alumina, silica, alkalies, and phosphorus, the greater the number of possible uses for the material.

The chemical composition of a large body of limestone or dolomite can be determined from a relatively small, but representative sample. The analyses of limestones and dolomites in this report (Tables 2, 3, 4, and 5) were obtained from samples weighing 3 to 10 pounds. Chips of fresh rock one to two inches across were collected at stratigraphic intervals of a foot or so, and no attempt was made to avoid impure partings.

Not all high-calcium limestones or high-magnesium dolomites are of the same quality, even though their total carbonate content may be uniformly high. For many uses, even minute amounts of some substances are undesirable. Since phosphorus is particularly objectionable in the manufacture of calcium carbide by the electrometallurgical process, limestones having a phosphorus pentoxide content of less than 0.01 per cent are preferable. In the Appalachian Valley of Virginia, there are two principal varieties of high-calcium limestone. One type, commonly identified as Mosheim limestone, is prevailingly dove-gray and very fine grained; the other variety which includes the familiar Holston-type limestone is coarse grained, light-gray, but not uncommonly pinkish. As shown in Table 2, the coarse-grained limestones contain relatively much more phosphorus pentoxide than do limestones of Mosheim type. In making lime products only pure white material is used, a limestone containing exceptionally little iron being required. In general, the coarser grained limestones are somewhat higher in iron oxides than are limestones of Mosheim type (Table 2). Production of magnesium metal from dolomite is facilitated by a low content of alkalies, and high-magnesium dolomites containing less than 0.06 per cent of soda and potash are preferred.

Deposits of limestone and dolomite are not likely to be developed industrially unless the available supply is sufficiently large to allow production over at least a 20-year period. Reserves of more than 10 million tons are much more likely to be developed than less extensive occurrences. The quantity of rock available for quarrying or mining can be definitely determined only by core-drilling. It is possible to determine by coring the quality and extent of the rock at depth, as well as the position of the water table and the possible occurrence of caverns and mud seams.

Quarrying, mining, and processing costs are in many instances greatly influenced by the physical characteristics of the rock. In general, dolomites are more difficult to quarry and crush than limestones. In contrast, the Honaker dolomite in many localities is so thoroughly fractured that it can be quarried with little blasting. Limestones of Mosheim type seem to hold less moisture and to burn more evenly than do coarse-grained limestones. The finer grained limestones are definitely preferred for rotary kilns. Processing costs for lime manufacture are largely determined by availability and cost of fuel. Since the Clinch Valley district is within a few miles of rather extensively developed deposits of high-grade bituminous coal, lime can be manufactured in that district at a lower cost than in any other part of the State.

Limestone and dolomite are "big tonnage" commodities and are shipped primarily by rail. Immediate access to a railroad will probably be the determining factor in the future commercial development of the limestones and dolomites of Clinch Valley, but possibly some deposits not along a railroad may receive consideration because of the unusual quantity and purity of the rock. Extensive occurrences of limestone and dolomite more than a few miles from a railroad and not served by a through highway are only potentially valuable.

In summary, the limestone deposits most likely to be commercially developed are those (1) containing at least 97 per cent calcium carbonate, less than 1.5 per cent magnesium carbonate, and less than 0.01 per cent of phosphorus pentoxide; (2) occurring in thickness exceeding 50 feet; (3) suitably situated for quarrying or mining of millions of tons of raw stone; and (4) occurring along or reasonably close to a railroad. Only those dolomites containing more than 42 per cent magnesium carbonate and less than 5 per cent of noncarbonates and located along or near a railroad can be considered as immediately valuable for commercial development.

STRATIGRAPHY

The dolomite formations northwest of Clinch Mountain in southwestern Virginia range from Middle Cambrian to Lower Ordovician. The lowermost dolomite unit, the Honaker formation, occurs between the Rome and Nolichucky shales in the northeastern part of the Clinch Valley district. Much of the

TABLE 2.—*Variations in composition of representative high-calcium limestones in the Clinch Valley district, Virginia*

(Froehling and Robertson, Inc., Analysts)

FORMATION	TYPE OF ROCK	THICKNESS (feet)	CHEMICAL COMPOSITION						
			SiO_2	Al_2O_3	Fe_2O_3	P_2O_5	$CaCO_3$	$MgCO_3$	Total
Five Oaks[a]	Limestone, very fine grained, dove-gray	25	0.46	1.14	0.08	0.029	95.92	2.51	100.14
Peery[b]	Limestone, very fine grained, dove-gray	109	0.44	0.94	0.04	0.005	97.19	1.30	99.92
Peery[c]	Limestone, very fine grained, dove-gray	155	0.20	1.10	0.04	0.007	97.67	1.24	100.26
Rockdell[d]	Limestone, coarse grained, light-gray to pinkish	146	1.36	0.44	0.08	0.039	95.68	1.84	99.44
Rockdell[e]	Limestone, pinkish, coarse to fine grained	150±	0.30	0.92	0.20	0.060	97.54	1.04	100.06
Rockdell[f]	Limestone, pinkish, coarse to fine grained	260±	0.84	0.26	0.12	0.033	97.08	1.17	99.50
Rockdell[g]	Limestone, coarse grained, light-gray	11	0.44	0.04	0.24	0.055	98.28	0.89	99.95
Benbolt[h]	Limestone, coarse grained, pinkish	55	0.56	0.18	0.08	0.030	97.88	0.86	99.59

[a] Quarry of Elk Garden Farm Products Corporation, Elk Garden, Russell County, Virginia.
[b] 250 feet southeast of Mt. Pleasant Church, Maxwell, Tazewell County, Virginia.
[c] 500 feet southeast of St. Clair School, near Bluefield, Tazewell County, Virginia.
[d] On hillside near intersection of State Highway 80 and Road 656, Elk Garden, Russell County, Virginia.
[e] Base of Clinch Mountain near State Highway 80, Rockdell, Russell County, Virginia.
[f] On hillside just east of intersection of State Highways 70 and 64, Dickensonville, Russell County, Virginia.
[g] West side of quarry of Pennsylvania-Dixie Cement Company, Marcem, Scott County, Virginia.
[h] East side of Ball Branch, 3 miles southwest of Blackford, Russell County, Virginia.

Honaker is high-magnesium dolomite, and the thickness of the formation ranges from 1,000 to 1,400 feet. Southwest of Castlewood, Russell County, the Honaker dolomite is supplanted by an equally thick succession of dark bluish-gray limestone. The Rogersville shale occurs in the lower 50 to 250 feet of this limestone succession, and the beds above and below the Rogersville correspond to the Maryville and Rutledge limestones, respectively. A thin zone of Rogersville shale occurring near the base of the Honaker, persists at least as far northeast as Wittens Mills, Tazewell County, where it is underlain by limy beds with characteristic Rutledge trilobites.[21]

Northwest of Clinch Mountain, Butts[3] divides the dolomitic strata above the Nolichucky formation into two formations, the Copper Ridge and Beekmantown. According to present usage,[29] the Copper Ridge includes the Cambrian dolomite below the Chepultepec (basal Ordovician) and above the Nolichucky shale. The Beekmantown contains distinctive fossils, but in most places the fossils are found only in loose blocks of chert. Butts[7] has arbitrarily drawn the Beekmantown-Copper Ridge contact just above the highest of several rather thick sandstones which he says are diagnostic of the Copper Ridge. In some belts southeast of Clinch Mountain, the Beekmantown and Copper Ridge dolomites, as mapped by Butts, are separated by a distinctive limestone containing Chepultepec fossils. The apparent absence of this limestone northwest of Clinch Mountain was interpreted by Butts[3] to indicate that the Chepultepec is absent there. More recently, Chepultepec fossils have been found in sandy dolomites in the upper part of the Copper Ridge dolomite of Butts[8] at Natural Tunnel, Scott County. This and other subsequent discoveries of Chepultepec fossils in the so-called Copper Ridge dolomite in Clinch Valley indicate that the Chepultepec should be recognized at least in parts of that district. Although the post-Nolichucky dolomites in the Clinch Valley district are known through fossils to contain representatives of the Copper Ridge, Chepultepec, and Beekmantown formations, the boundaries can not now be mapped with precision or consistency. Pending further study, it seems advisable to use the name "Knox" dolomite as a tentative, provisional designation, for the 2,000- to 2,500-foot succession of dolomite above the Nolichucky. In most parts of the Clinch Valley district the "Knox" is divisible into six lithologic members. These subdivisions vary considerably in thickness and probably should not be considered as precise time-stratigraphic units (Figs. 4, 16).

The lower 750 to 1,000 feet of the "Knox" is commonly oolitic and somewhat less cherty and sandy than the overlying beds. In some sections of Clinch Valley it contains quarriable thicknesses of high-magnesium dolomite. Above the oolitic member is 300 feet of sandy dolomite with intercalated beds of quartz sandstone. Much of the upper half of the "Knox" is very cherty. A thin but persistent limy zone, 200 to 400 feet above the top of the sandy member, is underlain and overlain by zones of cherty dolomite. The topmost subdivision of the "Knox" is characterized by pinkish dolomites containing some chert with fossils of Cotter and Powell (upper Canadian) ages. The limy member contains the *Lecanospira* fauna which occurs in the lower part of the Beekmantown of New York. A columnar section showing the nomenclature and lithologic units of the dolomites of Clinch Valley is given in Figure 4.

The "Knox" is succeeded by 1,000 feet or more of Middle Ordovician limestone which is divisible into several distinctive formations, most of which were recently named and described from exposures in Tazewell County.[18] Relation of the newly defined units to the older, more general formation names previously used in Clinch Valley is shown on Figure 3. In Tazewell County the principal high-calcium limestone is in the upper part of the Peery limestone. Farther southwest this limestone and the underlying Ward Cove limestone grade into a thick body of predominantly coarse-grained, clastic limestone herein named the Rockdell limestone. It is the principal high-calcium limestone zone of Russell and Scott counties. Much of the succeeding part of the Middle Ordovician formations is very argillaceous. The Benbolt and Wardell formations contain a thick succession of buff-weathering limestones and shales and, locally, some beds of relatively pure limestone, and the Moccasin includes prevailingly red beds. The Witten limestone just below the Moccasin, shows less variation in lithology and is more persistent than any of the other Middle Ordovician formations in the southern Appalachian region.

Thin limestones, none of which is sufficiently pure for industrial uses, occur in the upper part of the Silurian and in the Lower Devonian formations and in the northeastern and southern parts of Tazewell County.[22] A relatively thick succession of Mississippian limestone occurs along the northwestern border of the Clinch

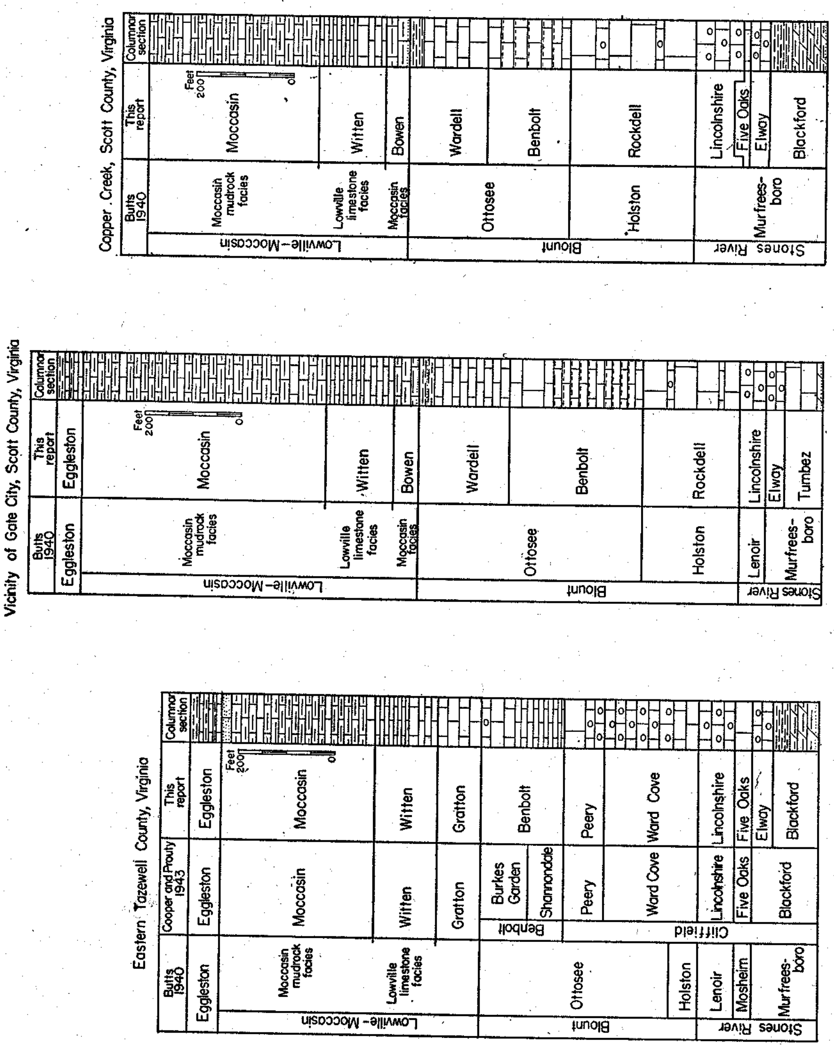


FIGURE 3.—Present and previous classifications of the Middle Ordovician formations in the Clinch Valley district.

Valley district. Locally in Tazewell County, the Little Valley, Hillsdale, "Ste. Genevieve," and "Gasper" limestones have been recognized.[23] Southwest of Honaker, Russell County, the Bluefield shale of Chester age is supplanted by impure limestones which are believed by Butts to represent the Glen Dean limestone, but the correlation is uncertain. The Mississippian limestones are too impure and shaly for most uses. Even the purest zones contain 4 to 6 per cent of noncarbonates and barely qualify as high-calcium limestone. The lithology and subdivisions of the Mississippian limestones are shown in Geologic Sections 53 to 55.

TAZEWELL COUNTY

GENERAL FEATURES

As shown in Figure 1, Tazewell County is adjacent to the major railroad junction and industrial center of Bluefield, Virginia-West Virginia. U. S. Route 19, the Trail of the Lonesome Pine, connects Tazewell, the county seat, with Bluefield and with towns to the southwest, including Lebanon, Abingdon, and Bristol. This and numerous State highways provide ready access to most sections of the county northwest of Clinch Mountain (Pls. 9, 10).

The Norton Division of the Norfolk and Western Railway, which unites with the main line of this railroad at Bluefield, passes through Tiptop, North Tazewell, Pounding Mill, Cedar Bluff, and Richlands. The Iaeger Branch of the Norfolk and Western Railway forms a direct connection between Cedar Bluff and Iaeger, West Virginia, which is on the main line connecting Cincinnati, Ohio, and Norfolk. Several spur lines extend northward from Richlands and Raven to the coal mines along Sandy Ridge. Other spur lines connecting with the main line of the Norfolk and Western in West Virginia serve the coal mines at Bishop and Boissevain.

The divide between the Ohio and Tennessee watersheds passes through Tiptop and Gratton, a few miles east of Tazewell. Most of Tazewell County is drained by Clinch River and its tributaries. Abbs Valley, Burkes Garden, and the valleys of Mud Fork, Bluestone, Clear Fork, and Wolf Creek drain into New River. The headwaters of Tug Fork of Big Sandy River rise in the coal-mining section of the county between Horsepen and Bandy. As shown by the strongly asymmetrical divide at The Jump, the drainage basin of the Big Sandy is enlarging at the expense of that of Clinch River.

GEOLOGY

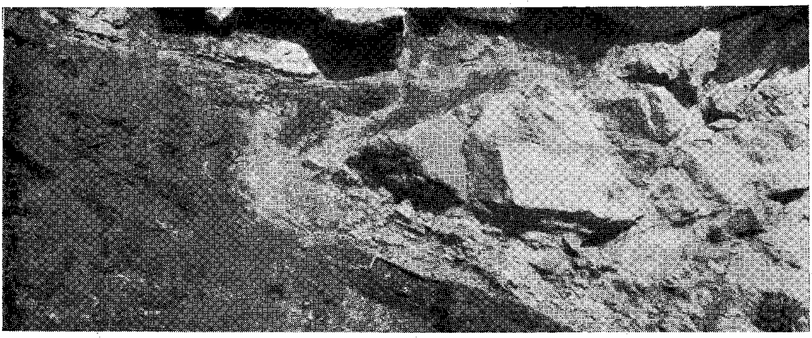
The rocks exposed in Tazewell County, are all of sedimentary origin and range from Lower Cambrian to Lower Pennsylvanian. They have an aggregate thickness of about 18,500 feet (Pl. 2), of which approximately half is limestone and dolomite. All of the limestones and dolomites, as well as most of the other rocks, are of marine origin, having been deposited in ancient island seas which at successive periods flooded much of North America during the Paleozoic era.

The coal-bearing portion of Tazewell County is in the Allegheny Plateau. The rest of the county, which comprises an alternation of rather narrow valleys and even-crested ridges, lies in the Appalachian Valley and Ridge province. Ridges south of U. S. Route 19 are made by Silurian sandstones, those to the north by thinner Mississippian sandstones. Valleys north of the St. Clair fault are in Mississippian shale and limestone. Most of the other valleys are in Cambrian and Ordovician limestone and dolomite. The valleys and ridges express the differing resistance to erosion of the various rocks. Folding of the beds accounts for repetition of the rocks in various belts.

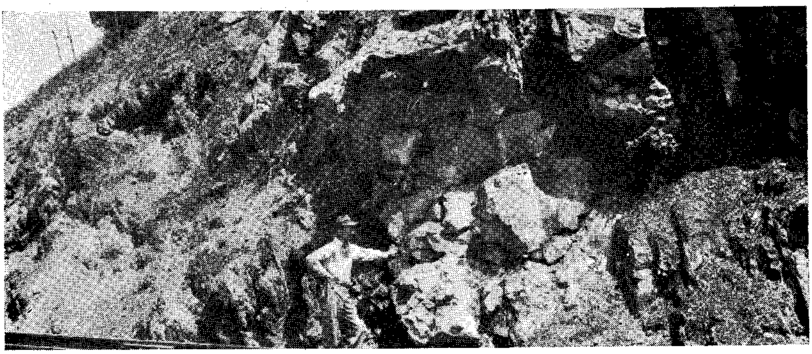
Some of the folds have been broken by great overthrust faults (Pl. 3A-B). The Richlands and Boissevain faults mark the southeastern border of the coal-bearing Pennsylvanian rocks. North of these thrusts, the rocks are relatively horizontal. The broad segment between these faults and the St. Clair overthrust is composed mainly of Mississippian rocks, the major structure of which is the Hurricane Ridge syncline[26] extending northeastward across the entire county and many miles into West Virginia. Another fault, the Narrows overthrust, extends as far southwest as Benbolt, where it dies out in crumpled Ordovician shales. These structures and numerous other folds are shown on Plate 9.

The limestones and dolomites are essentially confined to the valley areas and are well exposed. Except locally atop Kent Ridge, the soil and mantle rock are exceptionally thin. Dissection of the limestones and dolomites has tended to lower the ground-water level, so that in many places relatively large quantities of "dry rock" are available for quarrying. Because of the occurrence of large quantities of low- and high-volatile coals within a few miles, the limestones and dolomites of Tazewell County can be calcined at exceptionally low cost. This factor and the accessibility of the area to main-line railroads, make Tazewell County one of the most favorable areas in the eastern United States for the future commercial utilization of limestone and dolomite.

The character and distribution of the rocks in Tazewell County are shown on the Pocahontas and Tazewell folios of the U. S. Geological Survey Geologic Atlas.[15, 16] Bassler[2] described the limestones in the vicinity of Five Oaks, near Tazewell, and in Thompson Valley. The rocks in the eastern half of the county have been mapped and described in detail by the writer.[20] The revised nomenclature for the Ordovician limestones was introduced by Cooper and Prouty[18] in 1943.



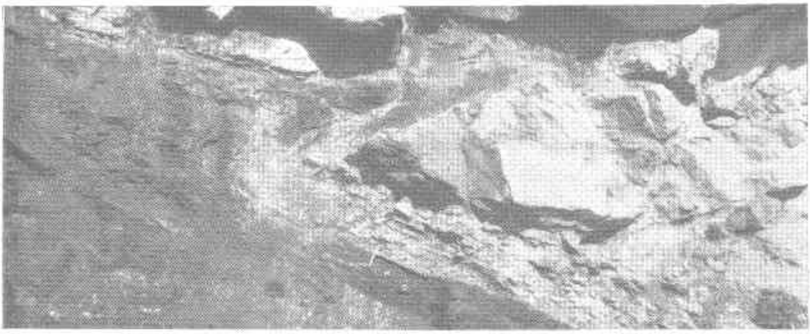
A.



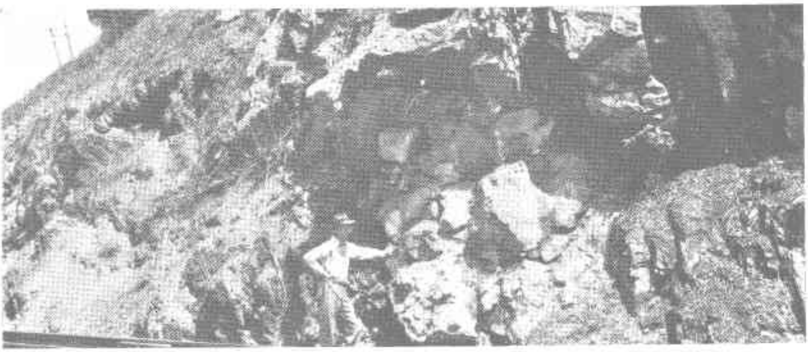
B.

C.

A, Rutledge limestone on Mississippian black shale along the Hunter Valley fault, near Horton Summit, Scott County, Virginia. B, "Knox" (?) dolomite on Devonian black shale along St. Clair fault, at Cedar Bluff, Tazewell County, Virginia. C, Natural exposure of fractured Honaker dolomite near Richlands, Tazewell County, Virginia.



A.



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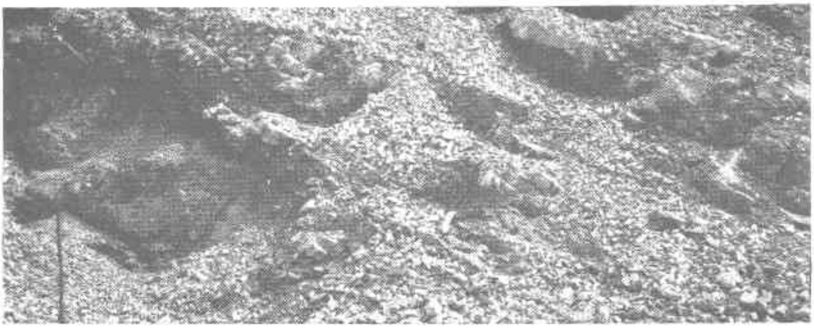
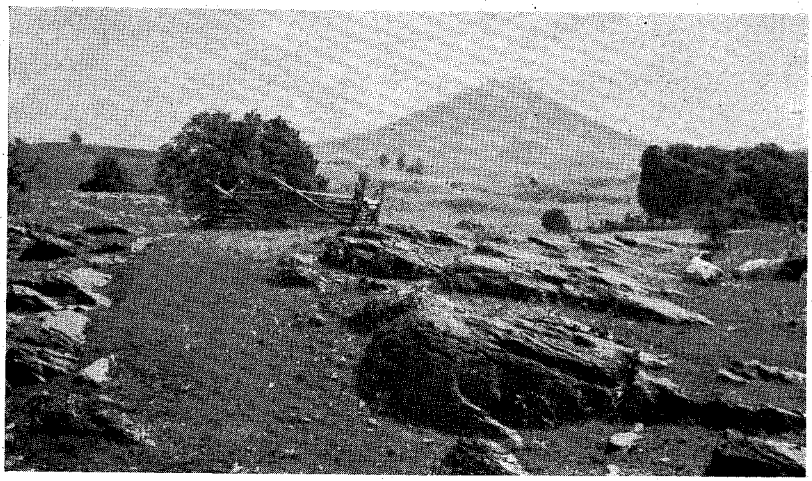


C.

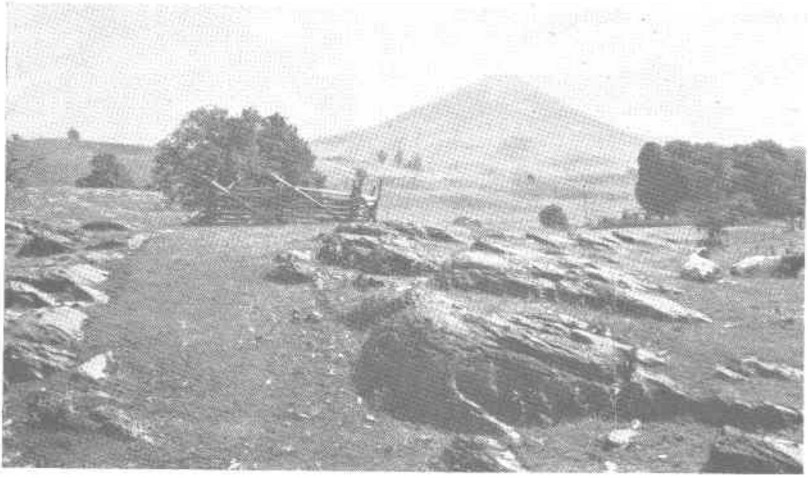
A, Rutledge limestone on Mississippian black shale along the Hunter Valley fault, near Horton Summit, Scott County, Virginia. B, "Knox" (?) dolomite on Devonian black shale along St. Clair fault, at Cedar Bluff, Tazewell County, Virginia. C, Natural exposure of fractured Honaker dolomite near Richlands, Tazewell County, Virginia.



A.

B.

A, *Nidulites*-bearing Ward Cove limestone in Thompson Valley, Tazewell County, Virginia. B, Typical exposure of Ordovician limestone, near Tazewell, Virginia. Photographs by Arthur Bevan.



A.

B.

A, *Nidulites*-bearing Ward Cove limestone in Thompson Valley, Tazewell County, Virginia. B, Typical exposure of Ordovician limestone, near Tazewell, Virginia. Photographs by Arthur Bevan.

DOLOMITE

HONAKER FORMATION

The Honaker formation is composed mainly of dolomite with minor amounts of dark bluish-gray banded limestone and drab-gray noncalcareous shale. The dolomite is prevailingly dark bluish-gray and finely granular, but there are a few intercalated zones of light-gray and brownish-gray brecciated dolomite (Pl 3C). The main belt of the Honaker lies south of the St. Clair fault and north of the crest of Kent Ridge. Another belt occurs along the Narrows fault northeast of Gratton, but because of its remote location is not now considered important for quarrying.

Unlike the other dolomitic formations, the Honaker contains little siliceous matter, being essentially free of sand and chert. Most of the formation is high-magnesium dolomite having a total carbonate content of 97 to 98 per cent (Table 2). Good exposures of the Honaker occur along all of the roads crossing Kent Ridge, and along Roads 650 and 651 north of Wittens Mills. The general composition, thickness, and character of the formation are shown in Geologic Sections 1 and 2.

Geologic Section 1.—Honaker formation along Roads 650 and 651 north of Wittens Mills, at locality 13, Tazewell County, Virginia

	Thickness Feet
Nolichucky shale	
Honaker formation (1,383 feet)	
19. Dolomite, medium-gray, coarse grained, granular, silty	20
18. Dolomite, dark brownish-gray, medium bedded; weathers saccharoidal	63.5
17. Dolomite, brownish-gray, cuneiform jointed, medium grained	46
16. Dolomite, dark-gray, medium grained, with crinkled laminations of silt and clay; weathers rusty-brown	21.75
15. Dolomite, dark bluish-gray, medium bedded; weathers rusty-brown	67.75
14. Dolomite, light-gray, granular, compact; weathers saccharoidal, flaggy, and rusty-brown	156.5
Analysis of units 14 to 19; thickness sampled, 375 feet: SiO_2, 1.68; R_2O_3, 1.53; $CaCO_3$, 53.93; $MgCO_3$, 43.17; Total, 100.31.	

	Thickness Feet
13. Limestone, dolomitic, dark-gray, silty, argillaceous	32.5
12. Covered interval, composed of two kinds of dolomite; one is creamy-white; the other is rusty-brown, coarse grained, and weathers ash-gray; about 65 per cent of the thickness is of the second type	224
11. Dolomite, bluish-black, argillaceous, blocky; weathers mealy; several intercalations of ribbon-banded argillaceous limestone composing about 20 per cent of the total thickness	551
10. Dolomite, bluish-black, argillaceous, blocky; weathers mealy; contains vugs of white calcite; a few thin intercalations of platy limestone containing *Obolus* cf. *O. minimus*	39.5
9. Limestone, bluish-gray, argillaceous, irregularly banded	19
8. Dolomite, bluish-gray, granular; weathers mealy	34
7. Dolomite, brownish-gray; shaly partings	12
6. Limestone and buff shale, interbedded	11
5. Shale, olive-drab to buff; contains *Ehmaniella* fauna of trilobites; represents the Rogersville shale	23.5
4. Dolomite, medium-gray, granular	6
3. Limestone, ribbon banded, argillaceous	44
2. Limestone, interbedded with silty shale	8
1. Limestone, bluish-gray, granular; oolitic laminae; contains *Solenopleurella*	3.5

Rome formation

Geologic Section 2.—Honaker formation at locality 92, in the vicinity of Cedar Bluff, Tazewell County, Virginia

	Thickness Feet
Nolichucky formation	
Honaker formation (1,356 feet)	
34. Limestone, dark bluish-gray, coarse grained, oolitic; contains thin beds of edgewise conglomerate	40

	Thickness Feet
33. Limestone, magnesian, medium to fine grained, ribbon banded	50
32. Limestone, medium to finely granular; some beds oolitic, others conglomeratic; thick bedded and relatively pure	26
31. Limestone, bluish-gray, banded; contains intercalated drab-gray to chocolate-brown shale	27
30. Limestone, dark bluish-gray, banded, clayey	16
29. Shale, olive-drab, calcareous; contains fucoids	3
28. Limestone, dark bluish-gray, banded	6
27. Shale, olive-drab; contains fucoids	3
26. Limestone, dark bluish-gray, magnesian	3
25. Shale, olive-drab	1.6
24. Limestone, dark bluish-gray, magnesian, banded; SiO_2, 6.89; R_2O_3, 3.20; $CaCO_3$, 68.82; $MgCO_3$, 21.09; Total, 100.00	27
23. Dolomite, dark bluish-gray, granular	64
22. Dolomite, light-gray, fine grained, dense	8

Analysis of units 22 and 23; thickness sampled, 72 feet: SiO_2, 8.44; R_2O_3, 2.46; $CaCO_3$, 55.43; $MgCO_3$, 37.08; Total, 103.41.

21. Limestone, dark bluish-gray, magnesian, medium grained; SiO_2, 0.62; R_2O_3, 0.60; $CaCO_3$, 81.28; $MgCO_3$, 18.16; Total, 100.66	13
20. Dolomite, dark-gray, thoroughly fractured	6
19. Dolomite, light-gray, fine grained	12

Analysis of units 19 and 20; thickness sampled, 18 feet: SiO_2, 15.33; R_2O_3, 1.56; $CaCO_3$, 45.94; $MgCO_3$, 37.65; Total, 100.48.

18. Dolomite, dark-gray, medium grained, fractured	21
17. Dolomite, dark-gray, fine grained, medium bedded	46

Analysis of units 17 and 18; thickness sampled, 67 feet: SiO_2, 0.76; R_2O_3, 0.37; $CaCO_3$, 54.31; $MgCO_3$, 45.39; Total, 100.83.

	Thickness Feet
16. Dolomite, light-gray with reddish streaks, fine grained; SiO_2, 1.02; R_2O_3, 0.23; $CaCO_3$, 57.76; $MgCO_3$, 39.53; Total, 98.54	
15. Dolomite, medium gray	12
14. Dolomite, light-gray, fine grained, shaly partings	32

Analysis of units 14 and 15; thickness sampled, 44 feet: SiO_2, 0.75; R_2O_3, 0.83; $CaCO_3$, 57.11; $MgCO_3$, 42.21; Total, 100.90.

13. Dolomite, dark bluish-gray; vugs of secondary dolomite	2.7

Analysis of units 13 to 23; thickness sampled, 217 feet: SiO_2, 1.46; R_2O_3, 0.86; $CaCO_3$, 55.27; $MgCO_3$, 42.53; Na_2O, trace; K_2O, 0.21; Total, 100.33.

12. Dolomite, dark-gray, finely granular, dense; SiO_2, 4.73; R_2O_3, 0.69; $CaCO_3$, 52.77; $MgCO_3$, 39.95; Total, 98.14	8
11. Dolomite, medium-gray, dense; vugs of secondary dolomite	31
10. Dolomite, dark bluish-gray, finely granular	96

Analysis of units 10 and 11; thickness sampled, 127 feet: SiO_2, 1.44; R_2O_3, 0.38; $CaCO_3$, 56.13; $MgCO_3$, 42.11; Total, 100.06.

9. Dolomite, bluish-gray, medium to fine grained; SiO_2, 3.60; R_2O_3, 1.31; $CaCO_3$, 53.58; $MgCO_3$, 42.96; Total, 101.45	339
8. Dolomite, dark bluish-gray, medium bedded; SiO_2, 1.19; R_2O_3, 0.97; $CaCO_3$, 53.99; $MgCO_3$, 42.18; Total, 98.33	118
7. Dolomite and magnesian limestone, dark bluish-gray	35

Analysis of units 7 to 12; thickness sampled, 627 feet: SiO_2, 0.74; R_2O_3, 0.66; $CaCO_3$, 56.07; $MgCO_3$, 42.83; Na_2O, trace; K_2O, 0.17; Total, 100.47.

	Thickness Feet
6. Limestone, magnesian, shaly; SiO_2, 27.57; R_2O_3, 4.70; $CaCO_3$, 58.78; $MgCO_3$, 8.91; Total, 99.96	34
5. Shale, greenish-gray to bluish-gray	4.6
4. Shale, bluish-gray to greenish-gray, with intercalated bluish-gray limestones	8.4
3. Limestone, bluish-gray, banded	2.6
2. Shale, dark bluish-gray to greenish-gray; units 2 to 5 represent the Rogersville shale	8.5
1. Rutledge limestone, dark bluish-gray, shaly, banded; contains a few dolomitic layers	51

Rome formation

"KNOX" DOLOMITE

In Tazewell County, the "Knox" dolomite is about 2,200 feet thick and consists mainly of cherty dolomite. The most nearly complete exposure is along State Highway 4 north of Claypool Hill (Geologic Section 4). Much of the upper half of the formation is exposed along the Norfolk and Western Railway and Road 650 near Wittens Mills (Geologic Section 3). The upper part of the formation is also well shown along the same railroad west of Pounding Mill, between localities 69 and 71. The "Knox" is divisible into several rather distinctive lithologic members (Fig. 4).

The *oolitic member* roughly comprises approximately the lower half of the "Knox" and is composed principally of medium- to dark-gray granular dolomites, many beds of which are oolitic. Thin beds of oolitic chert, intercalated at intervals of 5 to 20 feet, occur with almost rhythmic regularity. The upper half of the oolitic member is probably the purest part of the "Knox" in Tazewell County and contains quarriable thicknesses of high-magnesium dolomite (Geologic Section 4, units 35 to 126). Where any great thickness of the oolitic beds is exposed, the alternation of light and dark-gray dolomites produces a distinctive banding. In most parts of Tazewell County the oolitic member contains relatively little chert, but in Lynn Hollow (locality 17) northeast of Wittens Mills, the fields are strewn with large masses of *Cryptozoon*-bearing chert.

The *sandy member,* which overlies the oolitic member, is about 400 feet thick and consists chiefly of light- to medium-gray dolomite and numerous beds of quartz sandstone. Many of the dolomite beds are

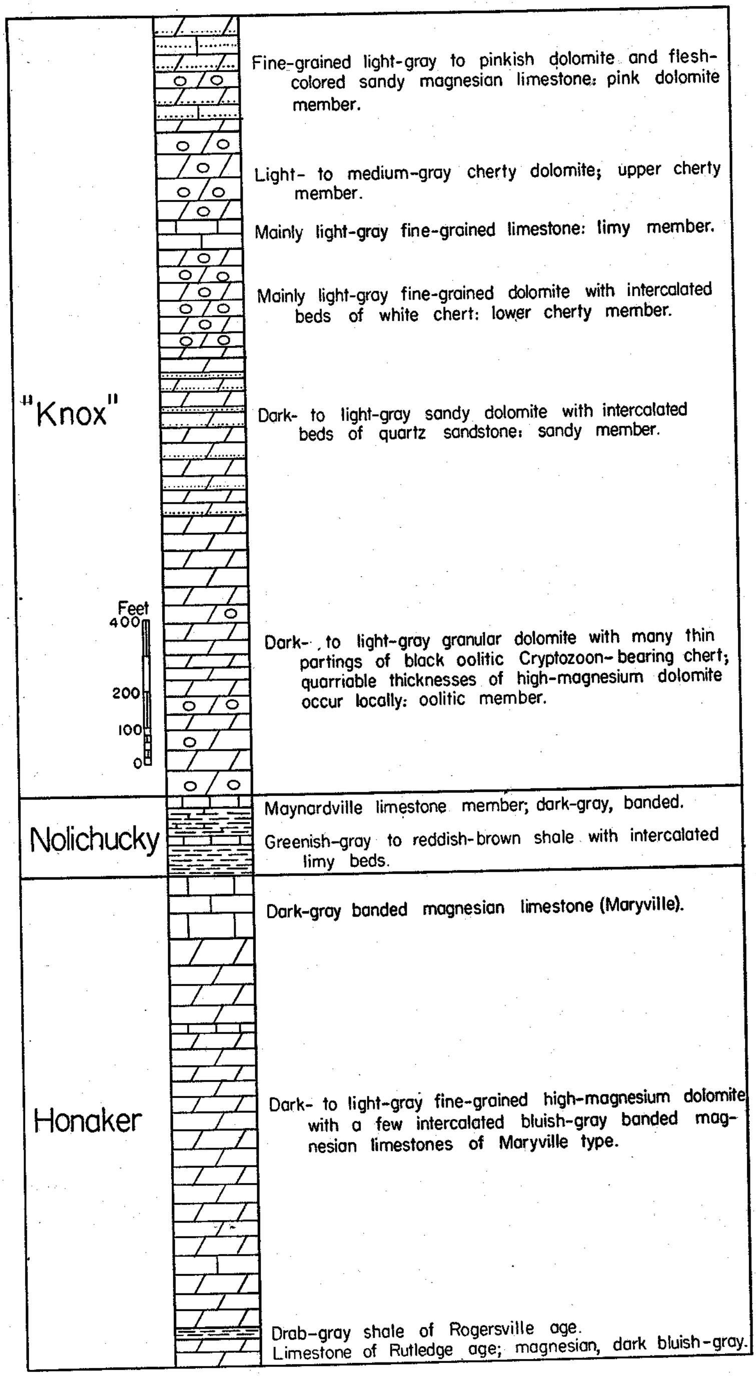


FIGURE 4.—Cambrian and Ordovician dolomites and related formations in Tazewell and Russell counties, Virginia.

also sandy. In most places the sandy beds are deeply weathered, as along U. S. Route 19 near Springville (locality 15) and along State Highway 16 at locality 49, near North Tazewell. The best exposure is along State Highway 4 north of Claypool Hill.

The *lower cherty member,* succeeding the sandy member, is 150 to 200 feet thick and consists of pearl-gray, fine-grained dolomite with prominent cherty beds 6 inches to 3 feet thick. Lenses and stringers of chert occur in many of the dolomitic beds but are not conspicuous except in fresh exposures. This member, like the underlying sandstone member, is probably too siliceous for chemical uses and because of the abundance of free silica it probably would be expensive to quarry and crush.

The *limy member,* next above the lower cherty member, ranges up to 100 feet in thickness and in the vicinity of Gratton, Marys Chapel, and Thompson Valley is nearly all fine-grained limestone. Elsewhere the limestone grades into and is interbedded with very coarse-grained dolomite. Locally the limy beds are almost wholly replaced by spongy textured, fossiliferous chert containing the same fossils as are common in the limestone.

The upper cherty member, overlying the limy member, is mainly pearl-gray, fine-grained dolomite with a few intercalated beds of chert. The thickness is about 150 feet west of Tazewell but east of Springville it is probably 250 feet thick. The upper cherty zone is best exposed along the Norfolk and Western Railway at locality 69 west of Pounding Mill and also along State Highway 4 north of Claypool Hill.

The *pink dolomite member* at the top of the "Knox" is a rather fine-grained dolomite many layers of which are pinkish. Some of the pinkish layers are laminated, others mottled with gray. Thin partings of red shale are not uncommon, and are well exposed at locality 70 west of Pounding Mill. The lower part contains several light-gray to flesh-colored cryptocrystalline layers of magnesian limestone. These beds, as well as many of the pinkish layers, contain disseminated grains and thin streaks of quartz sand. Some of the chert occurring in the pinkish member contains hollow oolites and grains of quartz sand. The thickness of the pink dolomite member ranges up to 400 feet, being greatest in the western third of the county, but in a few places particularly in Thompson Valley and east of Tazewell the member may be absent. The variation in thickness of the pink beds probably indicates the magnitude of the relief on the post-Beekmantown erosion surface which separates the "Knox" from the overlying Blackford formation. Some of the best exposures of the uppermost member of the "Knox" are: (1) in the quarry at locality 16, near Divide Church; (2) along U. S. Route 19 near Pounding Mill; and (3) along State Highway 4 north of Claypool Hill.

Quarriable zones of dolomite relatively free of chert and sand occur near the top and in the lower 1,000 feet of the "Knox," but very little of the high-magnesium dolomite averages less than 5 per cent noncarbonates. None of the "Knox" in Tazewell County is as suitable for chemical and physical uses as the Honaker formation.

Geologic Section 3.—"Knox" dolomite at locality 18, along the Norfolk and Western Railway, Wittens Mills, Tazewell County, Virginia

	Thickness Feet
"Knox" dolomite (2,075 feet)	
Pink dolomite member	
57. Poorly exposed; contains fine-grained dolomite with pinkish blotches, also a few beds of dolomite conglomerate	78
Upper cherty member, limy member, and lower cherty member (709.5 feet)	
56. Dolomite, gray, medium grained, cherty	37
55. Covered interval; probably contains some limestone	386
54. Dolomite, reddish blotches, coarse grained; with thin partings of red shale, cherty; SiO_2, 14.50; R_2O_3, 4.22; $CaCO_3$, 46.42; $MgCO_3$, 34.16; Total, 99.30	34
53. Dolomite and chert, interbedded; dolomite is gray; chert is gray and white banded	14
52. Dolomite, gray, medium grained, very cherty	32
51. Dolomite, coarse grained, brownish-gray; vugs and stringers of dolomite; SiO_2, 2.76; R_2O_3, 1.12; $CaCO_3$, 54.85; $MgCO_3$, 40.31; Total, 99.04	41
50. Dolomite, light pearl-gray, fine grained; SiO_2, 14.10; R_2O_3, 1.13; $CaCO_3$, 48.72; $MgCO_3$, 36.12; Total, 100.07	19
49. Dolomite, pearl-gray, fine grained	21
48. Dolomite, gray, with pink streaks	15
47. Dolomite, gray, fine grained	11
46. Dolomite, dark-gray, fine grained	3
45. Dolomite, gray, medium grained; chert in thin layers	18

	Thickness Feet
44. Dolomite, dark-gray, medium grained	30
43. Dolomite, gray, fine grained	7.2
42. Dolomite, gray, medium grained; contains 1-inch chert beds and thin intersecting streaks of quartz sand	22.2
41. Dolomite, light-gray, fine grained	12
40. Dolomite, buff-gray, with thin streaks of sand	0.6
39. Dolomite, light-gray, fine grained	6.5
Sandy member (423.5 feet)	
38. Dolomite, finely straticulate; contains thin sandy streaks	14
37. Dolomite, gray, medium grained: SiO_2, 9.36; R_2O_3, 1.10; $CaCO_3$, 50.67; $MgCO_3$, 39.45; Total, 100.58	10.9
36. Dolomite, light-gray, fine grained	24
35. Dolomite, medium-gray, medium grained	32.5
34. Covered interval	14
33. Sandstone, buff-gray, dolomitic	1.1
32. Dolomite, light-gray, fine grained	7
31. Dolomite, gray, coarse grained, cherty	5
30. Chert, gray	0.5
29. Edgewise conglomerate; composed of dolomite pebbles set in matrix of coarse dolomite	0.6
28. Dolomite, buff-gray, coarse grained; contains lenses of chert 1 to 5 inches thick	27
27. Dolomite, light-gray, medium grained	23
26. Dolomite, gray, medium grained	29
25. Covered interval	28.3
24. Sandstone, buff-gray	7.3
23. Dolomite, gray, fine grained, thin beds of chert and a few sandy streaks	33
22. Dolomite, coarse grained, white to buff; SiO_2, 8.35; R_2O_3, 0.84; $CaCO_3$, 51.29; $MgCO_3$, 39.75; Total, 100.23	14
21. Dolomite, light-gray, fine grained	15
20. Dolomite, light-gray, very fine grained; with crinkly laminae of fine-grained sandstone	19
19. Dolomite, gray, fine grained; SiO_2, 11.92; R_2O_3, 2.36; $CaCO_3$, 48.92; $MgCO_3$, 37.11; Total, 100.31	23

	Thickness Feet
18. Dolomite, very coarse grained, light-gray; SiO_2, 14.50; R_2O_3, 4.22; $CaCO_3$, 46.42; $MgCO_3$, 34.16; Total, 99.30	13
17. Dolomite, gray, medium grained; SiO_2, 7.27; R_2O_3, 1.55; $CaCO_3$, 51.73; $MgCO_3$, 39.51; Total, 100.06	4
16. Sandstone, buff-gray, dolomitic	2.6
15. Dolomite, gray, coarse grained	3
14. Sandstone, buff-gray, dolomitic; contains a few thin beds of edgewise conglomerate	7
13. Dolomite, light-gray	12
12. Dolomite, gray, medium grained	3
11. Dolomite, light-gray	15
10. Shale	0.4
9. Dolomite, buff-gray, medium grained	4.6
8. Dolomite, brownish-gray with thin siliceous crinkly laminae; SiO_2, 4.33; R_2O_3, 0.81; $CaCO_3$, 53.79; $MgCO_3$, 41.10; Total, 100.03	9
7. Dolomite, pearl-gray, medium grained	4
6. Sandstone, buff	1.6
5. Dolomite, gray, thick bedded; SiO_2, 1.59; R_2O_3, 0.50; $CaCO_3$, 56.17; $MgCO_3$, 42.20; Total, 100.46	11.5
4. Dolomite, gray, fine grained	1
3. Sandstone	3.6
Oolitic member (864 feet)	
2. Dolomite, gray, medium grained, dense	14
1. Dolomite, not continuously exposed; mostly medium- to dark-gray dolomite with thin intercalated partings of oolitic chert	850±

Geologic Section 4.—"Knox" dolomite along State Highway 4, at locality 91, between Claypool Hill and Cedar Bluff, Tazewell County, Virginia

	Thickness Feet
Blackford formation	
"Knox" dolomite (2,036.7 feet)	
Pink dolomite member (295 feet)	
215. Covered interval, a few exposed beds of light-gray dolomite with pinkish streaks and blotches	230

		Thickness Feet
214.	Chert, white, thick beds	16
213.	Dolomite, light bluish-gray, poorly exposed	26
212.	Dolomite, light-gray, very fine grained, vitreous texture, sandy	6.0
211.	Dolomite, medium grained, very sandy	3.0
210.	Dolomite, very fine grained, vitreous texture, sandy streaks	2.7
209.	Dolomite, medium-gray, sandy	0.8
208.	Dolomite, light-gray, fine grained, sandy	7.5
207.	Dolomite, very fine grained, dense, vitreous texture	3.0

Upper cherty member (150 feet)

206.	Dolomite, medium grained, sandy	1.4

Analysis of units 206 to 213; thickness sampled, 50.4 feet: SiO_2, 14.10; R_2O_3, 1.18; $CaCO_3$, 48.12; $MgCO_3$, 36.48; Total, 99.88.

205.	Dolomite, light bluish-gray, fine grained	4.5
204.	Dolomite, light-gray, medium grained	1.8
203.	Dolomite, very fine grained, vitreous texture; reddish streaks and blotches	9.3
202.	Dolomite, light-gray, medium grained; reddish streaks and blotches	14.0

Analysis of units 202 to 205; thickness sampled, 29.6 feet: SiO_2, 2.34; R_2O_3, 0.61; $CaCO_3$, 54.13; $MgCO_3$, 41.92; Total, 99.00.

201.	Dolomite, light-buff, fine grained, vitreous texture	2.5
200.	Dolomite, pearl-gray, silty	22.0
199.	Covered	10.5
198.	Dolomite, light-gray, fine grained	5.0
197.	Dolomite, medium-gray, speckled, fine grained	25.0
196.	Dolomite, medium-gray	7.0
195.	Dolomite, dark bluish-gray	9.0
194.	Dolomite, light-gray	4.5
193.	Dolomite, medium-gray	8.7
192.	Dolomite, buff-gray, sandy	.8
191.	Dolomite, banded light- and dark-gray	4.0
190.	Dolomite, light-gray, medium grained	3.4

		Thickness Feet
189.	Chert	0.6
188.	Dolomite, dark-gray	6.0
	Analysis of units 188 to 198; thickness sampled, 74 feet: SiO_2, 6.70; R_2O_3, 1.28; $CaCO_3$, 51.58; $MgCO_3$, 39.66; Total, 99.22.	
187.	Dolomite, light-gray, fine grained	5.0
186.	Chert, milky white	0.5
185.	Dolomite, very light-gray, fine grained, dense	4.5
Limy member		
184.	Covered; contains fine-grained light-gray limestone and saccharoidal dolomite	80.0
Lower cherty member (307.4 feet)		
183.	Dolomite, light-gray, fine grained, cherty; weathers whitish; sandy streaks	9.5
182.	Dolomite, dark- and light-gray banded; vugs of dolomite and chalcedony	16.0
181.	Dolomite, light-gray, medium grained, compact	10.0
180.	Chert	1.9
179.	Dolomite, pearl-gray, medium grained; SiO_2, 5.31; R_2O_3, 0.81; $CaCO_3$, 55.02; $MgCO_3$, 40.24; Total, 101.38	10.0
178.	Dolomite, dark-gray	9.2
177.	Dolomite, pearl-gray, fine grained, compact; vugs of dolomite and chalcedony	16.0
176.	Dolomite, coarse-grained; disseminated sand grains	0.5
175.	Chert, brecciated	0.5
174.	Dolomite, medium grained, cherty	1.5
173.	Chert	1.0
172.	Dolomite, light-gray, fine grained, dense; vugs of dolomite	8.0
171.	Dolomite, pearl-gray, medium to coarse grained	15.0
170.	Dolomite, poorly exposed	15.0
169.	Dolomite, medium-gray, medium grained	17.0
168.	Dolomite, coarse grained, vugs of dolomite	0.6
167.	Dolomite, pearl-gray, fine grained	8.0
166.	Chert	1.0
165.	Dolomite, bluish-gray	8.0

	Thickness Feet
164. Dolomite, light-gray, medium grained	1.4
163. Dolomite, bluish-gray	2.2
162. Dolomite, light-gray, fine grained	1.8
161. Dolomite, bluish-gray, fine grained	1.7
160. Dolomite, light-gray	1.6
Sandy member (429.90 feet)	
159. Dolomite, dark bluish-gray	17.3
158. Dolomite, bluish-gray, sandy, cherty	12.5
157. Dolomite, fine grained, light-gray, with thin sandy streaks	8.0
156. Dolomite, fine grained, dark bluish-gray; SiO_2, 1.88; R_2O_3, 0.80; $CaCO_3$, 54.79; $MgCO_3$, 43.69; Total, 101.16	40.0
155. Dolomite, bluish-gray, fine grained, cherty, brecciated	15.5
154. Dolomite, smoke-gray, sandy, conglomeratic	15.0
153. Sandstone, locally conglomeratic	12.5
152. Dolomite, sandy	1.5
151. Sandstone and sandy dolomite	2.5
150. Dolomite, medium-gray, medium grained	14.0
149. Dolomite, bluish-gray	17.9
148. Dolomite, light-gray, with sandy streaks	2.5
147. Dolomite, light-gray	2.5
146. Dolomite, light-gray	2.5
145. Dolomite, sandy	2.5
144. Dolomite, medium-gray	1.7
143. Dolomite, light-gray, fine grained, cherty	3.0
142. Dolomite, medium-gray	2.5
141. Poorly exposed interval of shale and sandstone	21.0
140. Dolomite, bluish-gray, straticulate	2.0
139. Chert	0.1
138. Dolomite, fine grained, cross bedded, sandy	1.0
137. Dolomite, brownish-gray	22.0
136. Sandstone, buff	3.2
135. Sandstone, gray, dolomitic	2.0
134. Dolomite, light-gray	2.5
133. Mostly covered; contains bluish-gray dolomite	32.0
132. Sandstone, rusty-brown	8.0

	Thickness Feet
131. Covered interval; contains some black and light-gray dolomites	65.0
130. Dolomite, medium-gray and dolomitic sandstone; poorly exposed	90.0
Oolitic member (774.4 feet)	
129. Dolomite, bluish-gray, cherty	66.0
128. Dolomite, light-gray, granular, mealy	16.0
127. Covered interval; contains *Cryptozoon*-bearing chert	16.0
126. Dolomite, bluish-gray, granular, cross bedded	14
125. Dolomite, light-gray, pink blotches	16
124. Dolomite, light-gray, fine to medium grained	10
123. Dolomite, bluish-black, weathers mealy	6.5
122. Dolomite, dark-gray, siliceous partings; vugs of drusy quartz	16
121. Dolomite, light-gray, sandy	1.2
120. Dolomite, light-gray, medium grained, cherty	4.5
119. Dolomite, black granular	55
118. Dolomite, buff, shaly	2
117. Dolomite, medium-gray, medium grained, cherty	14
116. Chert, oolitic	0.2
115. Dolomite, light bluish-gray mottled with buff, medium grained; contains sandy streaks	8
114. Dolomite, light-gray; contains vugs of quartz and dolomite	2
113. Chert, black, oolitic	0.7
112. Dolomite, medium-gray, fine grained	19
111. Dolomite, light-gray, very coarse grained	6
110. Dolomite, light-gray, medium grained, cherty; contains *Cryptozoon*	4
109. Dolomite, medium-gray, cherty	3
108. Dolomite, dark bluish-gray	7.8
107. Dolomite, medium-gray; contains chert concretions	6
106. Dolomite, bluish-gray	7.2
105. Chert, white, granular texture	1
104. Dolomite, bluish-gray	9.5
103. Dolomite, light-gray, fine grained	4
102. Dolomite, bluish-gray, medium grained	7
101. Conglomerate, composed of granules of dolomite	0.9

		Thickness Feet
100.	Dolomite, medium-gray	2.8
99.	Dolomite, dark bluish-gray	2.0
98.	Dolomite, reddish streaked, very fine grained	3
97.	Dolomite, bluish-gray	18.5
96.	Dolomite, light-gray, fine grained	1.6
95.	Dolomite, mottled gray and black, fine grained	3.5
94.	Dolomite, dark bluish-gray	9.3

Analysis of units 94 to 126; thickness sampled, 138.4 feet: SiO_2, 4.46; R_2O_3, 1.32; $CaCO_3$, 52.63; $MgCO_3$, 40.70; Total, 99.11.

93.	Dolomite, light-gray, fine grained	4.0
92.	Dolomite, light-gray, very coarse grained, with shaly partings	1.8
91.	Dolomite, light-gray, reddish tinted, fine grained	5.2
90.	Dolomite, bluish-gray	2.4
89.	Dolomite, medium-gray	1.8
88.	Dolomite, dark bluish-gray	2
87.	Dolomite, light-gray, fine grained	1.1
86.	Dolomite, dark bluish-gray	3.0
85.	Dolomite, dark bluish-gray, medium to fine grained, cherty at top	9
84.	Dolomite, medium-gray, coarse grained, sandy	1.6
83.	Dolomite, medium-gray, with sandy streaks	4.8
82.	Dolomite, bluish-gray, mottled, vuggy	2
81.	Dolomite, light-gray, fine grained, thoroughly fractured	6.9
80.	Dolomite, bluish-gray, fine grained	4.0
79.	Dolomite, medium-gray, medium grained	4.0
78.	Dolomite, bluish-gray, vuggy	5.2
77.	Chert, black, oolitic	0.5
76.	Dolomite, medium-gray	1.5
75.	Dolomite, dark bluish-gray; vugs of white dolomite	5
74.	Fault breccia along vertical fault, with displacement of about 5 feet	1
73.	Dolomite, light-gray, coarse grained	4.0

Analysis of units 73 to 93; thickness sampled, 70 feet: SiO_2, 14.02; R_2O_3, 2.42; $CaCO_3$, 47.26; $MgCO_3$, 34.61; Total, 98.31.

	Thickness Feet
72. Dolomite, dark bluish-gray, granular, vuggy	5.6
71. Dolomite, light-gray, thin bedded, cherty	4.0
70. Shale, brown	0.6
69. Dolomite, medium-gray, fine grained	1.2
68. Dolomite, bluish-gray; vugs of calcite	10.0
67. Dolomite, medium-gray; vugs of calcite	7.7
66. Dolomite, black, fine grained; vugs of dolomite	1.7
65. Dolomite, light-gray, medium to coarse grained	2.2
64. Dolomite, light-gray, fine grained	1.4
63. Dolomite, black; vugs of white dolomite	7.2
62. Dolomite, medium-gray	0.9
61. Dolomite, black; vugs of white dolomite	4.7
60. Chert, black, oolitic	0.3
59. Dolomite, bluish-gray, medium grained; contains thin wavy plates of chert and vugs of calcite	20.0
58. Dolomite, medium-gray	1.9
57. Dolomite, black, contains vugs of white dolomite	15.0
56. Dolomite, bluish-gray, finely straticulate, abundant *Cryptozoon* chert	6.0
55. Dolomite, bluish-gray; contains thin plates of oolitic chert	4.0
54. Dolomite, dark-gray, medium grained	24.0
53. Dolomite, medium-gray, fine grained	4
52. Dolomite, bluish-gray; contains vugs of white calcite	3.5
51. Dolomite, light-gray, coarse grained, sandy, oolitic	1.5
50. Dolomite, black, medium grained; vugs of white calcite	8.0
49. Dolomite, light-gray, with sandy streaks	1.0
48. Dolomite, dark-gray; contains stringers and vugs of white calcite	28
47. Dolomite, light- and dark-gray, mottled	2
46. Dolomite, medium to coarse grained	4
45. Dolomite, bluish-gray	0.5
44. Dolomite, medium-gray	2.7
43. Dolomite, dark bluish-gray, medium grained	9.0
42. Dolomite, black; contains chertified *Cryptozoon*	0.7
41. Dolomite, dark bluish-gray, granular, oolitic	2.9

Analysis of units 41 to 54; thickness sampled, 92 feet: SiO_2, 1.17; R_2O_3, 0.48; $CaCO_3$, 56.39; $MgCO_3$, 41.99; Total, 100.03.

	Thickness Feet
40. Dolomite, dark bluish-gray, granular, thick bedded; SiO_2, 8.42; R_2O_3, 2.97; $CaCO_3$, 49.27; $MgCO_3$, 40.40; Total, 101.06	3.0
39. Dolomite, light-gray, fine grained, sandy streaks	5.5
38. Dolomite, drab-gray, oolitic and cherty	1.4
37. Dolomite, medium-gray	1.8
36. Dolomite and chert, black; contains *Cryptozoon*	2.0
35. Dolomite, medium-gray, medium grained	0.7

Analysis of units 35 to 126, exclusive of cherty and shaly partings; thickness sampled, 538 feet: SiO_2, 2.32; R_2O_3, 0.88; $CaCO_3$, 55.57; $MgCO_3$, 41.41; Total, 100.18.

34. Shale	0.6
33. Dolomite, medium-gray, saccharoidal, deeply weathered	6.5
32. Chert	0.2
31. Dolomite, light-gray, fine grained	1.7
30. Shale and chert	0.2
29. Dolomite, light-gray, very fine grained	2.0
28. Shale, dark-gray, siliceous, interlaminated with black oolitic chert	0.3
27. Dolomite, medium-gray	1.5
26. Dolomite, light pearl-gray, pink blotches	5.3
25. Chert	0.3
24. Dolomite, light pearl-gray, pink blotches	2.0
23. Dolomite, medium-gray to bluish-gray, oolitic	13.0
22. Dolomite, dark bluish-gray, oolitic	3.0
21. Dolomite, light-gray, very coarse grained	2.0
20. Dolomite, pearl-gray	2.5

Analysis of units 20 to 33, exclusive of shale and chert; thickness sampled, 41 feet: SiO_2, 1.65; R_2O_3, 0.83; $CaCO_3$, 54.40; $MgCO_3$, 43.11; Total, 99.99.

19. Dolomite, medium gray, thin bedded, crinkled siliceous partings	5.0
18. Dolomite, dark-gray, shaly	6.0
17. Dolomite, light-gray	1.0

	Thickness Feet
16. Dolomite, medium-gray, fine grained	4.6
15. Chert, black, oolitic	0.4
14. Dolomite, medium-gray	1.6
13. Sandstone and sandy dolomite	3.4
12. Dolomite, medium-gray	3.6
Analysis of units 12 to 19; thickness sampled, 25± feet: SiO_2, 1.35; R_2O_3, 0.71; $CaCO_3$, 58.53; $MgCO_3$, 41.22; Total, 101.81.	
11. Dolomite, dark bluish-gray; contains oolitic chert	2.7
10. Dolomite, medium-gray, thin bedded	8.0
9. Dolomite, dark bluish-gray	6.0
8. Dolomite, medium-gray, with partings of edgewise conglomerate	2.4
7. Dolomite, dark-gray, straticulate, fine grained	54
Nolichucky formation (195 feet)	
6. Maynardville limestone member, magnesian, straticulate, irregularly banded with partings of clay	33
5. Shale, dark reddish-brown and dark-gray	43
4. Limestone, dark bluish-gray, magnesian	4.5
3. Shale, greenish-gray and reddish-brown	80
2. Limestone, dark-gray, banded, shaly	5
1. Shale, greenish-gray to dark bluish-gray, with limestone bands	62
Honaker formation	

DOLOMITE OF UNCERTAIN AGE

At The Jump and at Cedar Bluff Station on the Norfolk and Western Railway, a faulted slice of dolomite forms the trend of the St. Clair overthrust block. Although this dolomite is associated with red and green shales of the Rome formation, it is not part of that formation. The general character and color suggest that the dolomite beds are slices of Upper Cambrian or Lower Ordovician dolomite, dislodged from the tread of the fault and carried along with the overriding thrust block. The following section is exposed along the railroad near the junction of the Norton Division and the Iaeger Branch of the Norfolk and Western Railway (Pl. 3B).

Geologic Section 5.—Dolomite along the St. Clair fault, at locality 93, Cedar Bluff Station, Tazewell County, Virginia

	Thickness Feet
Honaker formation	
Rome formation (223.3 feet)	
31. Shale, red and green	3.0
30. Limestone, magnesian, banded, clayey	3.4
29. Shale, calcareous	1.2
28. Limestone, dark bluish-gray, magnesian, banded	4.0
27. Shale, bluish-gray, calcareous	2.7
26. Limestone, dark bluish-gray; dolomite	7.0
25. Shale, drab-gray	0.8
24. Dolomite, dark-gray, straticulate	24.0
23. Dolomite, bluish-gray, fine grained	48.0
22. Shale and siltstone, interbedded black, red, and green layers	27.0
21. Limestone, dark bluish-gray, banded	0.8
20. Shale, black	2.4
19. Limestone, dark bluish-gray, banded	1.3
18. Shale, black, with thin intercalated dolomites	8.0
17. Dolomite, light-gray	33.2
16. Limestone, magnesian, banded; intercalated silty shales	11.8
15. Conglomerate, composed of edgewise slivers of limestone and dolomite	0.4
14. Shale, dark-gray	16.0
13. Dolomite, bluish-gray; weathers rusty-brown	1.6
12. Shale, gray	8.0
11. Shale and arkosic siltstone	4.0
10. Shale, red and green	1.6
9. Siltstone, reddish-brown	4.5
8. Shale, red and green, silty, probably faulted at base	15.6
Dolomite of uncertain age	
7. Dolomite, light-gray, fine grained	188.0
6. Dolomite, dark-gray, medium grained	88.0
5. Dolomite, thoroughly fractured	20.0
4. Dolomite, light-gray, with argillaceous partings	8.0
3. Dolomite, medium-gray, medium grained	6.0

Analysis of units 3 to 7; thickness sampled, 310 feet: SiO_2, 10.70; R_2O_3, 1.90; $CaCO_3$, 49.44; $MgCO_3$, 37.40; Total, 99.44.

	Thickness Feet
Little Valley limestone (faulted slice)	
2. Limestone, sheared, crumbly, argillaceous	13.0
1. Limestone, coarse grained, with intercalated dolomitic layers; directly overlies Devonian black shale along the St. Clair fault (Pl. 3B)	35.0

QUARRIES

The Five Oaks Lime Company operated a small quarry (locality 20) in the upper part of the Beekmantown and lower Blackford formation during construction of U. S. Route 19 in the middle of the 1930's (Pl. 8B). The rock is exceedingly cherty and not particularly suitable for crushed stone. Many of the layers, particularly on the south side of the quarry, disintegrate to a fine rubble on exposure for a year or more. The quarry has been abandoned and the crusher dismantled.

Several small roadside quarries in dolomite were operated temporarily by the State Department of Highways during the construction of U. S. Route 19 between Wittens Mills and Bluefield. The largest of these openings is along the highway about 0.30 mile west of Divide Church (locality 16). Most of the 75 feet of beds exposed in the quarry are medium-gray, sandy dolomite.

QUARRY SITES

Extensive deposits of high-magnesium dolomite in the upper part of the Honaker formation are available in the vicinity of locality 14,

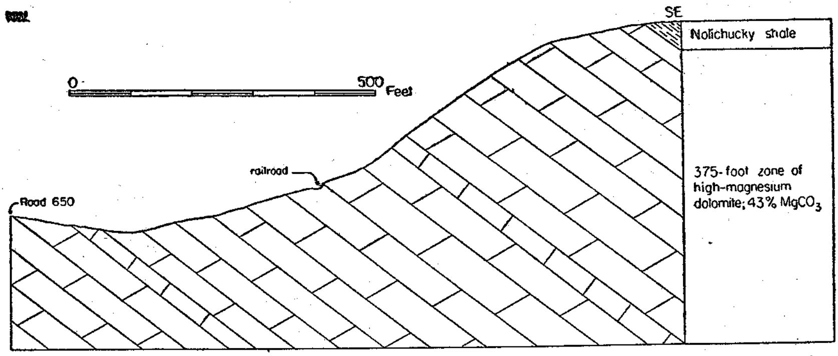
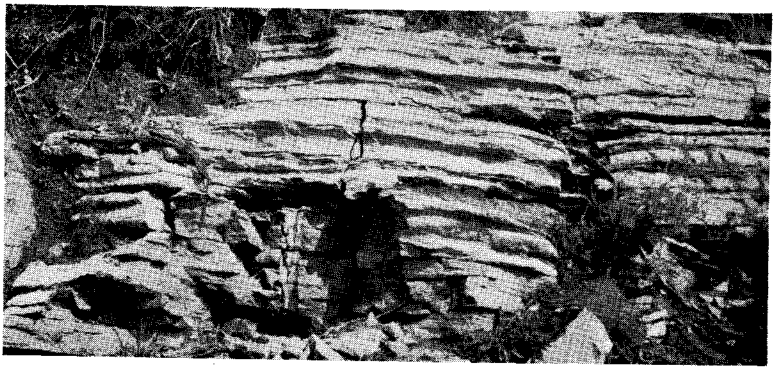


FIGURE 5.—High-magnesium dolomite in upper part of the Honaker formation near Wittens Mills, Tazewell County, Virginia.

north of Wittens Mills (Fig. 5). A quarry face 150 feet high could be developed and the workings extended northeastward along the strike

A.

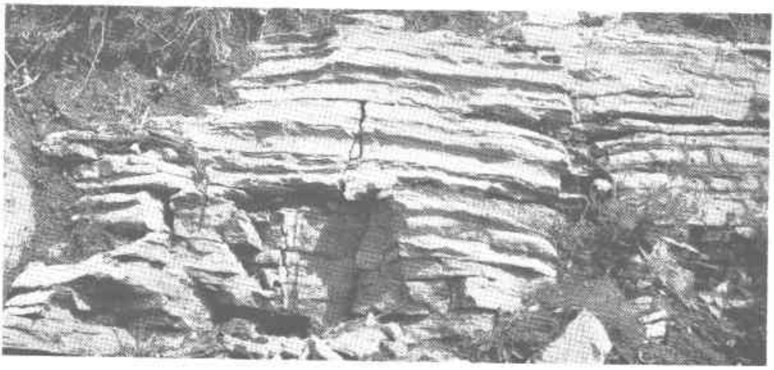


B.

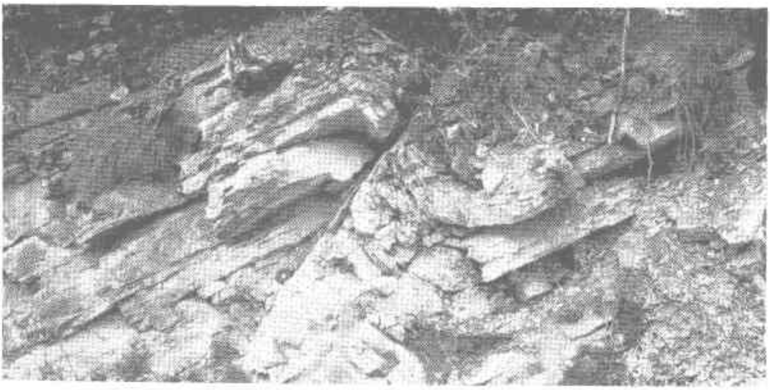
C.

A, Ordovician limestone at locality 28, near Gratton, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.) B, "Marble" beds in the Moccasin formation in Burkes Garden, Tazewell County, Virginia. C, Fold and reverse fault in Witten limestone, along State Highway 91 in Thompson Valley, Tazewell County, Virginia.

A.

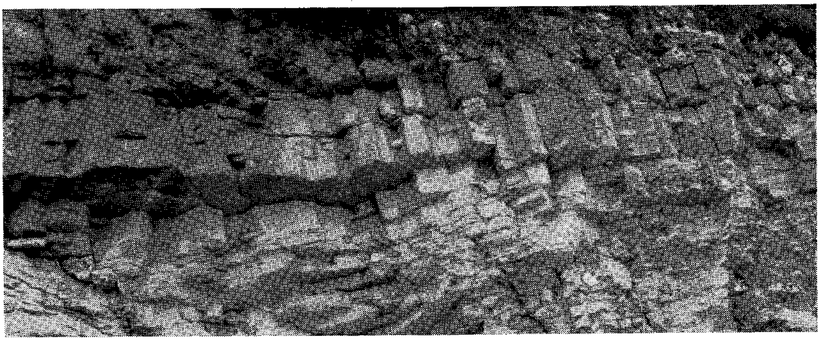


B.

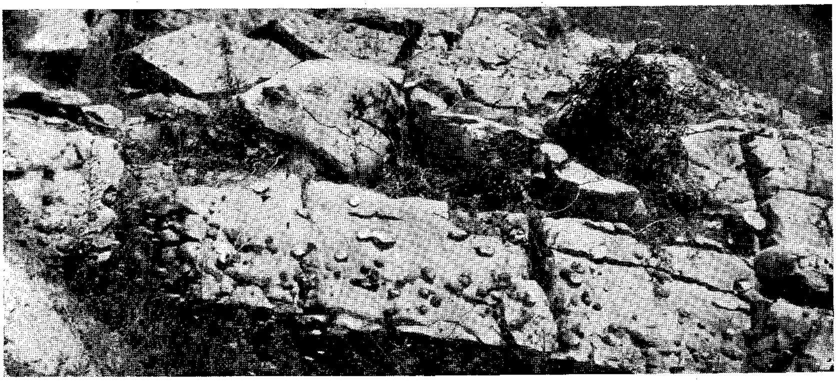


C.

A, Ordovician limestone at locality 28, near Gratton, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.) B, "Marble" beds in the Moccasin formation in Burkes Garden, Tazewell County, Virginia. C, Fold and reverse fault in Witten limestone, along State Highway 91 in Thompson Valley, Tazewell County, Virginia.



A.



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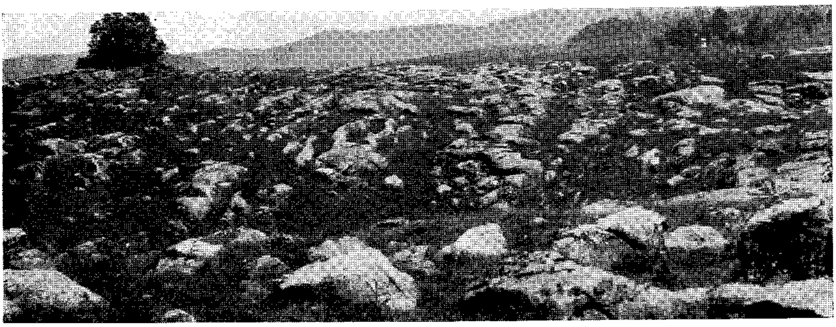
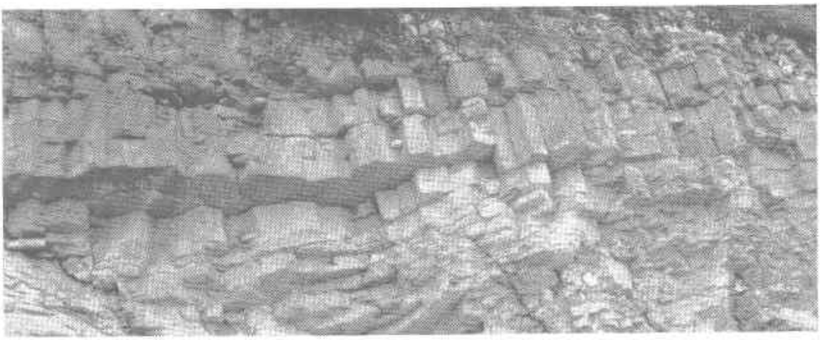


C.

A, Columnar jointing in Witten limestone near Tazewell, Virginia. (From Virginia Geological Survey Bulletin 60.) B, Mississippian cherty limestone near Bandy, Tazewell County, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.) C, Ward Cove limestone at the type locality in western Tazewell County, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.)



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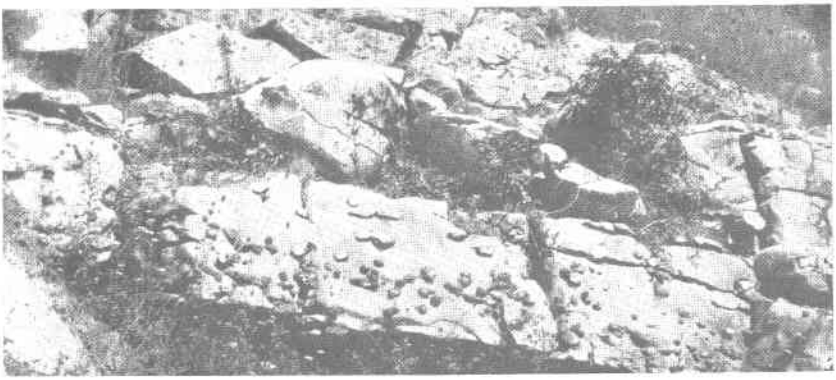


B.

C.

A, Columnar jointing in Witten limestone near Tazewell, Virginia. (From Virginia Geological Survey Bulletin 60.) B, Mississippian cherty limestone near Bandy, Tazewell County, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.) C, Ward Cove limestone at the type locality in western Tazewell County, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.)

for somewhat more than 7,500 feet, along the south side of the railroad. The same beds could also be quarried extensively in the hills west of Wittens Mills.

The most favorable site for obtaining large quantities of high-magnesium dolomite in the Honaker is in the south environs of Cedar Bluff. In the hills immediately west of State Highway 4, practically inexhaustible quantities of uniformly high-grade rock are available well above the level of Clinch River (Fig. 6). Analyses of the Honaker dolomite are given in Geologic Sections 1 and 2 and in Table 3.

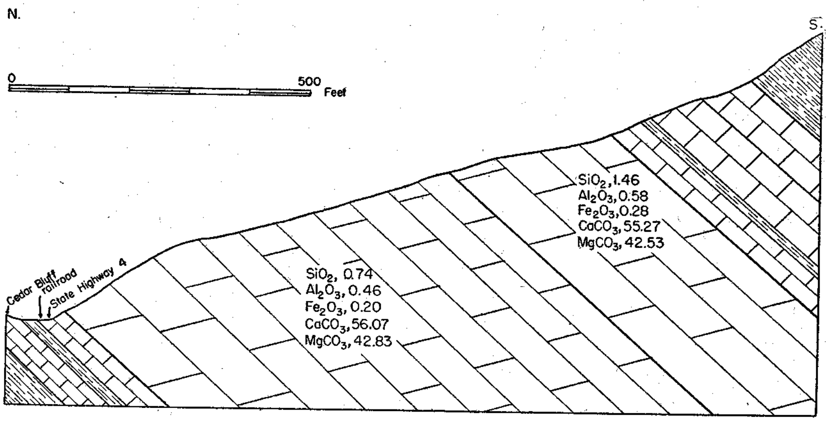


FIGURE 6.—Structure of the high-magnesium dolomites in the Honaker formation south of Cedar Bluff, Tazewell County, Virginia.

Occurrences of dolomite suitable for use as crushed stone and stone sand are so numerous that no specific localities need to be discussed. Quarries in the "Knox" dolomite can not be expected to yield stone containing less than 5 per cent noncarbonates, even though the more sandy and cherty portions are avoided. Since the Honaker is also suitable for crushed stone, as well as chemical uses, it seems very unlikely that any quarries, other than small temporary local ones for road stone, will be opened in the "Knox" dolomite in Tazewell County.

LIMESTONE

"KNOX" DOLOMITE

Although the "Knox" is composed principally of dolomite, it contains an intercalation of high-carbonate limestone which is 50 to 75 feet thick. This limestone is very fine grained and compact. Most layers are pearl-gray, but some are mottled with mauve, pale-green, and shades of red. The best exposure of limestone in the "Knox" is in an abandoned quarry near Gratton (locality 31), where about 75 feet of mottled limestone was once quarried for crushed rock. The same beds are exposed on the crest of an anticline along State Highway 61 west of Marys Chapel (locality 27). The same unit is 20 to 40 feet thick along Road 609 at locality 97 and is about 50 feet thick at locality 98, near the Russell-Tazewell County line.

In Thompson Valley, a similar limestone, occurring at about the same horizon in the "Knox," is well exposed between localities 37 and 40. Near Creagers Mill, locality 40, it is about 70 feet thick (Table 3). This limestone has been traced southwestward to the base of Morris Knob, thence around the nose of the Thompson Valley anticline northeastward to Road 604. Beyond this point the limestone is largely replaced by fossiliferous chert. Some of this limestone was burned for lime in an old kiln at locality 39. Analyses of the limestone member of the "Knox" are given in Table 3.

ELWAY LIMESTONE

The Elway limestone consists of dove-gray to dark bluish-gray, fine-grained argillaceous limestones containing much chert which weathers into characteristic blocks (Figs. 7-8). Generally the Elway is very poorly exposed, but its position is invariably marked by an abundance of fossiliferous blocks of chert in the mantle rock. Among the distinctive fossils are *Dinorthis holdeni,* species of *Calliops,* and *Leperditia.* The average thickness is 35 to 40 feet. Although the Elway as a whole is too impure for any use, the residual chert has been used on some secondary roads. Fine exposures of the Elway occur along U. S. Route 19 near Pisgah (locality 56), near Pounding Mill (locality 76), and at Five Oaks (Geologic Section 6). The weathered, spongy-textured, blocky chert containing an abundance of characteristic fossils is extensively displayed in the vicinity of the intersection of U. S. Route 19 and State Highway 4 at Claypool Hill.

The zone of blocky chert here named the Elway limestone was formerly classed with the Blackford, but in this report the Blackford is restricted to the succession of ash-gray shales (Pl. 14B) and underlying basal clastics[19]. The name Elway is taken from a settlement along U. S. Route 19 near Lebanon, Russell County, Virginia. The type section is along State Highway 80 near Blackford, Russell County (Geologic Section 85).

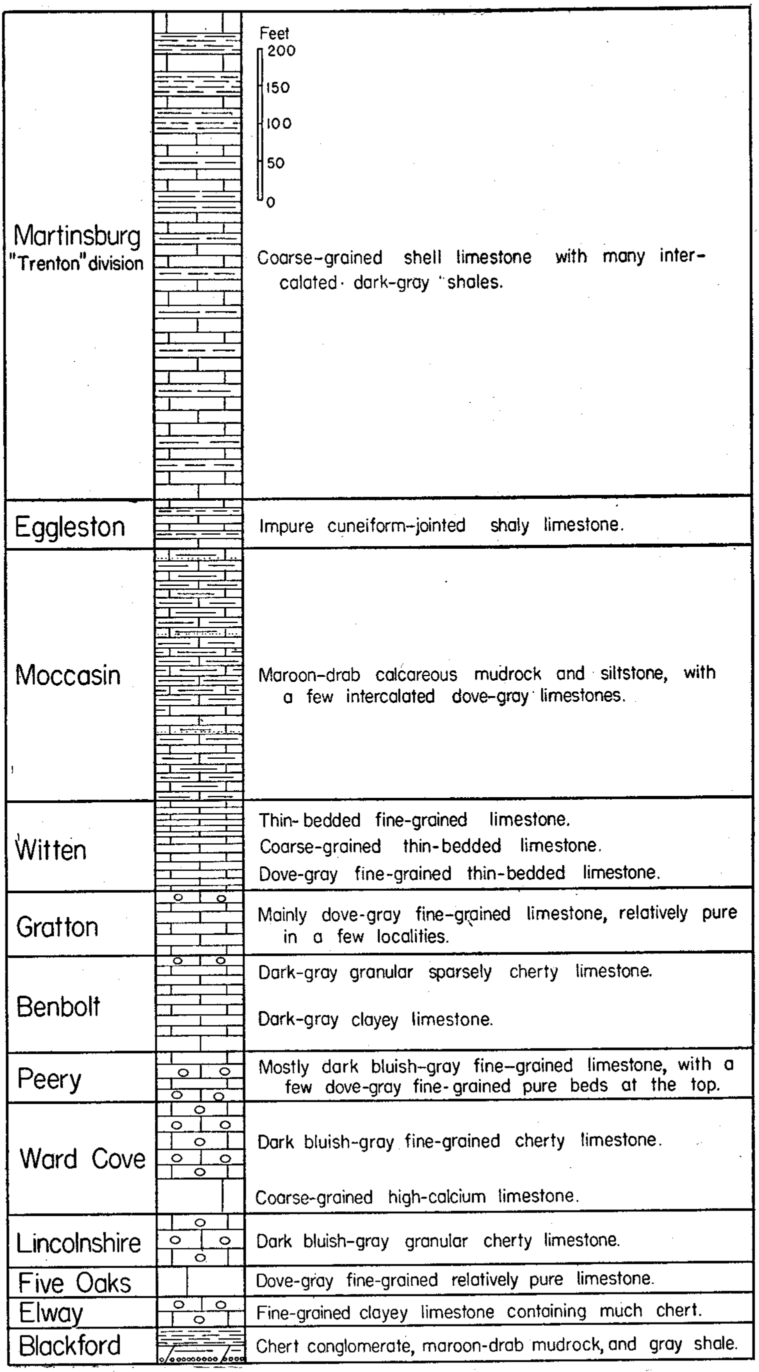


FIGURE 7.—Middle Ordovician limestones in eastern Tazewell County, Virginia.

FIVE OAKS LIMESTONE

The Five Oaks limestone, known as Mosheim limestone in older reports, is composed mainly of very fine-grained, compact limestone of a prevailingly dove-gray color (Figs. 7-8). The maximum thickness of 117 feet occurs in the quarry of the Peery Lime Company at North Tazewell (Geologic Section 56). The type section is in the quarry at Five Oaks (Pl. 8C).

Geologic Section 6.—Five Oaks limestone and associated beds in the lime quarry at Five Oaks, Tazewell County, Virginia

	Thickness Feet
Lincolnshire limestone (lower part)	
10. Limestone, dark bluish-gray, medium grained, cherty	35
Five Oaks limestone	
9. Limestone, dove-gray, fine grained; SiO_2, 1.14; R_2O_3, 0.57; $CaCO_3$, 97.62; $MgCO_3$, 0.45; Total, 99.78	50
Elway limestone (only upper 14 feet exposed)	
8. Limestone, fine grained, dove-gray, cherty	1.25
7. Limestone, dove-gray, fine grained	1.2
6. Limestone, dove-gray, fine grained, cherty	1.5
5. Limestone, gray	1.1
4. Limestone, dove-gray, fine grained, cherty	1.2
3. Limestone, light-gray, fine grained	4.2
2. Covered	2.6
1. Limestone, thin bedded, argillaceous; lowest beds exposed in quarry	0.9

In Tazewell County, there are very few places where the Five Oaks consists of 30 feet or more of high-calcium limestone. It is about 20 feet thick at locality 23, east of Five Oaks; 35 feet thick along Lincolnshire Branch, locality 19; about 15 feet thick at locality 56 along U. S. Route 19 west of Pisgah Church; 18 feet thick at locality 61, near Maxwell; about 18 feet thick in a quarry at locality 45, beside Road 648 just beyond the east limits of Tazewell; 25 feet thick at locality 76, along Pounding Mill Branch; 0 to 15 feet thick in Ward Cove; and 15 feet thick at locality 90 north of Wardell. At locality 36, west of Marys Chapel, and also at locality 7 south of Shannondale,

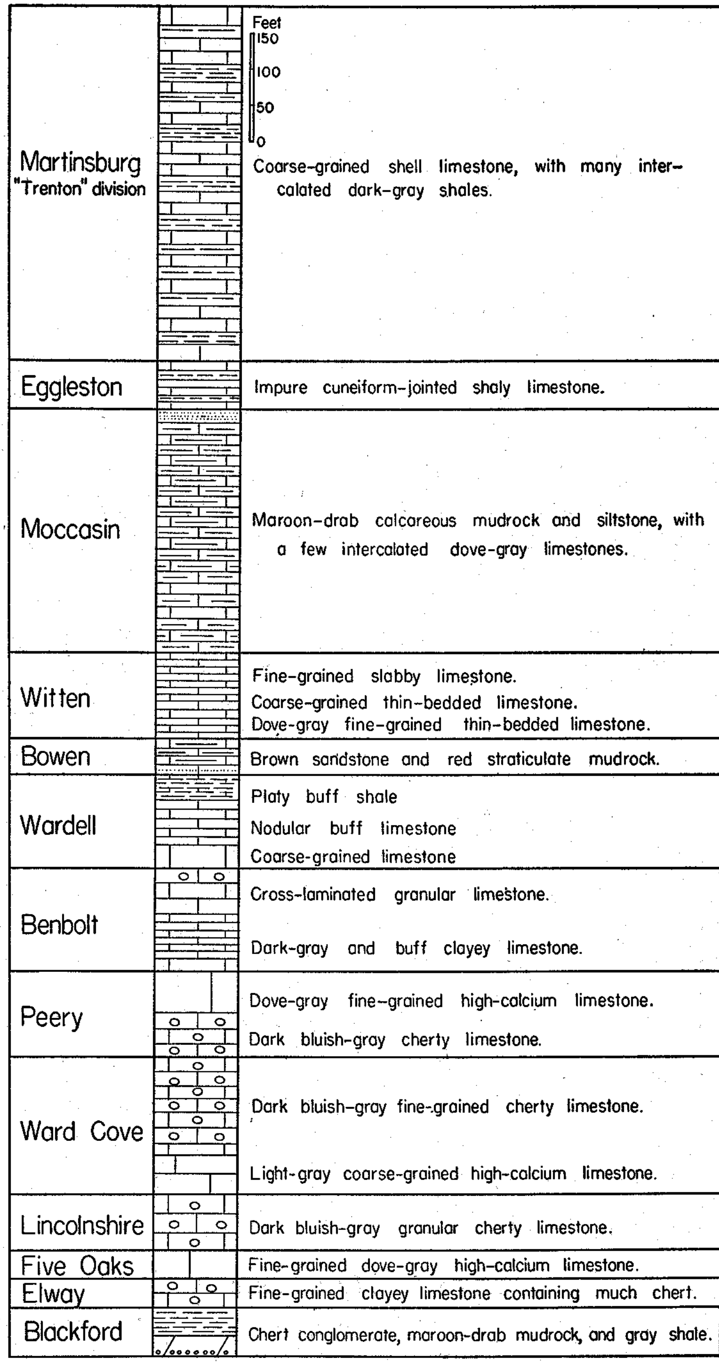


FIGURE 8.—Middle Ordovician limestones in western Tazewell County, Virginia.

the Five Oaks consists of 44 feet of thick-bedded, high-calcium limestone. In other sections of the Appalachian Valley in Virginia, the Five Oaks ("Mosheim") is considerably thicker and the main source of chemical lime, but in Tazewell County the formation is too thin to be quarried for industrial limestone. Analyses of the Five Oaks limestone are given in Table 3 and Geologic Section 6.

LINCOLNSHIRE LIMESTONE

The Lincolnshire limestone (Geologic Section 7) is composed mainly of dark bluish-gray cherty limestone with an average thickness of about 75 feet (Figs. 7-8). It forms the overhanging ledge in the quarry at Five Oaks and the north rim of the large quarry at Pounding Mill (locality 77, Fig. 4). Except for chert nodules which are rather abundant in some layers, the Lincolnshire is relatively pure limestone. The Lincolnshire is persistent and occurs in all of the Ordovician limestone belts in Tazewell County.

Geologic Section 7.—Lincolnshire limestone at locality 19, along Lincolnshire Branch, Tazewell County, Virginia

	Thickness Feet
Ward Cove limestone	
Lincolnshire limestone (102 feet)	
5. Limestone, dark bluish-gray, medium grained, cherty	52
4. Limestone, medium-gray	5
3. Limestone, dark-gray, cherty	21
2. Limestone, dark-gray, compact, "worm-eaten"	6
1. Limestone, dark bluish-gray, medium grained	18

Analysis units 1 to 5, exclusive of chert nodules which constitutes 8 to 10 per cent of the rock; thickness sampled, 102 feet: SiO_2, 1.37; R_2O_3, 0.43; $CaCO_3$, 97.53; $MgCO_3$, 2.44; Total, 101.77.

Five Oaks limestone (Table 3)

WARD COVE LIMESTONE

In central and western Tazewell County, the Ward Cove limestone is 175 to 225 feet thick and consists of 25 to 75 feet of coarse-grained limestone at the base, and 120 to 185 feet of dark bluish-gray fine-grained cherty limestone in the middle and upper parts (Figs. 7-8). The Ward Cove is well exposed at locality 88 in Thompson Valley, near the junction of State Highway 91 and Road 604 (Pls. 4A, 6C), and just northeast of the junction of State Highway 16 and Road 604 on the northwest side of Thompson Valley, near locality 43.

Geologic Section 8.—Ward Cove limestone at locality 88, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Peery limestone	
Ward Cove limestone (219 feet)	
12. Limestone, brownish-gray, nodular, fine grained; sparse *Nidulites*	18
11. Limestone, light-gray, fine grained, argillaceous, shaly	18
10. Limestone, dark-gray, fine grained, cherty, nodular; contains abundant *Nidulites*	20
9. Limestone, dark-gray, coarse grained; *Receptaculites* abundant	75
8. Limestone, gray, coarse grained, cross laminated	19
7. Limestone, dark-gray, cherty, fine grained	44
6. Limestone, buff-gray, medium to coarse grained, granular	6
5. Limestone, brownish-gray, granular	26
4. Limestone, medium to coarse grained, cobbly	13
3. Limestone, light-gray, coarse grained, clastic texture	10
2. Limestone, mottled reddish-tan and gray, coarse grained; contains *Oxoplecia holstonensis*	10
1. Limestone, light-gray, pinkish, saccharoidal	10
Lincolnshire limestone	

Geologic Section 9.—Ward Cove limestone near locality 43, along State Highway 16, Thompson Valley, Virginia

	Thickness Feet
Peery limestone	
Ward Cove limestone (181 feet)	
4. Limestone, dark bluish-gray to brownish-gray, fine grained, cherty	40
3. Limestone, bluish-gray, fine grained	45
2. Limestone, very cherty, medium grained	46
Analysis of units 2 to 4; thickness sampled, 131 feet: SiO_2, 3.25; R_2O_3, 0.32; $CaCO_3$, 88.25; $MgCO_3$, 3.22; Total, 95.04.	
1. Limestone, light-gray, coarse grained; SiO_2, 0.70; R_2O_3, 0.35; $CaCO_3$, 95.52; $MgCO_3$, 3.22; Total, 99.79	60
Lincolnshire limestone	

Northeast of Tazewell, the Ward Cove thins perceptibly and is composed almost wholly of cherty limestone, except locally where very fine-grained or coarse-grained, relatively pure limestones predominate (Geologic Sections 56, 58-60). The coarse-grained limestones at the base are about 20 feet thick at locality 80, about a mile southwest of Gillespie; 72 feet thick in the main quarry at Pounding Mill (Pl. 7B; Fig. 9); and 18 feet thick at locality 44, west of Tazewell. Some of the coarse-grained beds were burned locally for lime at locality 88 in Thompson Valley many years ago. At Pounding Mill, the coarse-grained beds of the Ward Cove are quarried for fluxing stone.

Geologic Section 10.—Ward Cove limestone in the main quarry of the Pounding Mill Quarry Corporation (locality 77), Pounding Mill, Tazewell County, Virginia

	Thickness Feet
Peery limestone (lower part)	
5. Limestone, black, fine grained, cherty; contains lenses of coarse-grained limestone	11
4. Limestone, dark-gray, cherty	19

	Thickness Feet
Ward Cove limestone (167 feet)	
3. Limestone, dark-gray, cherty, thin bedded; many *Nidulites*	25
2. Limestone, medium to fine grained, sparsely cherty, with thin intercalated coarse-grained layers; beds weather with a thick chalky crust which is full of fossils	80
Analysis of units 2-5, exclusive of chert; thickness sampled, 135 feet: SiO_2, 2.92; R_2O_3, 0.42; $CaCO_3$, 92.16; $MgCO_3$, 4.01; Total, 99.51.	
1. Limestone, gray, medium to coarse grained; SiO_2, 0.62; R_2O_3, 1.28; $CaCO_3$, 96.52; $MgCO_3$, 1.05; Total, 99.47	62
Lincolnshire limestone	

PEERY LIMESTONE

The Peery limestone, which succeeds the Ward Cove, is characterized by marked variations in thickness and character. Where typically developed, it consists of dark bluish-gray cherty limestone below and an overlying zone of dove-gray relatively pure fine-grained, high-calcium limestone (Figs. 7-8). The cherty beds are relatively persistent, but in many parts of the county the overlying dove-gray limestone is absent. Locally, the upper, dove-gray limestones contain clastic layers which are cross bedded, granular, and conglomeratic. The best display of cross-laminated limestone is at locality 88, along State Highway 91 in Thompson Valley (Pl. 13C). The principal belt of high-calcium limestone in Tazewell County is in the Peery formation along U. S. Route 19 and the Norfolk and Western Railway between Pounding Mill and Pisgah Church. Within this belt, the fine-grained beds range in thickness from 57 to 165 feet. In most other parts of Tazewell County where exposed, the Peery is much thinner and contains little if any high-calcium limestone.

Geologic Section 11.—Peery limestone at locality 72, near Claypool Hill, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (74 feet)	
2. Limestone, dove-gray, fine grained	40
1. Limestone, cherty, dark-gray	34
Ward Cove limestone	

Geologic Section 12.—Peery limestone in roadside quarry at locality 73, east of Claypool Hill, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (80 feet)	
2. Limestone, dove-gray, fine grained: SiO_2, 5.35; R_2O_3, 0.93; $CaCO_3$, 92.89; $MgCO_3$, 0.69; Total, 99.86	60
1. Limestone, dark-gray, cherty	20
Ward Cove limestone	

Geologic Section 13.—Peery limestone at locality 74, about 1.7 miles west of Pounding Mill, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (97 feet)	
6. Limestone, dove-gray, very fine grained, pure	41
5. Limestone, buff-gray, clayey, laminated	4.5
4. Limestone, impure, drab-gray, clayey	7
3. Limestone; light-gray, fine grained; weathers mealy	18.5
2. Limestone, clastic texture, cross laminated, impure	3
1. Limestone, dark-gray, cherty	23
Ward Cove limestone	

Geologic Section 14.—Peery limestone at locality 75, about 0.8 mile west of Pounding Mill, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (107 feet)	
4. Limestone, dove-gray, thick bedded	28
3. Limestone, dove-gray, thin bedded	49
Analysis of units 3 and 4; thickness sampled, 77 feet: SiO_2, 1.46; R_2O_3, 0.94; $CaCO_3$, 95.31; $MgCO_3$, 1.27; Total, 98.98.	
2. Limestone, dove-gray, cross laminated; clastic texture	10
1. Limestone, dark-gray, cherty	20
Ward Cove limestone	

Geologic Section 15.—Peery limestone at locality 78, Pounding Mill, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (99 feet)	
4. Limestone, dove-gray, fine grained; SiO_2, 0.62; R_2O_3, 1.28; $CaCO_3$, 96.52; $MgCO_3$, 1.05; Total, 99.47	57
3. Limestone, light- to medium-gray, coarse-grained; SiO_2, 2.42; R_2O_3, 0.52; $CaCO_3$, 95.23; $MgCO_3$, 1.91; Total, 100.08	12
2. Limestone, black, fine grained, cherty; lenses of coarse-grained limestone	11
1. Limestone, dark-gray, cherty	19
Ward Cove limestone	

Geologic Section 16.—Peery limestone at locality 81, about 0.6 mile southwest of Gillespie, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (118 feet)	
3. Limestone, dove-gray, thick bedded, pure	87
2. Limestone, dove-gray, granular; few clayey layers	19
Analysis of units 2 and 3; thickness sampled, 106 feet: SiO_2, 1.36; R_2O_3, 0.68; $CaCO_3$, 96.94; $MgCO_3$, 0.85; Total, 99.83.	
1. Limestone, dark-gray, cherty	12
Ward Cove limestone	

Geologic Section 17.—Peery limestone at locality 82, Gillespie, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (122 feet)	
3. Limestone, dove-gray, fine grained; SiO_2, 1.04; R_2O_3, 0.76; $CaCO_3$, 96.46; $MgCO_3$, 1.35; Total, 99.61	92
2. Limestone, drab-gray, laminated, mealy	10
1. Limestone, dark-gray, cherty	20
Ward Cove limestone	

Geologic Section 18.—Peery limestone at locality 83, about 0.4 mile east of Cliffield, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (171 feet)	
4. Limestone, dove-gray, fine grained, thick bedded	109
3. Limestone, dove-gray, thinner bedded	22
Analysis of units 3 and 4; thickness sampled, 131 feet: SiO_2, 0.78; R_2O_3, 1.10; $CaCO_3$, 96.90; $MgCO_3$, 1.36; Total, 100.14.	

	Thickness Feet
2. Limestone, dove-gray, finely granular	15
1. Limestone, dark-gray, cherty, thin bedded	25

Ward Cove limestone

Geologic Section 19.—Peery limestone at locality 85, 1.1 miles northeast of Cliffield, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (217 feet)	
5. Limestone, dove-gray, fine grained	33
4. Limestone, brownish-gray, relatively impure	17
3. Limestone, dove-gray, fine grained; SiO_2, 0.64; R_2O_3, 0.86; $CaCO_3$, 97.28; $MgCO_3$, 1.33; Total, 100.11	95
2. Limestone, dark-gray, impure; weathers nodular	8
1. Limestone, dove-gray, fine to coarse grained; clastic texture; SiO_2, 0.72; R_2O_3, 1.12; $CaCO_3$, 96.35; $MgCO_3$, 1.35; Total, 99.54	64

Ward Cove limestone

Geologic Section 20.—Peery limestone at locality 86, near Maxwell, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (120+ feet)	
3. Limestone, dove-gray, very fine grained; SiO_2, 0.66; R_2O_3, 0.22; $CaCO_3$, 97.67; $MgCO_3$, 1.80; Total, 100.35	110
2. Limestone, dove-gray to medium-gray	10
1. Limestone, dark bluish-gray, cherty	——

Ward Cove limestone

Geologic Section 21.—Peery limestone at locality 60, near Maxwell, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (149 feet)	
3. Limestone, dark dove-gray, fine grained; SiO_2, 0.44; R_2O_3, 0.98; P_2O_5, 0.005; $CaCO_3$, 97.19; $MgCO_3$, 1.30; Total, 99.92	109
2. Limestone, dove-gray, fine grained; few drab-gray layers near the base; SiO_2, 0.56; R_2O_3, 1.18; $CaCO_3$, 96.35; $MgCO_3$, 1.23; Total, 99.32	40
1. Limestone, dark-gray, cherty	—
Ward Cove limestone	

Geologic Section 22.—Peery limestone at locality 52, near Pisgah Church, Tazewell County, Virginia

	Thickness Feet
Benbolt formation (lower part)	
3. Limestone, white, very coarse grained	8
Peery limestone (145 feet)	
2. Limestone, dove-gray, fine grained; clayey partings	118
Analysis of units 2 and 3; thickness sampled, 126 feet: SiO_2, 2.52; R_2O_3, 1.64; $CaCO_3$, 91.05; $MgCO_3$, 4.48; Total, 99.69.	
1. Limestone, black, fine grained; weathers whitish	27
Ward Cove limestone	

Geologic Section 23.—Peery limestone at locality 50, near junction of Roads 631 and 632, near North Tazewell, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Peery limestone (55 feet)	
2. Limestone, dove-gray, fine grained; clayey partings	40
1. Limestone, dark bluish-gray, cherty; weathers with white crust	15
Ward Cove limestone	

Geologic Section 24.—Peery limestone at locality 46, at the south end of the quarry, Peery Lime Company, North Tazewell, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Peery limestone (24 feet)	
2. Limestone, dove-gray, fine grained	14
1. Limestone, dark bluish-gray, fine grained; weathers with ash-gray crust full of fossils	10

Analysis of units 1 and 2; thickness sampled, 24 feet: SiO_2, 7.87; R_2O_3, 1.04; $CaCO_3$, 85.03; $MgCO_3$, 6.27; Total, 100.21.

Ward Cove limestone

Geologic Section 25.—Peery limestone at locality 42, along Plum Creek, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (58 feet)	
3. Limestone, dove-gray, fine grained	3
2. Limestone, gray, granular, clastic texture	17
1. Limestone, dark bluish-gray, cherty	48
Ward Cove limestone	

Geologic Section 26.—Peery limestone at locality 87, along State Highway 91, 1.5 miles west of Liberty, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (74 feet)	
2. Limestone, dove-gray, fine grained, medium bedded	34
1. Limestone, dark-gray, cherty; only upper 18 feet well exposed	40
Ward Cove limestone	

Geologic Section 27.—Peery limestone at locality 35, about 0.75 mile southwest of Marys Chapel, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (88 feet)	
2. Limestone, granular, cross-bedded, dark-gray	10
1. Limestone, gray, coarse grained	78
Ward Cove limestone	

Geologic Section 28.—Peery limestone at locality 7, south of Shannondale, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (90 feet)	
2. Limestone, dove-gray, fine grained	5–8
1. Limestone, fine and medium grained, cherty	82
Ward Cove limestone	

Geologic Section 29.—Peery limestone at locality 9, 8.5 miles northeast of Gratton, Tazewell County, Virginia

	Thickness Feet
Benbolt limestone	
Peery limestone (46 feet)	
2. Limestone, dark-gray, cherty, nodular	32
1. Limestone, dark brownish-gray, fine grained, very cherty; weathers ash-gray; many gastropods	14
Ward Cove limestone	

BENBOLT LIMESTONE

The characteristic beds of the Benbolt are dark-gray nodular limestones, but in western Tazewell County and in Burkes Garden, much of the upper half of the formation is coarse-grained cross-bedded, high-carbonate limestone. Generally, the very top of the formation is marked by distinctive beds of dark bluish-gray cherty limestone (Figs. 7-8). The basal layers of the Benbolt are very coarse grained and relatively pure; they are well exposed at locality 52, near Pisgah

Church. The following sections are representative of the Benbolt limestone in Tazewell County.

Geologic Section 30.—Benbolt limestone at locality 80, along State Highway 91, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (126 feet)	
4. Limestone, light-gray, coarse grained; some pinkish beds; SiO_2, 1.55; R_2O_3, 1.08; $CaCO_3$, 90.37; $MgCO_3$, 6.00; Total, 99.00	42.5
3. Limestone, thin bedded, cross laminated; weathers cobbly	11.35
2. Limestone, buff, nodular, shaly partings	34.0
1. Limestone, dark-gray, nodular, clayey	38.0
Peery limestone	

Geologic Section 31.—Benbolt limestone at locality 34, County Farm, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Benbolt limestone	
7. Limestone, steel-gray, cherty, faintly cross laminated	7.5
6. Limestone, light-gray, coarse grained, cross laminated, weathers saccharoidal	10
5. Limestone, granular, crumbly	11.5
4. Limestone, medium grained, saccharoidal	28
Analysis of units 4 to 6; thickness sampled, 49.5 feet: SiO_2, 4.61; R_2O_3, 1.13; $CaCO_3$, 92.51; $MgCO_3$, 3.34; Total, 101.59.	
3. Limestone, dark-gray, argillaceous, nodular; SiO_2, 7.10; R_2O_3, 2.15; $CaCO_3$, 87.40; $MgCO_3$, 2.93; Total, 99.58	33.5
2. Limestone, fine to coarse grained	3.5
1. Limestone, light-gray, coarse grained	6.6
Analysis of units 1 and 2; thickness sampled, 10± feet: SiO_2, 1.11; R_2O_3, 0.50; $CaCO_3$, 95.92; $MgCO_3$, 3.70; Total, 101.23.	
Peery limestone	

Geologic Section 32.—Benbolt limestone at locality 28, near Concord Church, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Benbolt limestone (45 feet)	
2. Limestone, coarse grained, thin bedded, cross laminated; SiO_2, 1.23; R_2O_3, 0.91; $CaCO_3$, 97.39; $MgCO_3$, 1.74; Total, 101.27	20
1. Limestone, nodular, argillaceous, dark-gray	25
Peery limestone	

Geologic Section 33.—Peery and Benbolt limestones at locality 58, near Youngs, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Benbolt limestone (169 feet)	
5. Limestone, light-gray, coarse grained, cross laminated; SiO_2, 2.09; R_2O_3, 0.75; $CaCO_3$, 92.23; $MgCO_3$, 5.10; Total, 100.17	63
4. Limestone, dark-gray, argillaceous, nodular; SiO_2, 4.5; R_2O_3, 2.39; $CaCO_3$, 92.03; $MgCO_3$, 2.28; Total, 101.20	91
3. Limestone, coarse grained, light-gray; SiO_2, 0.60; R_2O_3, 0.24; $CaCO_3$, 98.08; $MgCO_3$, 0.82; Total, 99.74	15
Peery limestone (119 feet)	
2. Limestone, fine grained, dove-gray; SiO_2, 0.56; R_2O_3, 0.81; $CaCO_3$, 97.92; $MgCO_3$, 1.25; Total, 100.54	99
1. Limestone, dark-gray, cherty	20
Ward Cove limestone	

GRATTON LIMESTONE

The Gratton limestone, averaging considerably less than 100 feet thick, is composed mainly of dove-gray limestone (Fig. 8). In most places, the greater part of the formation is sufficiently low in insoluble material to qualify generally as high-carbonate limestone but only locally is it high-calcium limestone. The basal few feet is laminated and in a few places sparsely cherty. Intercalated beds of dark-bluish, cherty limestone also occur locally. The Gratton is absent in the western portion of Tazewell County. The following sections show the range in thickness and character of the Gratton in Tazewell County.

Geologic Section 34.—Gratton limestone at locality 34, County Farm, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Gratton limestone (48 feet)	
4. Limestone, dove-gray to brownish-gray, very fine grained	17
3. Limestone, bluish-gray; stylolites	20.3
2. Limestone, taupe-gray; weathers smoky-gray	1.3
1. Limestone, clayey, laminated	9.5
Benbolt limestone	

Geologic Section 35.—Gratton limestone at locality 30, north of Gratton, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Gratton limestone (71 feet)	
2. Limestone, dove-gray, fine grained; SiO_2, 2.92; R_2O_3, 1.04; $CaCO_3$, 93.24; $MgCO_3$, 2.06; Total, 99.26	55
1. Limestone, buff-gray, laminated	16
Benbolt limestone	

Geologic Section 36.—Gratton limestone at locality 7, south of Shannondale, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Gratton limestone (135 feet)	
4. Limestone, dove-gray, thin bedded, partly laminated	60
3. Limestone, dove-gray, fine grained; partings of buff shale along the bedding	43

	Thickness Feet
2. Limestone, fine to medium grained, compact	22
1. Limestone, light-gray, thin bedded	10

Benbolt limestone

Geologic Section 37.—Gratton limestone at locality 25, along U. S. Route 19, Wittens Mills, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Gratton limestone (60 feet)	
2. Limestone, dark-gray; some layers mottled with golden-gray; medium to thick bedded	42
1. Limestone, dove-gray, thin bedded, platy	18

Analysis of units 1 and 2; thickness sampled, 60 feet: SiO_2, 2.67; R_2O_3, 1.52; $CaCO_3$, 93.09; $MgCO_3$, 3.67; Total, 100.95.

Benbolt limestone

Geologic Section 38.—Gratton limestone at locality 48, North Tazewell, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (132 feet)	
5. Limestone, dove-gray, medium bedded; few impure layers; exposed south of old quarry	46
4. Limestone, dove-gray; medium bedded; thin partings of yellowish clay	32
3. Limestone, dark bluish-gray, granular; lenses and stringers of coarse-grained limestone	25

Analysis of units 3 and 4; thickness sampled, 57 feet: SiO_2, 4.60; R_2O_3, 1.52; $CaCO_3$, 91.05; $MgCO_3$, 2.73; Total, 99.90.

2. Limestone, buff-gray, very clayey, thin bedded	10
1. Limestone, dove-gray, medium to thick bedded	19

Peery limestone

Geologic Section 39.—Gratton limestone at locality 41, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (69 feet)	
6. Limestone, dove-gray, fine grained	8.0
5. Limestone, buff-gray, shaly	1.5
4. Limestone, dove-gray, fine grained	15.0
Analysis of units 4 to 6; SiO_2, 5.83; R_2O_3, 2.34; $CaCO_3$, 89.85; $MgCO_3$, 2.42; Total, 100.44.	
3. Limestone, dove-gray, very fine grained	38.3
2. Limestone, pinkish and gray, coarse grained	2.0
1. Limestone, dove-gray, fine grained, laminated	4.5
Analysis of units 1 to 3; thickness sampled, 45 feet: SiO_2, 3.47; R_2O_3, 1.05; $CaCO_3$, 94.34; $MgCO_3$, 1.28; Total, 100.14.	
Benbolt limestone	

Geologic Section 40.—Gratton limestone at locality 43, along State Highway 16, 0.4 mile southeast of U. S. Route 19, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (109+ feet)	
2. Limestone, cherty, dark-gray, fine grained, compact; SiO_2, 2.08; R_2O_3, 1.40; $CaCO_3$, 94.04; $MgCO_3$, 2.21; Total, 99.73	104
Benbolt limestone	

Geologic Section 41.—Gratton limestone at locality 55, near U. S. Route 19, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (85 feet)	
2. Limestone, buff-gray to dove-gray, finely laminated	27.5

	Thickness Feet
1. Limestone, thick bedded, dove-gray; SiO_2, 0.36; R_2O_3, 1.42; $CaCO_3$, 96.52; $MgCO_3$, 1.25; Total, 99.55	57.5

Benbolt limestone

Geologic Section 42.—Gratton limestone at locality 57, about 0.7 mile east of Youngs, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (94 feet)	
2. Limestone, thick bedded, dove gray, fine grained; SiO_2, 1.27; R_2O_3, 0.42; $CaCO_3$, 97.98; $MgCO_3$, 1.78; Total, 101.45	67
1. Limestone, dark-gray, laminated	27

Benbolt limestone

Geologic Section 43.—Gratton limestone at locality 59, Blue Grass Lime Company's quarry, Maxwell, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (100 feet)	
8. Limestone, gray, thin bedded, fine grained	13
7. Limestone, dark-gray, interbedded with buff shaly limestone; SiO_2, 5.13; R_2O_3, 0.55; $CaCO_3$, 93.33; $MgCO_3$, 1.55; Total, 100.56	25
6. Limestone, conglomeratic; pebbles of fine-grained limestone	4
5. Limestone, dark-gray, granular, sparsely cherty	9
4. Limestone, thin bedded, laminated	10

Analysis of units 4 to 6; thickness sampled, 23 feet: SiO_2, 4.19; R_2O_3, 1.00; $CaCO_3$, 91.37; $MgCO_3$, 4.61; Total, 101.17.

	Thickness Feet
3. Limestone, dove-gray, medium bedded; main quarry rock; SiO_2, 0.75; R_2O_3, 1.10; $CaCO_3$, 96.70; $MgCO_3$, 1.23; Total, 99.78	37
2. Limestone, buff-gray, finely laminated	2
Benbolt limestone (upper 12 feet, exposed in quarry)	
1. Limestone, gray to dark-gray, coarse grained; exposed on north side of quarry; SiO_2, 4.30; R_2O_3, 1.18; $CaCO_3$, 91.86; $MgCO_3$, 2.45; Total, 99.79	20–25

Geologic Section 44.—Gratton limestone in main quarry at Pounding Mill, Tazewell County, Virginia

	Thickness Feet
Wardell limestone	
Gratton limestone (68 feet)	
3. Limestone, dark bluish-gray, cherty	29
2. Limestone, buff-gray to dove-gray; a 3-foot zone shows columnar jointing	9
1. Limestone, laminated; a few thicker beds near the base	28
Analysis of units 1 and 2; thickness sampled, 37 feet: SiO_2, 6.92; R_2O_3, 1.40; $CaCO_3$, 90.11; $MgCO_3$, 1.47; Total, 99.90.	
Benbolt limestone	

Geologic Section 45.—Gratton limestone at locality 87, about 1.5 miles northeast of Liberty, Tazewell County, Virginia

	Thickness Feet
Wardell formation	
Gratton limestone (8.5 feet)	
2. Limestone, dove-gray, fine grained	7.5
1. Limestone, dove-gray, finely laminated	1.0
Benbolt limestone	

WARDELL FORMATION

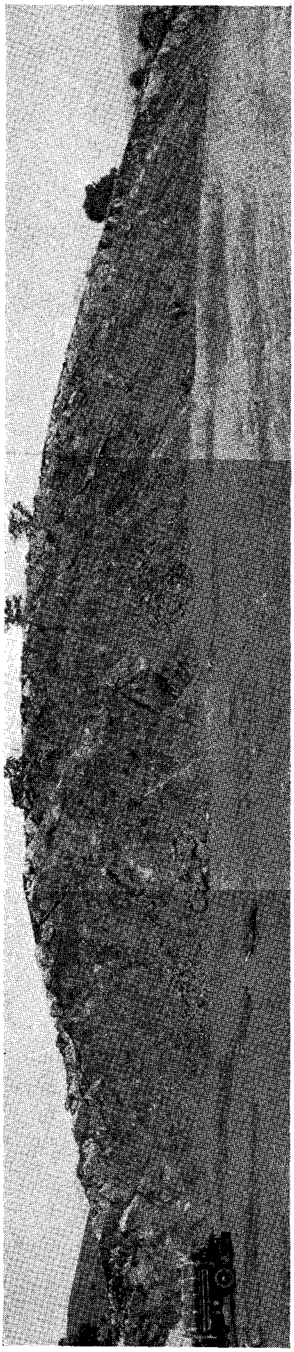
Most of the Wardell formation is composed of impure limestone, but a persistent and characteristic zone of buff-weathering platy shale occurs at the top of the formation (Figs. 7-8). The lowest beds generally are coarse grained and contain colonial hydrazoans (*Stromatocerium*) and corals (*Lichenaria* and *Favistella*). Thin lenticular masses of coarse-grained limestone are also present in the middle and upper parts at some localities. The thickness ranges up to 200 feet, being greatest along the southeast base of Paint Lick Mountain. The best exposed section is along State Highway 16, on the north side of Thompson Valley.

Geologic Section 46.—Wardell formation at locality 42, along State Highway 16, Tazewell County, Virginia

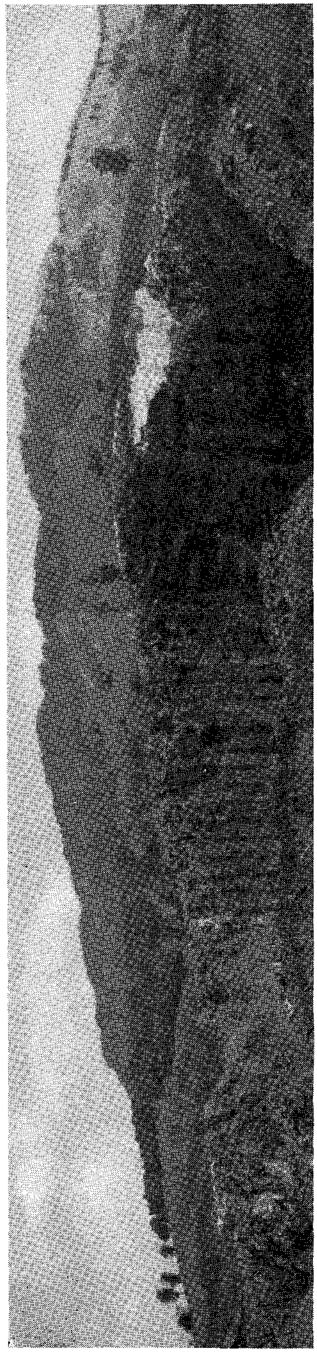
	Thickness Feet
Bowen formation	
Wardell formation (96 feet)	
4. Shale, bluish-gray and calcareous where fresh; weathers buff and platy; lenses of coarse-grained limestone	47.3
3. Limestone, light-gray, coarse grained; thin partings of buff shale	20.0
2. Limestone, nodular, argillaceous	14.0
1. Limestone, light-gray, medium to coarse grained; clastic texture; contains corals	14.6

Geologic Section 47.—Wardell formation at locality 80, about 1.5 miles northeast of Liberty, Tazewell County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (108 feet)	
5. Shale, buff, platy	34
4. Limestone, buff, nodular, shaly	28
3. Limestone, very coarse grained, crinoidal	14
2. Limestone, buff, nodular	16
1. Limestone, light-gray, coarse grained, medium grained; SiO_2, 1.39; R_2O_3, 6.02; $CaCO_3$, 84.94; $MgCO_3$, 1.76; Total, 94.11	16
Gratton limestone	

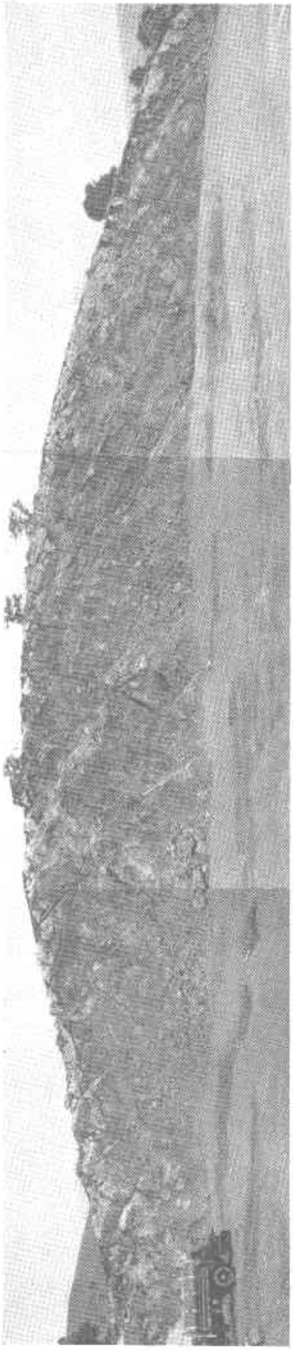


A.



B.

A, Quarry of the Peery Lime Company, North Tazewell, Virginia. B, Quarry of the Pounding Mill Quarries Corporation, Pounding Mill, Virginia.



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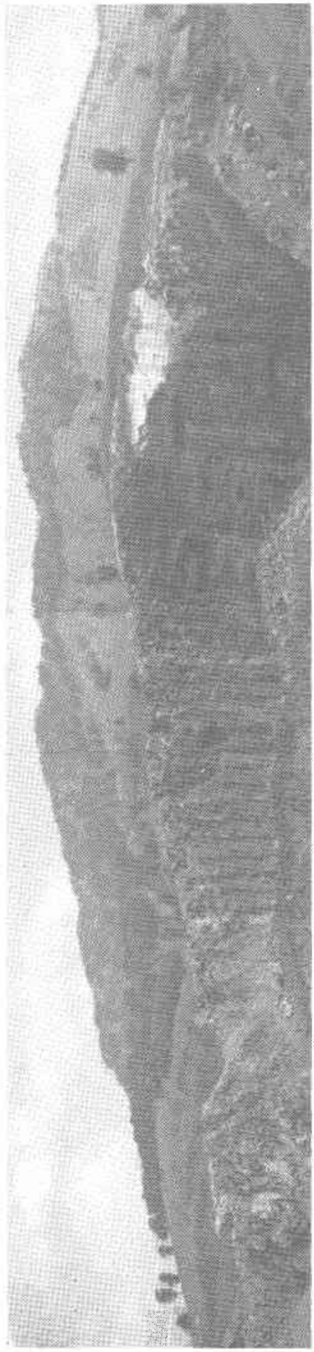
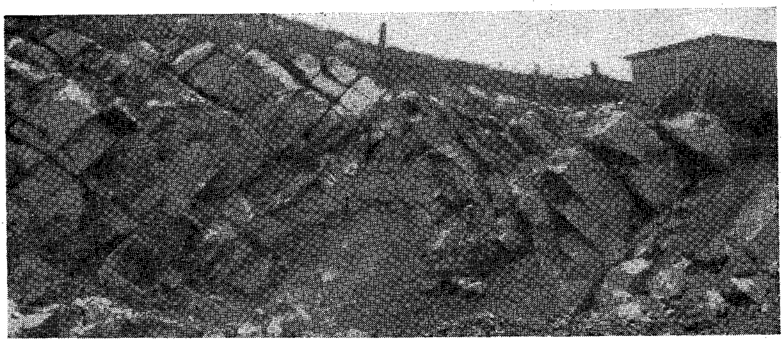


B.

A, Quarry of the Peery Lime Company, North Tazewell, Virginia. B, Quarry of the Pounding Mill Quarries Corporation, Pounding Mill, Virginia.



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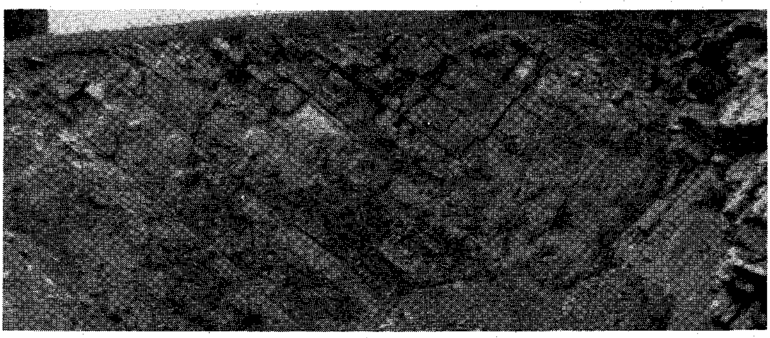
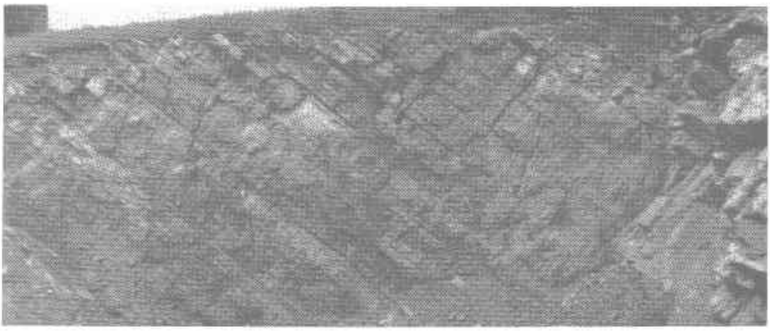


B.

C.

A, Henry Buchanan quarry in Gratton limestone, Thompson Valley, Tazewell County, Virginia. B, Quarry in upper "Knox" and lower Blackford beds at Five Oaks, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.) C, Quarry in the Five Oaks limestone, Five Oaks, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.)

A.



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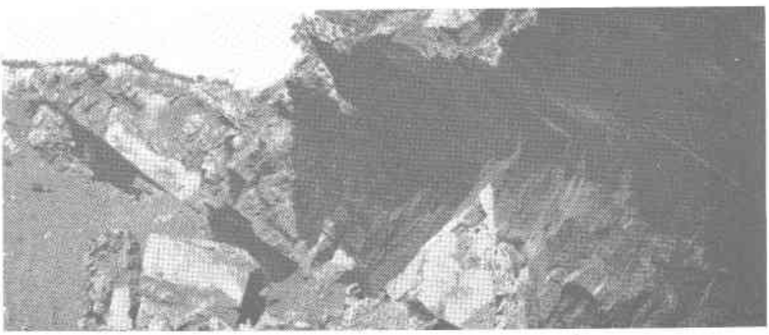


C.

A, Henry Buchanan quarry in Gratton limestone, Thompson Valley, Tazewell County, Virginia. B, Quarry in upper "Knox" and lower Blackford beds at Five Oaks, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.) C, Quarry in the Five Oaks limestone, Five Oaks, Tazewell County, Virginia. (From Virginia Geological Survey Bulletin 60.)

Locally along the southeast base of Paint Lick Mountain and also along the southeastern side of Thompson Valley, northeast of State Highway 16, the lower part of the Wardell is high-carbonate limestone. However, these relatively pure beds are nowhere more than 60 feet thick, and the maximum thicknesses occur in relatively remote parts of the county. Analyses of various parts of the Wardell formation are shown in Table 3.

BOWEN FORMATION

The Bowen formation is composed mainly of maroon-drab, calcareous mudrock and argillaceous limestone, and in western Tazewell County the base is formed by 10 to 20 feet of brown-weathering sandstone (Fig. 8). The average thickness is about 50 feet, with a progressive thinning to the northeast. The Bowen is absent northeast of Thompson Valley, Marys Chapel, and North Tazewell. The best exposed section is along State Highway 16 on the north side of Thompson Valley.

Geologic Section 48.—Bowen formation at locality 42, along State Highway 16, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Bowen formation (36 feet)	
4. Limestone, greenish-gray, clayey; interbedded with calcareous mudrock	2.25
3. Limestone, greenish-gray, clayey; interbedded with maroon-drab mudrock	10
2. Limestone and mudrock; greenish-gray and maroon-drab, lumpy	12
1. Mudrock, maroon and gray, straticulate, mud-cracked, columnar jointed	11.6

Analysis of units 1 to 4; thickness sampled, 36 feet: SiO_2, 30.40; R_2O_3, 8.88; $CaCO_3$, 54.70; $MgCO_3$, 4.01; Total, 97.99.

Wardell formation

WITTEN LIMESTONE

The Witten is the only limestone formation whose thickness and character are practically the same throughout Tazewell County (Figs. 7-8). Four divisions are distinguishable in most exposures: 15 to 20 feet of straticulate columnar jointed clayey limestone, at the base (Pl. 6A); 25 to 40 feet of golden-gray, thin-bedded, fine-grained limestone; 15 to 25 feet of coarse-grained fossiliferous limestone; and 50 to 75 feet of dove-gray to golden-gray fine-grained shaly limestone with intercalated coarse-grained layers. The Witten is well exposed (1) along U. S. Route 19 east and west of Tazewell, (2) along State Highways 16 and 91 in Thompson Valley (localities 42 and 88, Pl. 5C); and (3) at locality 51, about 0.25 mile west of the junction of Roads 631 and 632, northwest of Tazewell.

Geologic Section 49.—Witten limestone at locality 42, along State Highway 16, Thompson Valley, Tazewell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (94 feet)	
6. Limestone, lilac-gray to golden-gray, thin wavy bedded, fine grained, full of buff clayey stringers; intercalated coarse-grained limestones	12
5. Limestone, medium bedded, granular; intercalated calcareous shales	4
4. Limestone, dark-gray, fine grained, thin bedded; intercalated coarse-grained layers; SiO_2, 5.32; R_2O_3, 0.85; $CaCO_3$, 92.38; $MgCO_3$, 0.02; Total, 98.57	42.5
3. Limestone, thin bedded, coarse grained except at the very base; SiO_2, 2.99; R_2O_3, 1.22; $CaCO_3$, 92.82; $MgCO_3$, 3.03; Total, 100.06	19.7
2. Limestone, golden-gray, fine grained, argillaceous; SiO_2, 11.53; R_2O_3, 4.92; $CaCO_3$, 81.60; $MgCO_3$, 0.02; Total, 98.07	12.2
1. Limestone, fine grained, greenish-gray, argillaceous	3.25
Bowen formation	

MOCCASIN FORMATION

The Moccasin formation is composed mainly of maroon-drab argillaceous limestone and calcareous mudrock (Pls. 5B, 13C; Figs. 7-8). Some beds are pale-green to drab-gray, and there are a few beds of dove-gray argillaceous limestone. The average thickness is 325 feet. Generally at the top are a few beds of very distinctive black-weathering siltstone.

Geologic Section 50.—Moccasin formation and associated limestones, locality 22, near Wittens Mills, Tazewell County, Virginia

	Thickness Feet
Eggleston formation	
Moccasin formation	
5. Mudrock and limestone, maroon-drab; a few intercalated beds of dove-gray limestone; SiO_2, 24.72; R_2O_3, 3.94; $CaCO_3$, 68.71; $MgCO_3$, 1.35; Total, 98.72	325
Witten limestone (142 feet)	
4. Limestone, golden-gray, fine grained, thin bedded; SiO_2, 4.56; R_2O_3, 1.84; $CaCO_3$, 87.75; $MgCO_3$, 4.40; Total, 98.55	55
3. Limestone, thin bedded, coarse grained, shaly	22
2. Limestone, golden-gray to buff-gray, very fine grained; SiO_2, 6.04; R_2O_3, 1.14; $CaCO_3$, 91.42; $MgCO_3$, 0.91; Total, 99.51	40
1. Limestone, fine grained, straticulate	25
Gratton limestone	

Although the Moccasin is generally described as an argillaceous limestone, the analysis given in Geologic Section 49 suggests that much of the noncarbonate content is free silica. The Moccasin probably could be used in the manufacture of Portland cement.

MARTINSBURG AND EGGLESTON FORMATIONS

The red beds of the Moccasin are succeeded by a relatively great thickness of buff-weathering calcareous rocks, the lower 50 to 75 feet of which is the Eggleston formation (Figs. 7-8). Most of the Eggleston is fine-grained argillaceous limestone and drab-gray calcareous mudrock. It contains several beds of altered volcanic ash (metabentonite), and the mudrocks next to these beds are silicified and cuneiform jointed (locality 26). The Eggleston is too impure for any use.

The lower several hundred feet of the Martinsburg formation, which succeeds the Eggleston, is composed of thin- and medium-bedded granular limestones and intercalated buff-weathering shales. The general character of these beds is well shown at the intersection of State Highway 61 and U. S. Route 19, about 1.5 miles east of Tazewell. Although individual beds in the lower part of the Martinsburg contain as much as 90 per cent calcium carbonate, the average is much lower (Table 2).

TONOLOWAY LIMESTONE

The Tonoloway (Silurian) limestone consists of 25 to 50 feet of thin-bedded argillaceous limestone which directly overlies the resistant, ridge-making Silurian sandstones. The limestone is deeply weathered in most places and generally is concealed by boulders and wash from the higher outcropping sandstones. The fresh limestone is seen chiefly in road cuts and along streams; elsewhere its position is marked by a few feet of laminated, sticky residual clay streaked with manganese. The best exposed section is in Nye Cove.

Geologic Section 51.—Tonoloway limestone at locality 8, along Road 662 in Nye Cove, Tazewell County, Virginia

	Thickness Feet
Rocky Gap sandstone	
Tonoloway limestone (49 feet)	
14. Limestone, drab-gray, ribbon banded, fine grained, argillaceous; weathers salmon-pink....	5
13. Shale, bluish-gray, calcareous, platy....	3.5
12. Limestone, dark bluish-gray, platy to blocky....	2.6
11. Limestone, dove-gray to salmon-pink, fine grained, blocky	5.0
10. Limestone, dark-gray, coarse grained, sandy; weathers saccharoidal	7.5
9. Limestone, light-gray, mealy....	3.5

	Thickness Feet
8. Quartz sandstone, dark bluish-gray, calcareous	3.2
7. Limestone, light-gray, mottled with pink, mealy, fine grained, cherty	2.3
6. Limestone, light-gray, compact	.8
5. Shale, ash-gray with pinkish blotches, platy	5.8
4. Limestone, drab-gray, straticulate; weathers porous and spongy; bright reddish and yellow stains on weathered surfaces	3.6
3. Limestone, dull-buff, argillaceous; weathers spongy	1.3
2. Limestone, buff, platy, mealy, calcareous	5.6
Wills Creek sandstone	
1. Shale and sandstone, buff, calcareous	25.0
Rose Hill formation	

In Freestone Valley, the Tonoloway as seen in the few available exposures is a dark bluish-gray granular limestone. Some of it has been quarried and burned for agricultural lime along Matneys Branch (locality 38). Except for this local use, the formation is too thin and impure to be of any value.

DEVONIAN LIMESTONE

A few thin limestones of New Scotland (Devonian) age occur just north of the St. Clair fault in the vicinity of Bluefield, Virginia, but they are too impure for industrial use. These beds are well exposed at the south entrance to the ball park (locality 2) near the Virginia-West Virginia state line, and have been described by Reger,[27] Butts,[11] Woodward,[31, 32] and by the writer.[20]

MISSISSIPPIAN LIMESTONE

LITTLE VALLEY FORMATION

The Little Valley formation, overlying a thick succession of Devonian and Mississippian shales and sandstones, is approximately 2,500 feet stratigraphically above the Tonoloway and 4,200 feet above the Moccasin formation. Most of the Little Valley formation is drab-gray impure shaly-weathering limestone. In the western part of Tazewell County, particularly at locality 94, northwest of Cedar Bluff, the

Little Valley formation contains thin beds of dolomite. These magnesian beds are also conspicuous at locality 99 along Road 609 south of Richlands. The Little Valley formation is well exposed along the Norfolk and Western Railway at locality 12 northeast of Wittens Mills; at locality 68 northeast of Cedar Bluff; along State Highway 16 opposite the consolidated school at Bishop; along Road 627 about 1.3 miles southwest of Bandy; and along Road 656 just south of Bailey Church.

Geologic Section 52.—Little Valley formation along Road 656, south of Bailey Church, Tazewell County, Virginia

	Thickness Feet
Hillsdale limestone	
Little Valley formation (57 feet)	
15. Limestone, gray, fine grained; contains a few partings of calcareous shale	2
14. Limestone, dark-gray, fine grained, argillaceous; partings of buff shale	5
13. Limestone, dark-gray, medium grained; weathers greenish-gray	9
12. Limestone, drab-gray, argillaceous, platy	3
11. Limestone, gray, argillaceous; streaks of shell fragments	2.25
10. Limestone, dark bluish-gray, argillaceous, fine grained	4
9. Limestone, light-gray, crinoidal, medium grained	3.75
8. Limestone, argillaceous, glauconitic; weathers yellowish-green	6.3
7. Limestone, light-gray; silicified on the outcrop; weathers greenish-yellow and mealy	2
6. Limestone, yellowish-green to buff, very argillaceous; glauconitic streaks	1.25
5. Limestone, olive-drab, very argillaceous	1.5
4. Covered	2.5
3. Limestone, medium grained, granular, clayey	2.0
2. Limestone, light-gray, compact, fine grained	6.5
1. Limestone, dull-gray, coarse-grained, clastic, oolitic	6.2
Maccrady formation	

HILLSDALE LIMESTONE

Succeeding the Little Valley formation is the Hillsdale limestone with an average thickness of about 75 feet. The Hillsdale is very cherty and characteristically black and fine grained. Many layers contain rounded, concentrically banded markings suggestive of calcareous algae. Basaltiform corals, particularly *Lithostrotionella castelnaui,* occur in sufficient abundance for ready identification of the formation. The thickness of the Hillsdale ranges from a few feet to 125 feet, averaging somewhat less than 75 feet. The best exposure is along Road 627, southwest of Bandy.

"STE. GENEVIEVE" LIMESTONE

The "Ste. Genevieve" contains a variety of limestones with an aggregate thickness of 150 to 400 feet. Some beds are dove-gray to drab-gray, very fine grained, and compact, resembling the Five Oaks, Peery, and Gratton limestones. More abundant are beds of coarse-grained crinoidal limestone and oolitic layers. These three varieties have an average calcium carbonate content of 90 to 96 per cent, but they almost invariably occur in thicknesses less than 50 feet, being intercalated in greenish-gray shales and shaly or cherty limestones (Pl. 6B). The "Ste. Genevieve" is well exposed along the Norfolk and Western Railway about 1.25 miles southwest of Tiptop, along the southside of Wrights Valley, and along State Highway 16 southeast of Bishop (Geologic Sections 53 and 54).

"GASPER" LIMESTONE

The "Gasper" limestone resembles the "Ste. Genevieve" but differs in having fewer fine-grained dove-gray beds, less chert, and a greater proportion of crinoidal and oolitic layers. Drab-gray argillaceous limestones and calcareous mudrocks are as abundant as they are in the "Ste. Genevieve." The thickness averages 350 feet or more. The purer limestones, as in the "Ste. Genevieve," occur in zones averaging less than 50 feet thick. A zone of red shale, which is apparently very persistent, occurs about 135 feet below the top of the "Gasper," and generally the greatest thickness of high-calcium or high-carbonate limestone in the formation occurs about 100 feet stratigraphically below the red shale. The "Gasper" is well exposed (1) at locality 5, in the west environs of Bluefield, Virginia; (2) at locality 67 along Road 627 southwest of Bandy; (3) at locality 65 along Road 637 about 1.2 miles north of The Jump; and (4) along State Highway 16 at localities 63 and 64. In the latter locality, the base of the formation is at the top of a fine-grained limestone exposed 500 feet west of the first hairpin turn in the road ascending Stony Ridge.

Geologic Section 53.—Mississippian limestones at locality 64, along State Highway 16, southeast of Bishop, Tazewell County, Virginia

	Thickness Feet
Bluefield shale	
"Gasper" limestone (436.3 feet)	
128. Limestone, dark drab-gray, dense, argillaceous, fossiliferous	2.0
127. Limestone, taupe-gray, very fine grained, shaly partings	2.5
126. Limestone, drab-gray, magnesian, silty	1.1
125. Shale, bluish-gray; weathers drab	3.7
124. Limestone, gray, medium grained, oolitic	2.3
123. Shale, calcareous, silty, deeply weathered	9.7
122. Shale, red, silty	0.5
121. Shale, drab-gray, silty, calcareous	8.5
120. Limestone, very coarse grained, crinoidal; contains *Pentremites godoni major*	2.9
119. Shale, light chocolate-red, silty; intercalated greenish beds	1.2
118. Shale, drab-gray, glauconitic	1.7
117. Limestone, shaly, argillaceous, glauconitic; contains large *Dictyoclostus*	1.6
116. Limestone, coarse grained, crinoidal, oolitic, thick bedded; weathers dark	6.8
115. Shale, greenish-gray	1.0
114. Limestone, coarse-grained, crinoidal, oolitic; weathers dark dingy-gray	3.2
113. Limestone, drab-gray, shaly, crinoidal	2.2
112. Limestone, greenish-gray, crinoidal, medium grained	3.8
111. Limestone, drab-gray, argillaceous, shaly, crinoidal	3.0
110. Limestone, light-gray, oolitic	0.5
109. Limestone, greenish-gray, shaly, crinoidal	2.1
108. Limestone, gray, oolitic	1.9
107. Limestone, dark-gray, argillaceous, cherty	4.5

	Thickness Feet
106. Limestone, light-gray, oolitic, thick bed	3.7
105. Limestone, medium grained, cherty; argillaceous partings cause rock to weather shaly	6.0
104. Limestone, coarse grained, gray, crinoidal; partings of greenish-gray shale	7.8
103. Covered	2.0
102. Limestone, coarse grained, crinoidal; partings of buff clay	7.6
101. Limestone, dark-gray, argillaceous, crinoidal; weathers drab-buff	4.8
100. Limestone, gray, thin bedded, shaly, oolitic; greenish-gray partings	14.0
99. Limestone, argillaceous; weathers drab-gray, lumpy	3.6
98. Limestone, very coarse grained, crinoidal, regularly bedded, gray; weathers dark-rusty gray	20.6

Analysis of units 98 to 112; thickness sampled, 86 feet: SiO_2, 7.49; R_2O_3, 1.93; $CaCO_3$, 85.74; $MgCO_3$, 5.78; Total, 100.94.

97. Shale, dark-gray, calcareous; weathers smoke-gray to yellow-buff	37.8
96. Limestone, dark bluish-gray; weathers with white chalky crust; shaly seams	7.1
95. Limestone, bluish-gray, shaly; weathers drab-buff	12.1
94. Limestone, dark bluish-gray; weathers rusty-gray; cherty	8.0
93. Mudrock, fine grained, bluish-gray, calcareous; intercalated blocky beds of argillaceous limestone	28.9
92. Mudrock and shale, dark bluish to drab-gray, calcareous; contains intercalated beds of crinoidal limestone; *Pentremites*	4.1
91. Limestone, drab-gray, fine grained; weathers buff	2.5
90. Limestone, light-gray, thin bedded, argillaceous	2.2
89. Limestone, coarse grained, crinoidal	0.4
88. Limestone, light-gray, oolitic, cross laminated	6.3
87. Limestone, dove-gray, very fine grained	1.0
86. Limestone, medium-gray, crinoidal, oolitic, very fossiliferous; contains *Pentremites, Agassizocrinus,* and *Pterotocrinus serratus*	9.8

	Thickness Feet
85. Limestone, dove-gray, fine grained	1.0
84. Limestone, light-gray; nodules of black chert; contains *Agassizocrinus*	4.0
83. Limestone, drab-gray, oolitic, crinoidal; intercalated thin seams of clay	1.5
82. Shale, greenish-gray, calcareous, crinoidal; contains large crinoid stems	1.5
81. Limestone, greenish-gray, argillaceous, medium grained	4.0
80. Limestone, dove-gray, very fine grained, blocky	2.7
79. Limestone, greenish-gray, argillaceous, crinoidal; contains *Agassizocrinus* and *Talarocrinus inflatus*	4.4
78. Limestone, dove-gray, thick bedded, very fine grained	6.5
77. Limestone, greenish-gray, very compact, crinoidal	1.6
76. Limestone, light-gray, oolitic	6.8
75. Shale, greenish-gray, calcareous; weathers greenish-yellow	8.6
74. Limestone, dove-gray, very fine grained, blocky	7.6
73. Shale, gray, laminated, calcareous; thin streaks of oolitic limestone; weathers olive-drab	4.7
72. Limestone, oolitic with partings of greenish-gray shale	0.8
71. Limestone, medium grained, oolitic, crinoidal; contains *Talarocrinus inflatus*	2.9
70. Shale, greenish-gray, platy	0.2
69. Limestone, medium-gray, oolitic, thick bedded	10.5
68. Limestone, greenish-gray, fine grained	1.2
67. Limestone, gray, oolitic, medium to thick bedded; weathers smoke-gray	12.6
66. Limestone, dark-gray; thin clayey seams along the bedding	2.6
65. Covered	3.0
64. Limestone, greenish-gray, oolitic, argillaceous, glauconitic	1.6
63. Limestone, gray, oolitic	2.6
62. Covered	10.0
61. Limestone, dark-gray, fine grained; contains thin wavy partings of oolitic limestone	4.0

	Thickness Feet
60. Limestone, dark bluish-gray, medium bedded, sparsely cherty	9.0
59. Limestone, dark-gray, fine grained; weathers mealy	8.5

Analysis of units 59-70, thickness sampled 65± feet: SiO_2, 1.17; R_2O_3, 0.89; $CaCO_3$, 96.05; $MgCO_3$, 1.13; Total, 99.24.

58. Limestone; weathers drab-gray and mealy	13.0
57. Limestone, dark bluish-gray, very fine grained; partings of buff shale; limestone weathers with white chalky crust	5.9
56. Limestone, medium grained; thin oolitic streaks	4.7
55. Limestone, dove-gray, very fine grained, medium bedded	10.0
54. Limestone, thick bedded, cross laminated, crinoidal, oolitic	17.0

Analysis of units 54 to 58; thickness sampled, 50 feet: SiO_2, 7.19; R_2O_3, 6.22; $CaCO_3$, 79.22; $MgCO_3$, 8.23; Total, 100.86.

53. Limestone, silty and shaly, drab-gray	4.3

"Ste. Genevieve" limestone (225.1 feet)

52. Limestone, light-gray, very fine grained	9.0
51. Limestone, bluish-gray, very fine grained; weathers smoky-gray	4.0
50. Limestone, dark bluish-gray, argillaceous; weathers shaly and drab-buff	3.0
49. Limestone, dark-gray, very fine grained; stylolites	6.0
48. Limestone and mudrock, drab-gray to buff-gray	7.8
47. Mudrock, drab-gray, calcareous, silty; contains thin intercalations of crinoidal limestone with *Platycrinites huntsvillae*	4.0
46. Limestone, drab-gray, medium to coarse grained; contains *Platycrinites huntsvillae* and a large *Pentremites*	7.5

Analysis of units 46 to 52; thickness sampled, 41 feet: SiO_2, 34.25; R_2O_3, 6.77; $CaCO_3$, 53.42; $MgCO_3$, 3.08; Total, 97.52.

	Thickness Feet
45. Limestone, very coarse grained, crinoidal	3.2
44. Limestone, dark-gray, very fine grained; contains many *Platycrinites huntsvillae*	6.5
43. Limestone, shaly, weathers buff; thin partings of coarse-grained crinoidal limestone	8.0
42. Limestone, very coarse grained; thick even beds; crinoidal, oolitic, relatively pure	5.0
41. Limestone, medium bedded, very clayey, abundantly cherty	9.3
40. Limestone, bluish-gray, medium grained, very argillaceous, shaly	13.6
39. Siltstone, drab-gray to olive-drab, mealy, calcareous	12.0
38. Limestone, very oolitic, medium bedded	3.2
37. Limestone, sparsely cherty, fine grained; thin streaks of oolitic limestone; contains spineless *Platycrinites* stemplates	19.0
36. Limestone, thin bedded, argillaceous	8.2
35. Limestone, dove-gray, very fine grained; thin argillaceous partings	6.0
34. Limestone, light-gray, oolitic	2.5

Analysis of units 34 to 38, exclusive of clay partings; thickness sampled, 38.7 feet: SiO_2, 7.20; R_2O_3, 0.74; $CaCO_3$, 90.89; $MgCO_3$, 2.24; Total, 101.07.

33. Limestone, clayey and silty, slightly oolitic	4.0
32. Shale, laminated, calcareous; weathers greenish-gray	7.0
31. Mudrock, greenish-gray, glauconitic; contains large crinoid fragments	1.3
30. Shale, calcareous, platy; weathers drab-gray	4.0
29. Limestone, light-gray, coarse grained, medium bedded, relatively pure	5.0
28. Shale, calcareous, silty; weathers drab-buff	32.0
27. Limestone, black, crinoidal	4.0
26. Limestone, bluish-gray, fine grained, sparsely cherty; contains many brachiopods	6.0
25. Siltstone and shale, drab-gray, calcareous; exposed along road for distance of 250 feet	5.0
24. Limestone, dark-gray, crinoidal, sparsely cherty	5.0

	Thickness Feet
23. Limestone, black, fine grained, dense; contains *Platycrinites huntsvillae*, small *Spirifer*, and *Triplophyllites spinulosum*	8.0
22. Limestone, bluish-gray, very argillaceous; weathers platy	6.0
Hillsdale limestone (53.4 feet)	
21. Limestone conglomerate; dolomitic; matrix weathers rough and pitted	2.0
20. Limestone, black, fine grained; shaly partings	2.0
19. Limestone, dark-gray; contains small spherical oolites	1.4
18. Limestone, black, fine grained, silty; weathers clayey	7.0
17. Siltstone, calcareous; weathers yellowish-green	9.0
16. Limestone, medium bedded, dolomitic, fossiliferous, cherty; contains many corals, particularly *Lithostrotionella castelnaui*	6.0
15. Mudrock, bluish-gray, calcareous; weathers mealy	3.0
14. Limestone, black, medium grained, cherty; contains *Syringopora virginica, Lithostrotion castlenaui,* and *Lithostrotionella proliferum*	4.0
13. Siltstone, greenish-yellow, calcareous; weathers mealy; SiO_2, 42.88; R_2O_3, 7.62; $CaCO_3$, 42.74; $MgCO_3$, 4.34; Total, 97.58	7.0
12. Limestone, black, medium grained, argillaceous, cherty; contains algal structures and corals: SiO_2, 6.13; R_2O_3, 1.75; $CaCO_3$, 89.50; $MgCO_3$, 2.37; Total, 99.75	12.0
Little Valley formation (100.5 feet)	
11. Limestone, very argillaceous, contains numerous geodes discoidal to irregular in shape and filled with drusy quartz and calcite; very fossiliferous; contains *Spirifer bifurcatus* and *Orthotetes kaskaskiensis;* SiO_2, 9.73; R_2O_3, 3.39; $CaCO_3$, 66.35; $MgCO_3$, 17.60; Total, 97.07	4.0
10. Siltstone, light-gray; weathers mealy and platy	8.0
9. Mudrock and limestone, dark bluish-gray, platy; black chert along master bedding joints	6.5

	Thickness Feet
8. Limestone, gray, very argillaceous; weathers to shale	6.0
7. Shale, greenish-buff, calcareous, platy	12.0
6. Shale with reniform inclusions of limestone	4.0
5. Limestone, smoke-gray, argillaceous; contains *Camarotoechia mutata*	4.0
4. Limestone, porous, dark bluish-gray; contains small geodes	4.0
3. Limestone, bluish-gray, silty; weathers to shale; contains small geodes	15.0
2. Shale, buff, lumpy	16.0
1. Limestone, buff; intercalations of buff shale; poorly exposed; basal contact approximate	25.0

Analysis of units 1 to 9; thickness sampled, 92 feet: SiO_2, 23.26; R_2O_3, 7.31; $CaCO_3$, 64.67; $MgCO_3$, 5.89; Total, 101.13.

Maccrady formation

Geologic Section 54.—Mississippian limestone at locality 67, along Road 627, about 1.5 miles southwest of Bandy, Tazewell County, Virginia

	Thickness Feet
"Gasper" and "Ste. Genevieve" limestones (611 feet)	
54. Limestone, dark-gray, fine grained, dense; contains scattered oolites	9
53. Limestone, medium gray, thick bedded, oolitic; 12 feet exposed at top of roadside quarry; SiO_2, 6.08; R_2O_3, 6.18; $CaCO_3$, 72.44; $MgCO_3$, 16.27; Total, 100.97	34
52. Limestone, greenish-gray, very shaly; exposed in quarry	14
51. Limestone, dove-gray, fine grained; SiO_2 11.68; R_2O_3, 3.76; $CaCO_3$, 72.70; $MgCO_3$, 12.74; Total, 100.88	50
50. Covered, mostly drab-gray, calcareous mudrock	20
49. Limestone, dove-gray, very fine grained; disseminated oolites; SiO_2, 8.22; R_2O_3, 2.60; $CaCO_3$, 77.70; $MgCO_3$, 11.00; Total, 99.52	12

	Thickness Feet
48. Limestone, light-gray, thick bedded, oolitic, medium grained	9
47. Covered	18
46. Limestone, medium gray, thick bedded, compact, very oolitic	14
45. Limestone, drab-gray; weathers mealy	13
44. Limestone, dark-gray; clayey partings; thin bedded	7
43. Limestone, bluish-gray; weathers brownish-gray; very shaly	8
42. Limestone, fine grained, thin bedded, thoroughly fractured; SiO_2, 2.14; R_2O_3, 0.85; $CaCO_3$, 94.02; $MgCO_3$, 1.98; Total, 98.99	7
41. Limestone, dark-gray, fine grained	3.5
40. Limestone, light-gray, fine grained, dolomitic	6
39. Limestone, medium-gray, oolitic	5
38. Limestone, dark-gray, very fine grained	16
37. Covered	7
36. Limestone, black, fine grained; thin shaly partings; SiO_2, 49.62; R_2O_3, 6.06; $CaCO_3$, 39.47; $MgCO_3$, 4.00; Total, 99.15	15
35. Limestone, gray, oolitic	17
34. Limestone, dove-gray, fine grained, thick bedded, oolitic	6
33. Limestone, dove-gray, very fine grained, compact	15
32. Limestone, argillaceous; contains siliceous geodes 1 to 2 inches in diameter	7
31. Limestone, gray, medium grained, oolitic	17.5
30. Limestone, drab-gray, argillaceous	2.5
29. Limestone, light-gray, medium grained, oolitic	7
28. Limestone, dove-gray, very fine grained	8
27. Covered, mostly argillaceous limestone	13
26. Limestone, crinoidal, impure; clastic texture; SiO_2, 2.37; R_2O_3, 1.38; $CaCO_3$, 90.72; $MgCO_3$, 4.35; Total, 98.82	4
25. Limestone, medium gray, coarse grained, crinoidal, oolitic; SiO_2, 15.98; R_2O_3, 5.03; $CaCO_3$, 73.36; $MgCO_3$, 6.69; Total, 101.06	8
24. Limestone, medium grained, slightly cherty	7

	Thickness Feet
23. Limestone, drab-gray, argillaceous; SiO_2, 4.71; R_2O_3, 1.32; $CaCO_3$, 94.13; $MgCO_3$, 1.46; Total, 101.62	4
22. Limestone, dove-gray, fine grained, cherty	8
21. Covered	15
20. Shale, drab-gray, calcareous	15
19. Limestone, coarse grained, crinoidal	3.5
18. Limestone, drab-gray, impure	22
17. Limestone, black, medium grained, fossiliferous	4
16. Limestone, fine grained, gray, rather pure; 2,099-foot bench mark 4 feet above base; SiO_2, 21.36; R_2O_3, 5.46; $CaCO_3$, 68.33; $MgCO_3$, 4.20; Total, 99.35	22
15. Limestone, black, fine grained, thin bedded	18
14. Limestone, drab-gray, sparsely oolitic; few impure partings	43

Analysis of units 14 to 15; thickness sampled, 61 feet: SiO_2, 3.74; R_2O_3, 1.54; $CaCO_3$, 93.60 $MgCO_3$, 2.68; Total, 101.56.

13. Limestone, dark bluish-gray, fine grained; weathers bluish-gray	28
12. Limestone, bluish-gray, fine grained, cherty	10
11. Limestone, bluish-gray, fine grained; no chert	13
10. Limestone, very dark-gray, impure; weathers greenish-gray and mealy	26

Hillsdale limestone (90 feet)

9. Limestone, black, fine grained, cherty except in upper part	43
8. Limestone, black; contains algal markings; very cherty	6

Analysis of units 8 to 13; thickness sampled, 126 feet: SiO_2, 3.30; R_2O_3, 0.88; $CaCO_3$, 94.85; $MgCO_3$, 2.14; Total, 101.17.

7. Limestone, medium grained, black, cherty; some algal layers	20

	Thickness Feet
6. Limestone, argillaceous, cherty; weathers shaly; poorly exposed	10
5. Limestone, medium gray, cherty	11
Analysis of units 5 to 7; thickness sampled, 41 feet: SiO_2, 2.28; R_2O_3, 1.35; $CaCO_3$, 90.29; $MgCO_3$, 6.08; Total, 100.00.	
Little Valley formation	
4. Limestone, black, argillaceous, shaly, dolomitic; SiO_2, 4.34; R_2O_3, 1.54; $CaCO_3$, 92.13; $MgCO_3$, 2.79; Total, 100.80	10
3. Limestone, bluish-gray, argillaceous, dolomitic, laminated, cherty	18
2. Limestone, dolomitic, shaly, fine grained; poorly exposed along railroad; SiO_2, 2.32; R_2O_3, 1.09; $CaCO_3$, 94.80; $MgCO_3$, 2.77; Total, 100.98	76
Maccrady formation	
1. Mudrock, red and greenish-gray	12
Price formation	

Geologic Section 55.—"Ste. Genevieve" limestone along the Norfolk and Western Railway at locality 11, near Tiptop, Tazewell County, Virginia

	Thickness Feet
"Gasper" limestone	
"Ste. Genevieve" limestone (460 feet)	
35. Covered interval, composed of oolitic limestone interbedded with taupe-gray fine-grained limestone	120
34. Limestone, taupe-gray, very fine grained, medium bedded, sparsely cherty	15
33. Limestone, coarse grained, clastic, crinoidal, cherty; carries *Platycrinites huntsvillae* stem plates	15.5
32. Limestone, gray, very fine grained, compact, slightly cherty; beds 1 to 2 feet thick	6
31. Shale, calcareous, mealy; weathers buff; contains lenses of coarse crinoidal limestone; corresponds to top of Patton shale of Reger	3.5

	Thickness Feet
30. Limestone, taupe-gray, very fine grained, medium bedded; contains no chert	4.5
29. Shale, bluish-gray, calcareous; weathers yellowish gray; contains large irregular masses of coarse-grained limestone with *Platycrinites* plates and small *Pentremites*	6.25
28. Limestone, bluish-gray, fine grained, shaly, fossiliferous; contains *Composita* sp., *Athyris densa, Pentremites princetonensis, Triplophyllites spinulosum, Lioclemella* sp., and *Stenopora*	2
27. Shale, ash-gray, calcareous, mealy, fossiliferous; contains few *Productus*	11.5
26. Limestone, light-gray, oolitic, crinoidal, medium bedded	1
25. Limestone, bluish-gray, shaly, argillaceous, sparsely cherty	7.5
24. Limestone, taupe-gray, oolitic, cherty	3
23. Limestone, metallic-gray, fine grained, dense, with abundant nodules of black chert	5.5
22. Shale, calcareous, lumpy; weathers yellowish-gray; contains fragments of plant fossils; corresponds to the base of Patton shale of Reger	18
21. Limestone, medium-gray, clastic textured, oolitic; thin bedded with shaly partings 1 to 3 inches thick; SiO_2, 1.98; R_2O_3, 0.71; $CaCO_3$, 92.92; $MgCO_3$, 3.18; Total, 98.79	5
20. Limestone, taupe-gray, very fine grained, dense; stylolites abundant; sparsely cherty; partly concealed	74
19. Limestone, taupe-gray, very fine grained; sparingly fossiliferous; weathers light-gray with pitted and welted surfaces	20
Analysis of units 19 and 20; thickness sampled, 94 feet: SiO_2, 2.12; R_2O_3, 0.68; $CaCO_3$, 93.92; $MgCO_3$, 3.54; Total, 100.26.	
18. Limestone, taupe-gray, even bedded, fine grained	17.5
17. Calcilutite, dark-taupe, sparsely cherty; contains *Syringopora* and *Productus parvus*	7.5

	Thickness Feet
16. Limestone, granular, oolitic, brownish-gray	22
15. Limestone, very fine grained, very dense, thick bed-bed; with abundant stylolites; sparsely cherty	3
14. Limestone, medium-gray, oolitic, granular, crinoidal	11.25
13. Limestone, bluish-gray, argillaceous, compact	1.25
12. Limestone, medium bedded, granular, oolitic; clastic textured; contains large inclusions of reddish clay	4.25
11. Limestone, powder-gray, argillaceous, shaly bedded; weathers buff	5.5
10. Limestone, light-gray, oolitic, crinoidal	3.75
9. Limestone, taupe-gray, uneven textured, wavy-bed-bed, fossiliferous	3.25
8. Limestone, medium-gray, medium grained, very oolitic, fossiliferous; contains an abundance of *Platycrinites huntsvillae*	6.5
7. Limestone, coarse grained, oolitic, fossiliferous; composed almost entirely of matted shells; laminated structure with partings of yellowish clay	14.5
6. Limestone, light-gray, finely granular, compact, crinoidal; full of crinoid stem-plates	9
5. Limestone, light-gray, coarse grained, granular, oolitic; bedding surfaces pitted	6.25
4. Limestone, smoky-gray, very argillaceous, shaly; weathers greenish-gray; a few plant fragments in lowest layers	20
3. Limestone, coarse grained, very fossiliferous; weathers greenish yellow; contains dark-greenish galls of clay	1.75
2. Limestone, very fine grained, taupe-gray, fine grained, dense; contains white veins and vugs of secondary calcite	2.75
1. Limestone, dark-gray, shaly; thin streaks of coarse-grained limestone	2

Hillsdale limestone

QUARRIES

FIVE OAKS

A quarry in the Five Oaks limestone was operated at Five Oaks for many years and the stone burned for lime. The quarry (Pl. 8C) has been inactive since 1941 and in 1944 the kiln and bagging plant were dismantled. The rock exposed in the quarry is described in Geologic Section 8. The quarry is an open cut about 100 feet deep, 100 feet wide and 175 to 200 feet long. The ledge on the southeast rim (Pl. 8C) is made by the cherty beds of the Lincolnshire limestone; the foot wall by cherty limestones at the top of the Elway. In this quarry the Five Oaks limestone is about 50 feet thick, but it is now largely concealed by the slumped overburden. Since the Five Oaks limestone thins abruptly to the east and is only 15 to 20 feet thick at locality 23, the advisability of reopening of the quarry at Five Oaks is questionable.

NORTH TAZEWELL

The Peery Lime Company operates a quarry in the Five Oaks, Lincolnshire, Ward Cove, and Peery limestones in the east environs of North Tazewell and along State Highway 61 (Pl. 7A). Chemical lime and building lime are the main products, and some agricultural lime is sold. From time to time, small quantities of crushed stone are produced for resurfacing near-by highways. The character and composition of the beds in the quarry are shown in Geologic Section 56. The quarry face (Pl. 7A) has a maximum height of about 60 feet, is about 450 feet long, and has been developed at approximately right angles to the strike.

Geologic Section 56.—Ordovician limestone at locality 46, exposed in the quarry of the Peery Lime Company, North Tazewell, Tazewell County, Virginia

	Thickness Feet
Gratton limestone	
Peery limestone (24 feet)	
24. Limestone, dove-gray, very fine grained	14

	Thickness Feet
23. Limestone, dark bluish-gray, fine grained; weathers with ash-gray crust containing *Phragmolites* sp., *Tetradium syringoporoides, Lophospira procera, Lophospira bicincta, Leperditia pinguis, Ancistrorhyncha* sp.	10

Analysis of units 23 and 24; thickness sampled, 24 feet: SiO_2, 7.87; R_2O_3, 1.04; $CaCO_3$, 85.03; $MgCO_3$, 6.27; Total, 100.21.

Ward Cove and Lincolnshire limestones (216 feet)

22. Limestone, medium-gray, medium grained; contains stylolites and calcite veins	8
21. Limestone, mottled, fine grained; contains *Girvanella*	2.25
20. Limestone, very fine grained; contains vugs of calcite 0.25 to 0.50 inch in diameter	9
19. Limestone, very fine grained, thick bedded	5
18. Limestone, very fine grained, shaly	1.2
17. Limestone, greenish-gray, shaly	0.2
16. Limestone, very fine grained	3.0
15. Limestone, greenish-gray; very shaly at top	2.2
14. Limestone, very fine grained, pure	5

Analysis of units 14 to 22; thickness sampled, 36 feet: SiO_2, 2.52; R_2O_3, 0.24; $CaCO_3$, 94.87; $MgCO_3$, 1.91; Total, 99.54.

13. Limestone, dove-gray, shaly; SiO_2, 24.74; R_2O_3, 3.34; $CaCO_3$, 66.12; $MgCO_3$, 2.62; Total, 96.82	2.2
12. Limestone, very fine grained; contains fine criss-crossing black streaks	20.6
11. Limestone, dove-gray and golden-gray mottled; fine grained; contains *Girvanella*	5.5
10. Limestone, medium gray, coarse grained	.75
9. Limestone, mottled gray, fine grained	4.5
8. Limestone, medium gray, coarse grained	20.2

Analysis of units 8 to 12; thickness sampled, 50± feet: SiO_2, 2.28; R_2O_3, 0.40; $CaCO_3$, 95.07; $MgCO_3$, 1.94; Total, 99.69.

	Thickness Feet
Five Oaks limestone (127.5 feet)	
7. Limestone, very fine grained, dove-gray to brownish-gray	4
6. Limestone, light dove-gray, fine grained	2.1
5. Chert and travertine	0.1
4. Limestone, dove-gray, very fine grained	50
Analysis of units 4 to 7; thickness sampled, 56± feet: SiO_2, 0.98; R_2O_3, 0.56; $CaCO_3$, 97.18; $MgCO_3$, 1.32; Total, 100.04.	
3. Limestone, very fine grained, dove-gray; contains *Girvanella;* SiO_2, 1.76; R_2O_3, 0.52; $CaCO_3$, 94.64; $MgCO_3$, 2.47; Total, 99.39	11
2. Limestone, dove-gray, very fine grained; SiO_2, 1.94; R_2O_3, 0.36; $CaCO_3$, 96.07; $MgCO_3$, 1.38; Total, 99.75	21.3
1. Limestone, dove-gray, very fine grained; exposed on slope north of footwall of quarry	19
Elway limestone	

The thick occurrence of fine-grained, dove-gray, limestone in the Peery Lime Company quarry is distinctly localized. At locality 47, along Roads 644, about 0.5 mile southwest of the quarry, the Five Oaks limestone is less than 30 feet thick, and is succeeded by about 50 feet of cherty Lincolnshire limestone and this, in turn, by 120 feet of cherty Ward Cove limestone. At North Tazewell, the Ward Cove is succeeded by about 50 feet of Peery limestone, cherty in the lower 15 feet and dove-gray and fine grained in the upper part. About 0.8 mile northeast of the Peery Lime Company quarry along Road 645 (locality 19), the Five Oaks is 35 feet thick, the Lincolnshire 102 feet, and the overlying Ward Cove about 120 feet thick. Careful tracing of the strata between these localities shows that the relatively thick body of dove-gray, fine-grained limestone in the Peery Lime Company quarry interfingers with and grades laterally into the predominantly cherty limestones exposed along Roads 644 and 645. These marked lithologic changes along the strike are interpreted as facies gradations of unusual character which reflect locally varying conditions of sedimentation. The exact extent of the beds quarried to the southwest can not be ascertained because of poor exposures but, 600 feet northeast of the quarry, the beds undergo a marked change in lithology. Between 2 and 4 million tons of rock comparable to that now being quarried, could be obtained by extending the quarry 500 feet to the northeast.

MAXWELL

A small quarry in the Gratton and Benbolt limestones is operated by the Blue Grass Lime Company, near Maxwell (Geologic Section 43). The original opening was a relatively broad, shallow quarry, but for the past 15 years the workings have been carried on 50 to 75 feet below the floor of the old quarry. The present working face is about 75 feet high. The beds quarried extend northeastward, across the Norfolk and Western Railway, at least as far as locality 57, near Youngs, without any appreciable change in thickness or composition (Geologic Sections 42 and 43). Between these localities, the Gratton limestone is probably purer than in any other sector of its known occurrences in Virginia. The Blue Grass Lime Company is the only operation in the Appalachian Valley of Virginia, producing chemical lime from the Gratton limestone.

POUNDING MILL

Two quarries are operated by the Pounding Mill Quarries Corporation, at Pounding Mill (localities 77 and 78). The larger quarry (Pl. 7B) is an irregular, bowl-shaped excavation extending about 900 feet along the strike and approximately 650 feet southward from its northern rim, along the Norfolk and Western Railway. The quarry face is roughly semicircular, with a maximum height of about 200 feet. As shown in Figure 9, the beds in the quarry range from the Lincolnshire limestone to the approximate top of the Gratton. Crushed stone, stone sand, and agricultural limestone (agstone) are the chief products. Some coarse-grained limestone (Geologic Section 57, unit 9) is used for fluxing stone. Although several impure limestone beds are quarried, the average composition of the crushed stone and agstone averages slightly above 90 per cent calcium carbonate. Chert nodules, rather abundant in some layers exposed, seem to be considerably less abundant in the freshly exposed rock in the quarry than they are in near-by natural exposures. Although the floor of the main quarry is slightly

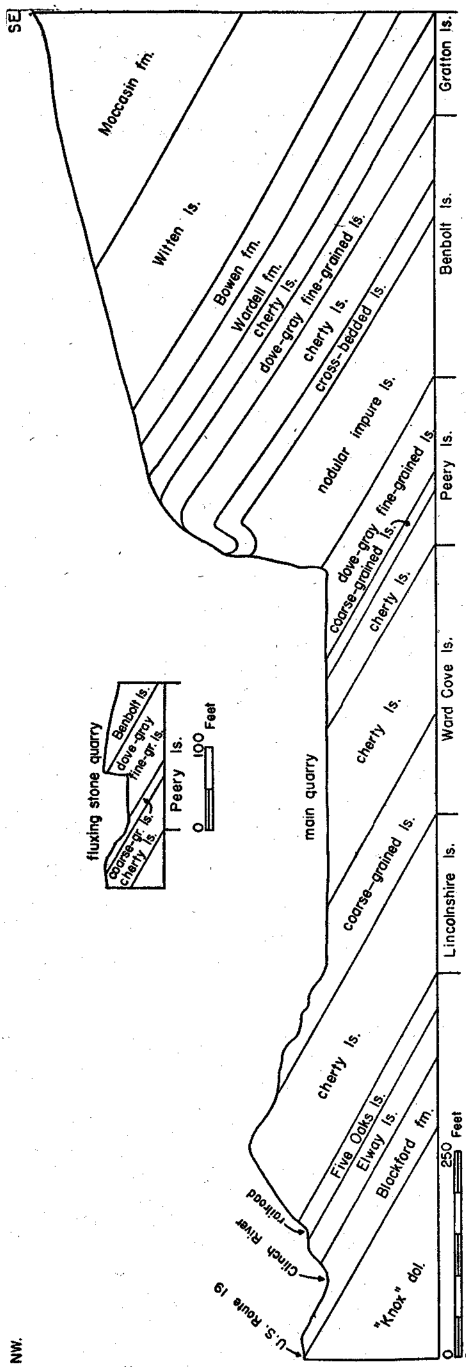


FIGURE 9.—Structure of the Middle Ordovician limestones in quarries at Pounding Mill, Tazewell County, Virginia.

below river level, the quarry is surprisingly dry. A little water seeps into the quarry from a saturated zone in a thin bed of limestone 75 feet above the quarry floor, but little or none from near-by Clinch River. Possibly the lower fine-grained, compact beds of the Five Oaks limestone and the ash-gray shales of the Blackford seal off the water from the river.

The small quarry east of the main working is in the pure dove-gray beds of the Peery limestone. This rock is quarried for fluxing stone exclusively.

Geologic Section 57.—Ordovician limestone at localities 77 and 78, in the mile north-northwest of Gratton, Tazewell County, Virginia

	Thickness Feet
Moccasin formation (415 feet)	
33. Mudrock, maroon-drab	195
32. Limestone, golden-gray to buff, argillaceous	51
31. Limestone, argillaceous, lumpy	11
30. Limestone, dull-gray	11
29. Mudrock, red and olive-drab, silty	89
28. Limestone, brick-red and greenish-gray, mottled, laminated	58
Witten limestone (128 feet)	
27. Limestone, dove-gray, fine grained, slabby; a few intercalated coarse-grained layers	83
26. Limestone, coarse grained; contains *Cryptophragmus antiquatus* and *Zygospira recurvirostris*	19
25. Limestone, very fine grained, medium bedded; clayey partings	26
Bowen formation (30 feet)	
24. Limestone, reddish buff, argillaceous, lumpy	29
23. Sandstone, brownish-gray	1
22. Shale, buff, platy	43
21. Limestone, coarse grained, crinoidal	49
Gratton limestone (63 feet)	
20. Limestone, dark bluish-gray, cherty; highest beds limestone	29

	Thickness Feet
19. Limestone, very fine grained, laminated; upper part columnar jointed; SiO_2, 6.92; R_2O_3, 1.40; $CaCO_3$, 90.11; $MgCO_3$, 1.47; Total, 99.90	37
Benbolt formation (163 feet)	
18. Limestone, cross laminated, slightly cherty, granular	47
17. Limestone, dark bluish-gray; weathers nodular	71
16. Limestone, nodular, shaly	45
Analysis of units 16 and 17; thickness sampled, 116 feet: SiO_2, 12.74; R_2O_3, 2.30; $CaCO_3$, 80.65; $MgCO_3$, 3.41; Total, 99.10.	
Peery limestone (99 feet)	
15. Limestone, fine grained, dove-gray; SiO_2, 0.62; R_2O_3, 1.28; $CaCO_3$, 96.52; $MgCO_3$, 1.05; Total, 99.47	57
14. Limestone, light to medium-gray, coarse grained; SiO_2, 2.42; R_2O_3, 0.52; $CaCO_3$, 95.23; $MgCO_3$, 1.91; Total, 100.08	12
13. Limestone, black, fine grained, cherty; lenses of coarse-grained limestone	11
12. Limestone, dark-gray, cherty	19
Ward Cove limestone (167 feet)	
11. Limestone, dark-gray, cherty, thin bedded; many *Nidulites*	25
10. Limestone, medium to fine grained, sparsely cherty; thin intercalated coarse-grained layers; beds weather with a thick chalky crust full of fossils	80
Analysis of units 10 to 13; thickness sampled, 135 feet: SiO_2, 2.92; R_2O_3, 0.42; $CaCO_3$, 92.16; $MgCO_3$, 4.01; Total, 99.51.	
9. Limestone, gray, medium to coarse grained; SiO_2, 0.56; R_2O_3, 0.84; $CaCO_3$, 96.76; $MgCO_3$, 1.64; Total, 99.80	62
Lincolnshire limestone (112.5 feet)	
8. Limestone, medium gray, medium to fine grained, granular; very sparsely cherty	52

	Thickness Feet
7. Limestone, very cherty; intercalated beds of coarse-grained limestone along north rim of quarry	44
6. Limestone, medium-gray, coarse grained, no chert	3.5
5. Limestone, dark-gray, medium grained, cherty	13
Five Oaks limestone (exposed at locality 76)	
4. Limestone, light-gray, thin bedded, partly cherty	25
Elway limestone	
3. Limestone, gray, very cherty	30
Blackford formation	
2. Shale and fine-grained limestone, ash-gray	30
1. Mudrock, shale, and dolomite, mainly maroon-drab; conglomeratic at the base	105.5
"Knox" dolomite	

THOMPSON VALLEY

A small quarry at locality 41, along State Highway 16, is operated by Henry Buchanan (Pl. 8A). The character and composition of the Gratton limestone exposed in this quarry are given in Geologic Section 39. Practically all of the rock obtained from this quarry is used for agstone and agricultural lime in Thompson Valley. The quarry is operated only on seasonal demands.

QUARRY SITES

GRATTON-CAVE SPRING BELT

Between localities 28 and 30 along the southeast base of Buckhorn Mountain, the Ward Cove and Peery limestones are very thick and composed mainly of high-calcium limestone. Except in this part of the valley between Rich and Buckhorn mountains, these two formations have an aggregate thickness of slightly less than 200 feet and are composed almost wholly of dark bluish-gray cherty limestone. The abnormal thickness and character of the formations in the Gratton-Cave Spring belt are the result of locally varying conditions of sedimentation on the floor of the ancient Appalachian sea. The dove-gray fine-grained type of limestone probably accumulated from the chemical precipitation of minute crystalline particles of calcium carbonate (lime mud), whereas the coarse-grained limestones are clastic deposits (shell sands) resulting from the disruption and abrasion of the calcareous skeletons of marine invertebrates, particularly cystids, crinoids, and bryozoans.

At locality 30, north of Gratton, the Peery and Ward Cove limestones are represented by 540 feet of dove-gray fine-grained limestone, with apparently no intercalated beds of dark bluish-gray cherty limestone such as elsewhere compose almost all of these formations. Similarly fine-grained limestones occur in the Gratton, just above the Benbolt, but they are not as pure as the lower beds (Geologic Section 58).

Geologic Section 58.—Ordovician limestones at locality 30, about 0.75 mile north-northwest of Gratton, Tazewell County, Virginia

	Thickness Feet
Witten limestone	
Gratton limestone (71 feet)	
15. Limestone, dove-gray, fine grained: SiO_2, 2.92; R_2O_3, 1.04; $CaCO_3$, 93.24; $MgCO_3$, 2.06; Total, 99.26	55
14. Limestone, buff-gray, laminated	16
Benbolt limestone	
13. Limestone, dark-gray, very impure, clayey; beds weather nodular	
Peery and Ward Cove limestones (537 feet)	
12. Limestone, light- to medium-gray; very fine grained; with stringers of coarse-grained calcite	29
11. Limestone, light-gray, very fine grained, thick bedded; contains intercalations of dove-gray clastic limestone; abundant veins of cream-colored calcite	44
10. Limestone, very fine grained, dove-gray, thick bedded; contains thin intercalations of clastic limestone	29

	Thickness Feet
9. Partly covered interval; all exposed beds are similar to those in unit 10	50
8. Limestone, very fine grained; contains abundant vugs and veins of cream-colored calcite; relatively thick bedded	38
7. Limestone, very fine grained; contains intersecting stringers and partings of clay; lower part slightly granular	50
6. Limestone, dove-gray, very fine grained; contains yellowish vugs of calcite; beds burned locally for lime	48
5. Partly covered interval; all exposed beds are fine-grained limestone or finely granular limestone; numerous thin partings of yellowish clay	125
4. Limestone, dove-gray, very fine grained, thick bedded; not fully exposed	124

Analysis of units 4 to 12; thickness sampled, 537 feet: SiO_2, 0.47; R_2O_3, 0.95; $CaCO_3$, 96.60; $MgCO_3$, 1.52; Total, 99.54.

Lincolnshire limestone (84 feet)

3. Limestone, medium-gray, granular, argillaceous	34
2. Limestone, dark-gray, coarse-grained, argillaceous; contains nodules of black chert	50

Five Oaks, Elway, and Blackford formations

1. Covered interval; extends to approximate top of "Knox" dolomite	190

"Knox" dolomite

The upper 250 feet seems to be somewhat thicker bedded and to contain fewer clayey partings than the lower half of the 540-foot zone, and it is therefore likely that the upper part is slightly higher in calcium carbonate than the 540-foot zone as a whole. The succession described above can not be traced very far along the strike, but if the beds persist southwestward for only 500 feet and could be quarried to a depth of 200 feet, more than 4.5 million tons of high-calcium limestone could be obtained near Gratton. The exact extent of the beds can be ascertained only by shallow core-drilling. Since the beds are vertical, the drill holes would not have to be extended very far down into the bedrock. This 540-foot zone comprises the greatest known thickness of dove-gray, fine-grained, high-calcium limestone in the Appalachian Valley of Virginia. Except for the rather remote location, about 6 miles from the nearest railroad, the locality 0.75 mile north of Gratton is one of the most favorable quarry sites in Tazewell County.

In the vicinity of Cave Spring, the Lincolnshire is succeeded by a relatively great thickness of coarse-grained light-gray limestone with a calcium carbonate content of more than 98 per cent. Although exposures are not continuous, these beds seem to comprise all or nearly all of a 225- to 250 foot zone comprising the Peery and Ward Cove limestones. The beds can be traced northeastward for at least 0.25 mile and southwestward for 0.5 mile or more, but with some thinning. Thus large tonnages of rock are available for quarrying. However, there is evidence of considerable underground solution. Cave Spring is the mouth of an underground stream which flows from a cavern. Considerable core-drilling would have to be done there to determine whether large-scale quarrying would be feasible.

At locality 28, north of Road 646, the beds from the top of the "Knox" up to the Witten are continuously exposed in a large hill rising abruptly 300 feet above the valley floor (Pl. 5A).

Geologic Section 59.—Ordovician limestones at locality 28, north of Road 646, Tazewell County, Virginia

	Thickness Feet
Moccasin formation (50+ feet)	
34. Mostly red mudrock; thickness not determined....	
33. Limestone and mudrock, brick-red and pale-green	50
Witten limestone (141 feet)	
32. Limestone, golden-gray, fine grained	72
31. Limestone, gray, mostly coarse-grained, shaly at base	17

	Thickness Feet
30. Limestone, dove-gray, very fine-grained, medium bedded; contains argillaceous partings	40
29. Limestone, dove-gray, straticulate	12
Wardell (?) formation (8 feet)	
28. Limestone, nodular; contains lenses of coarse-grained limestone	8
Gratton limestone (65 feet)	
27. Limestone, dove-gray, very fine grained, slightly granular near base	50
26. Limestone, slightly cherty, finely granular, straticulate	15
Benbolt limestone (45 feet)	
25. Limestone, cross laminated, thin bedded, coarse grained; SiO_2, 1.23; R_2O_3, 0.91; $CaCO_3$, 97.39; $MgCO_3$, 1.74; Total, 101.27	20
24. Limestone, argillaceous, nodular	25
Peery and Ward Cove limestones (467 feet)	
23. Limestone, dove-gray, very fine grained; contains numerous intercalations of limestone of uneven texture	30
22. Limestone, coarse grained, granular; contains pebble-like inclusions of fine-grained limestone; weathers nodular due to wavy streaks of clay	68
21. Limestone, light-gray, very fine grained, somewhat cherty; partly covered; SiO_2, 1.13; R_2O_3, 0.32; $CaCO_3$, 95.91; $MgCO_3$, 2.92; Total, 100.28	25
20. Limestone, very fine grained, very cherty in lower part, upper part massively bedded: SiO_2, 2.01; R_2O_3, 0.60; $CaCO_3$, 94.19; $MgCO_3$, 3.09; Total, 99.89	90
19. Limestone, gray, uneven grained	20
18. Limestone, taupe-gray, very fine-grained; in 6- to 8-inch beds; SiO_2, 1.08; R_2O_3, 0.53; $CaCO_3$, 97.04; $MgCO_3$, 0.94; Total, 99.59	15

	Thickness Feet
17. Limestone, gray, coarse-grained; SiO_2, 0.42; R_2O_3, 0.32; $CaCO_3$, 98.92; $MgCO_3$, 0.38; Total, 100.04	55
16. Limestone, light-gray; uneven texture; argillaceous; SiO_2, 1.47; R_2O_3, 0.65; $CaCO_3$, 97.15; $MgCO_3$, 0.90; Total, 100.17	18
15. Limestone, dark-gray; uneven texture	29
14. Limestone, light-gray, coarse grained; clastic texture; partly cross laminated	40
Analysis of units 14 and 15; thickness sampled, 69 feet: SiO_2, 1.29; R_2O_3, 0.59; $CaCO_3$, 96.39; $MgCO_3$, 1.65; Total, 99.92.	
13. Limestone, pseudoconglomeratic; texture very irregular; inclusions of fine-grained limestone	32
12. Limestone, dark-gray, coarse grained; bedding uneven	7
Analysis of units 12 and 13; thickness sampled, 39 feet: SiO_2, 1.51; R_2O_3, 0.63; $CaCO_3$, 96.35; $MgCO_3$, 1.96; Total, 100.45.	
11. Limestone, brownish-gray, mottled, fine grained, dense; bedding uneven	10
10. Limestone, dark-gray, dense, nodular, very cherty	14
9. Limestone, medium-gray, fine grained; texture uneven; SiO_2, 3.18; R_2O_3, 1.46; $CaCO_3$, 89.70; $MgCO_3$, 5.44; Total, 99.78	14
Lincolnshire limestone (111 feet)	
8. Limestone, clastic texture; thin, wavy beds; SiO_2, 0.08; R_2O_3, 0.18; $CaCO_3$, 96.39; $MgCO_3$, 3.24; Total, 99.89	67
7. Limestone, dark bluish-gray; has a peculiar "worm-eaten" appearance; SiO_2, 1.79; R_2O_3, 1.02; $CaCO_3$, 88.28; $MgCO_3$, 7.47; Total, 98.56	7
6. Limestone, dark bluish-gray, slightly cherty	10

	Thickness Feet
5. Limestone, dark bluish-gray, thin bedded; contains a one-foot intercalation of dove-gray fine grained limestone two feet above the base	27
Five Oaks limestone	
4. Limestone, very fine grained, dark-gray, medium bedded	25
Analysis of units 4 and 5; thickness sampled, 52 feet: SiO_2, 0.66; R_2O_3, 0.46; $CaCO_3$, 98.01; $MgCO_3$, 0.69; Total, 99.82.	
Elway limestone	
3. Chert, light-gray, blocky; fine-grained limestones intercalated in the chert	40
Blackford formation (30± feet)	
2. Shale, ash-gray; contains a few beds of shaly limestone	15
1. Partly covered; contains a few exposures of maroon-drab to brick-red silty dolomite and beds of chert conglomerate	5–15
"Knox" dolomite	

The principal zone of high-calcium limestone at locality 28 is about 190 feet thick (units 14 to 18) and averages about 97 per cent calcium carbonate. Other thinner high-calcium zones and considerably greater thicknesses of high-carbonate limestone also occur. Considering the size of the hill (Pl. 5A) and the general character of the exposed beds probably 40 million tons of rock, including at least 6 million tons of high-calcium limestone, could be quarried from this hill. The large spring issuing from the base of the hill, about 300 feet north of Road 646, may indicate the presence of underground solution passages.

ST. CLAIR

Along Road 650, south of St. Clair, more than 1,000 feet of dove-gray, very fine-grained limestone occurs between the "Knox" and the south branch of the St. Clair overthrust. Beds believed to represent the Lincolnshire limestone are exposed in the roadside quarry south of St. Clair Station. The succeeding 800 feet of limestone up to the nodular beds of the Benbolt, exposed along the road just south of St. Clair School, apparently represents a locally thickened occurrence of the Peery and Ward Cove limestones. The St. Clair section has been described by Butts.[10] The analyses of the various lithologic units he recognized are given in the following section, but the nomenclature of formations has been changed to conform with present usage.

Geologic Section 60.—Limestone above the "Knox" dolomite at locality 4, along Road 650, St. Clair, Tazewell County, Virginia

(After Butts)

	Thickness Feet
Gratton limestone (145 feet)	
31. Limestone, dove-colored, thick bedded, compact; calcite veins; with *Lophospira;* SiO_2, 0.34; R_2O_3, 1.94; $CaCO_3$, 97.18; $MgCO_3$, 0.97; Total, 100.43	70
30. Limestone, poorly exposed	75
Benbolt limestone	
29. Limestone, dark-colored, partly exposed, shaly; contains *Rafinesquina* sp., *Rhinidictya* sp., and *Isochilina* sp.	70
Peery and Ward Cove limestones (727 feet)	
28. Limestone, dove-colored, mainly thick bedded, compact, veined with calcite; contains *Lophospira, Maclurites,* or *Eotomaria;* SiO_2, trace; R_2O_3, 1.39; $CaCO_3$, 98.67; $MgCO_3$, 1.02; Total, 101.08	105
27. Limestone, mainly dark dove-colored, thick bedded; a little is pure, dove-colored, compact; SiO_2, trace; R_2O_3, 1.38; $CaCO_3$, 98.51; $MgCO_3$, 0.40; Total, 100.29	85

Analysis of upper 155 feet of units 27-28; SiO_2, 0.20; R_2O_3, 1.14; P_2O_5, 0.007; $CaCO_3$, 97.67; $MgCO_3$, 1.24; Total, 100.25.

	Thickness Feet
26. Limestone, dove-colored, thick bedded to medium thick bedded, mainly compact; SiO_2, trace; R_2O_3, 4.61; $CaCO_3$, 91.83; $MgCO_3$, 2.95; Total, 99.39	55
25. Limestone, dark dove-colored, mainly compact; a few argillaceous layers: SiO_2, trace; R_2O_3, 6.05; $CaCO_3$, 85.57; $MgCO_3$, 7.51; Total, 99.13	40
24. Limestone, dark dove-colored; SiO_2, 1.16; R_2O_3, 1.42; $CaCO_3$, 95.00; $MgCO_3$, 2.36; Total, 99.94	50
23. Limestone, dark dove-colored, compact or subcrystalline; SiO_2, 1.56; R_2O_3, 0.18; $CaCO_3$, 95.21; $MgCO_3$, 2.37; Total, 99.32	20
22. Limestone, finely crystalline, thinly laminated; SiO_2, 2.25; R_2O_3, 2.06; $CaCO_3$, 92.14; $MgCO_3$, 4.10; Total, 100.55	25
21. Not exposed	20
20. Limestone, dark- to dove-colored, finely crystalline; with bryozoa; SiO_2, 0.67; R_2O_3, 0.52; $CaCO_3$, 96.11; $MgCO_3$, 2.99; Total, 100.29	22
19. Limestone, dove-colored and dark dove-colored; thick and thin bedded, some shaly; a little chert; SiO_2, 2.80; R_2O_3, 1.29; $CaCO_3$, 93.26; $MgCO_3$, 3.20; Total, 100.55	45
18. Limestone, dove-colored and dark dove-colored; thick bedded, mostly compact; contains *Lophospira* and other gastropods; SiO_2, 0.39; R_2O_3, 1.95; $CaCO_3$, 95.09; $MgCO_3$, 2.51; Total, 99.94	65
17. Limestone, dove-colored and dark dove-colored; variable, thick and thin bedded; argillaceous streaks; lower 2½ feet shaly; contains *Tetradium syringoporoides;* SiO_2, 1.74; R_2O_3, 5.35; $CaCO_3$, 89.81; $MgCO_3$, 3.76; Total, 100.66	20
16. Limestone, mainly dark dove-colored; medium thick bedded; ostracodes abundant in some layers	16
15. Limestone, argillaceous; SiO_2, 0.97; R_2O_3, 11.29; $CaCO_3$, 84.06; $MgCO_3$, 2.80; Total, 99.12	4
14. Limestone, dove-colored, medium bedded, mainly compact	14

	Thickness Feet
13. Limestone, argillaceous; SiO_2, 4.93; R_2O_3, 10.14; $CaCO_3$, 74.62; $MgCO_3$, 9.74; Total, 99.43	2
12. Limestone, dove-colored; medium bedded, compact; SiO_2, 1.04; R_2O_3, 3.55; $CaCO_3$, 93.41; $MgCO_3$, 2.50; Total, 100.50	6
11. Limestone, fossiliferous; contains *Tetradium syringoporoides;* SiO_2, 0.76; R_2O_3, 2.55; $CaCO_3$, 92.04; $MgCO_3$, 5.32; Total, 100.67	4
10. Limestone, light-gray, thick bedded, compact; contains ostracodes; SiO_2, 1.70; R_2O_3, 2.76; $CaCO_3$, 92.52; $MgCO_3$, 3.44; Total, 100.42	19
9. Limestone as above, with calcite eyes; SiO_2, 2.27; R_2O_3, 2.51; $CaCO_3$, 91.37; $MgCO_3$, 4.18; Total, 100.33	21
8. Limestone as above; cherty below; SiO_2, 2.30; R_2O_3, 2.74; $CaCO_3$, 90.57; $MgCO_3$, 3.98; Total, 99.59	20
7. Limestone, bluish-gray, finely striped; nodules and plates of black chert, containing *Tetradium* sp.; SiO_2, 2.37; R_2O_3, 4.54; $CaCO_3$, 88.93; $MgCO_3$, 4.87; Total, 100.71	8
6. Limestone, bluish-gray, finely striped, fine-grained; SiO_2, 1.51; R_2O_3, 2.63; $CaCO_3$, 90.26; $MgCO_3$, 4.83; Total, 99.23	7
5. Limestone, light-colored, thick bedded, relatively dense; SiO_2, 1.60; R_2O_3, 1.59; $CaCO_3$, 93.43; $MgCO_3$, 3.44; Total, 100.06	13
4. Limestone dark drab-colored; medium bedded; fine grained; a few fossils; SiO_2, 2.12; R_2O_3, 1.66; $CaCO_3$, 93.34; $MgCO_3$, 3.49; Total, 100.61	40
3. Limestone, pearl-gray, compact; SiO_2, 2.47; R_2O_3, 2.83; $CaCO_3$, 89.79; $MgCO_3$, 4.88; Total, 99.97	1
Lincolnshire, Five Oaks, Elway, and Blackford formations	
2. Limestone, partly exposed across low ground; apparently all fine grained	280
"Knox" dolomite	
1. Dolomite	1,000

Because of the essentially homogeneous character of the fine-grained limestone, the various formations represented are obscure. After restudy of this anomalous section, the writer has revised his previous interpretations of Butts' section.[10] Unit 29 seems to be linked with the Benbolt and units 30 and 31 are now believed to represent the Gratton limestone. Traced eastward into the adjacent meadow, the nodular Benbolt exposed along Road 650 south of St. Clair School overlies a thick zone of very pure limestone. A

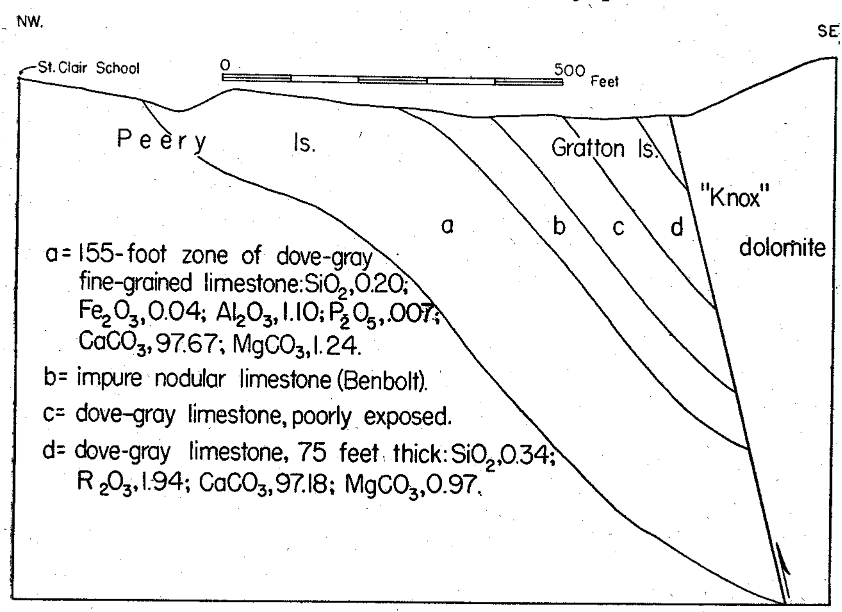


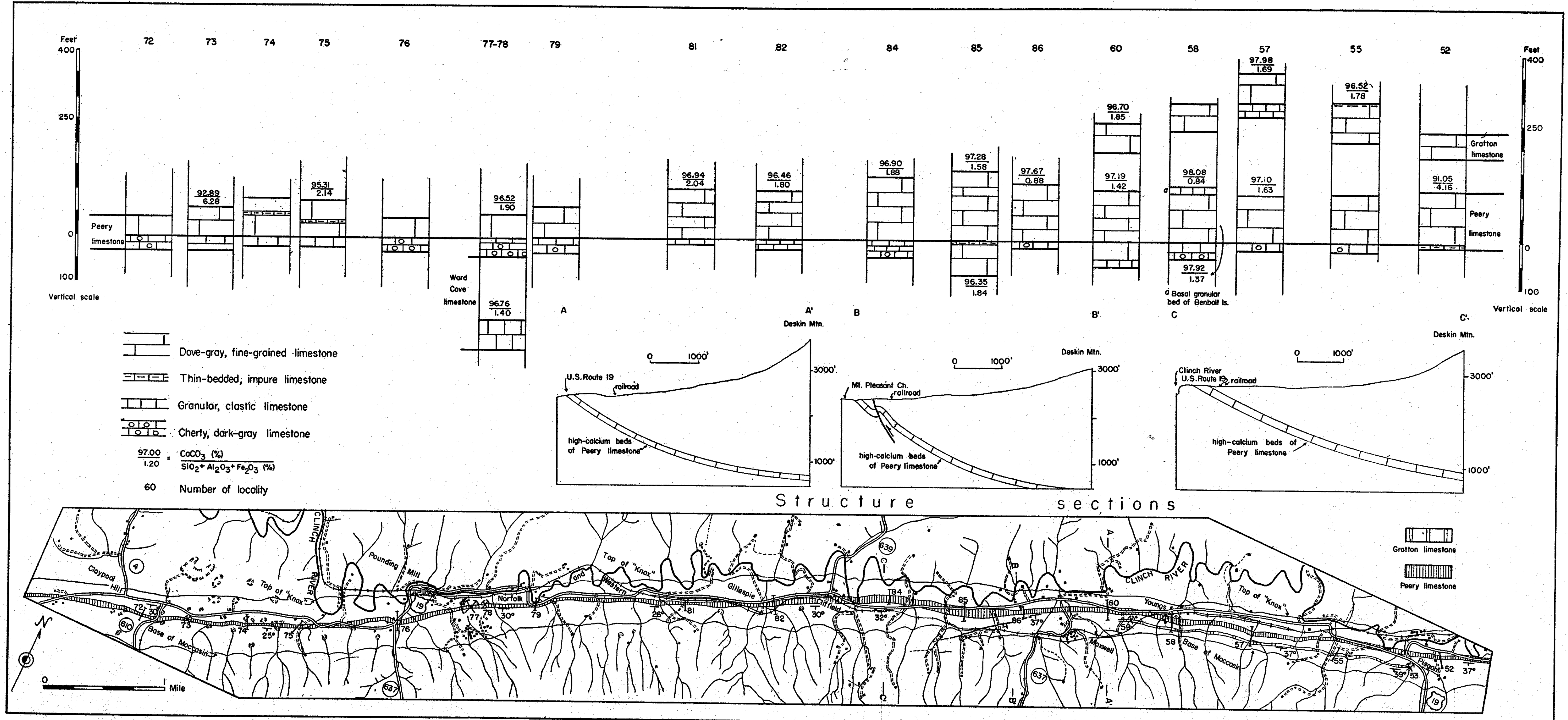
FIGURE 10.—Structure of the Peery, Benbolt, and Gratton limestones near St. Clair School, Tazewell County, Virginia.

sample collected from the 155 feet of exposed fine-grained limestone beneath the Benbolt, contains narly 98.00 per cent calcium carbonate (Table 3). Figure 10 shows the structural relations of this zone. The extent of the 155-foot, dove-gray limestone along the strike can not be accurately determined because of poor exposures, but at locality 3, a mile east of St. Clair School, the Benbolt is directly underlain by pure dove-gray beds at least 100 feet thick. If the belt of pure limestone is persistent between these localities, as it is reasonable to suppose, well over 10 million tons of rock could be mined at this location. West of Road 650 the pure limestones just below the Benbolt are largely concealed, but at locality 6, about 1.25 miles west of St. Clair School, apparently the same zone of dove-gray limestone is at least 100 feet thick. If the beds are persistent between these localities, an exceedingly large tonnage of high-calcium limestone could be obtained in this area by shallow quarrying. Large tonnages of high-carbonate rock could also be quarried from the dove-gray beds below the 155-foot zone of high-calcium limestone. The total amount of premium-grade limestone which could be extracted in the vicinity of St. Clair can be accurately determined only by core-drilling. The presence of sinks in the meadows east of St. Clair School suggests the possible presence of underground solution channels. The thick occurrence of dove-gray beds in the vicinity of St. Clair is not present in the belt of limestone along the northwest base of East River Mountain. At Shannondale (locality 7), about 3.5 miles southwest of St. Clair, the fine-grained limestone beneath the Benbolt is only 5 to 8 feet thick. These variations in character and thickness, like those noted in the Gratton-Cave Spring belt, are the result of varying conditions of sedimentation.

MAXWELL-POUNDING MILL BELT

The most favorable sites for quarrying or mining large tonnages of high-calcium limestone in Tazewell County are along the outcrop of the Peery limestone between Claypool Hill and Pisgah Church. The location, thickness variations, and analyses of the high-calcium limestone beds of the Peery in this area are shown on Plate 10. Locally, between Maxwell and locality 57, near Youngs, the Gratton is also a high-grade limestone, though not as pure as the Peery. Between Cliffield and the fluxing-stone quarry at Pounding Mill, the dove-gray, fine-grained limestone of the Peery averages 80 to 100 feet in thickness, contains about 96.8 per cent calcium carbonate, and dips approximately 30° SE. At locality 79, less than 0.3 mile to the east of the same quarry, the dove-gray beds are locally crumpled along U. S. Route 19, but elsewhere the structure appears to be regular. Within the Pounding Mill-Cliffield segment of the Pounding Mill-Maxwell belt, millions of tons of high-calcium limestone could be quarried or mined.

Just east of Cliffield, the high-calcium beds of the Peery limestone crop out north of U. S. Route 19 and the railroad, and are well exposed at locality 83, where the thickness is about 150 feet. About 2.5 million tons could be quarried from this site, but underground mining would probably be prohibitive because of near-



High-calcium limestones between Claypool Hill and Pisgah, Tazewell County, Virginia.

ness to the railroad. Northeast of locality 83, the same beds, 100 to 150 feet thick and averaging about 97 per cent calcium carbonate, crop out between the railroad and U. S. Route 19. Between localities 60 and 84, nearly 15 million tons of high-calcium limestone could be quarried and probably much larger amounts could be mined. Locally west of Maxwell Station, the Witten and lower Moccasin beds are crumpled and displaced by a small thrust. Whether this disturbance of the otherwise regular structure persists down as far as the Peery is unknown. Since the general structure of Deskin Mountain is synclinal, the general dip of the limestone beds may be expected to decrease in that direction (Plate 10). If the beds were mined down the dip southward only as far as the railroad, for a distance of about 600 feet, upwards of 30 million tons of stone could be recovered here. If core-drilling indicates that it is feasible to mine for a distance of 1,000 feet or more down the dip, the sector between localities 60 and 84 could be expected to yield well over 60 million tons of premium-grade limestone.

Between Maxwell and locality 57, the fine-grained Peery limestone is about 110 feet thick and averages close to 97 per cent calcium carbonate. The dip is about 37° SE. and the structure is regular. The quantity of high-calcium limestone available for quarrying or mining in this area is about 10 million tons. Farther northeast, toward Pisgah, the dove-gray beds, of the Peery, although more than 100 feet thick, are rather clayey and it is improbable that the rock could qualify as high-grade industrial limestone. As shown in Geologic Sections 41 to 43 and on Plate 10, the Gratton limestone between localities 55 and 58 east of Maxwell could yield moderately large tonnages of high-calcium limestone.

TABLE 3.—*Analyses of limestones and dolomites in Tazewell County, Virginia*

(Froehling and Robertson, Inc., and John H. Yoe, Analysts)

Locality (Shown on Plate 9)	Formation	Geologic Section		Thickness (Feet)	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3 (Al_2O_3 | Fe_2O_3)	SiO_2	Total		
4	Ward Cove	60	3	1	89.79	4.88	2.83	2.47	99.97		
4	Ward Cove	60	4	40	93.34	3.49	1.66	2.12	100.61		
4	Ward Cove	60	5	13	93.43	3.44	1.59	1.60	100.06		
4	Ward Cove	60	6	7	90.26	4.83	2.63	1.51	99.23		
4	Ward Cove	60	7	8	88.93	4.87	4.54	2.37	100.71		Along Road 650, south of St. Clair Station, near Bluefield, Virginia
4	Ward Cove	60	8	20	90.57	3.98	2.74	2.30	99.59		
4	Ward Cove	60	9	21	91.37	4.18	2.51	2.27	100.33		
4	Ward Cove	60	10	19	92.52	3.44	2.76	1.70	100.42		
4	Ward Cove	60	11	4	92.04	5.32	2.55	0.76	100.67		
4	Ward Cove	60	13	2	74.62	9.74	10.14	4.93	99.43		
4	Ward Cove	60	15	4	84.06	2.80	11.29	0.97	99.12		

4	Ward Cove	60	17	20	89.81	3.76	5.35		1.74	100.66	Along Road 650, south of St. Clair Station, near Bluefield, Virginia
4	Ward Cove	60	18	65	95.09	2.51	1.95		0.39	99.94	
4	Ward Cove	60	19	45	93.26	3.20	1.29		2.80	100.55	
4	Ward Cove	60	20	22	96.11	2.99	0.52		0.67	100.29	
4	Ward Cove	60	22	25	92.14	4.10	2.06		2.25	100.55	
4	Ward Cove	60	23	20	95.21	2.37	0.18		1.56	99.32	
4	Ward Cove	60	24	50	95.00	2.36	1.42		1.16	99.94	
4	Ward Cove	60	25	40	85.57	7.51	6.05		trace	99.13	
4	Ward Cove	60	26	55	91.83	2.95	4.61		trace	99.39	
4	Peery	60	27–28	155	97.67	1.24	1.10	0.04	0.20	100.25	
4	Peery	60	27	85	98.51	0.40	1.38		trace	100.29	
4	Peery	60	28	105	98.67	1.02	1.39		trace	101.08	
4	Benbolt	60	29	75	87.50	3.05	5.86		3.02	99.43	
4	Gratton	60	30	70	96.07	1.19	2.39		trace	99.65	
4	Gratton	60	31	70	97.18	0.97	1.94		0.34	100.43	
11	"Ste. Genevieve"	55	21	5	92.92	3.18	0.71		1.98	98.79	Near Tiptop, along the Norfolk and Western Railway
11	"Ste. Genevieve"	55	19–20	94	93.92	3.54	0.68		2.12	100.26	
13	Honaker	1	14–19	375	53.93	43.17	1.68		1.53	100.31	North of Wittens Mills Station

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

Locality (Shown on Plate 9)	Formation	Geologic Section		Thickness (Feet)	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
18	"Knox"	3	5	11.5	56.17	42.20	0.50		1.59	100.46	Along Norfolk and Western Railway, south of Wittens Mills Station
18	"Knox"	3	8	9	53.79	41.10	0.81		4.33	100.03	
18	"Knox"	3	17	4	51.73	39.51	1.55		7.27	100.06	
18	"Knox"	3	18	13	46.42	34.16	4.22		14.50	99.30	
18	"Knox"	3	19	23	48.92	37.11	2.36		11.92	100.31	
18	"Knox"	3	22	14	51.29	39.75	0.84		8.35	100.23	
18	"Knox"	3	37	10.9	50.67	39.45	1.10		9.36	100.58	
18	"Knox"	3	50	19	48.72	36.12	1.13		14.10	100.07	
18	"Knox"	3	51	41	54.85	40.31	1.12		2.76	99.04	
18	"Knox"	3	54	34	46.42	34.16	4.22		14.50	99.30	
20	Five Oaks			35	94.62	3.47	0.22		0.66	98.97	Quarry along Road 645, about 0.8 mile west of Five Oaks
20	Lincolnshire[a]	7	1–5	102	97.53	2.44	0.43		1.37	101.77	

22	Witten[b]	50	2	40	91.42	0.91	1.14	6.04	99.51	Along Norfolk and Western Railway, south of Five Oaks
22	Witten[b]	50	4	55	87.75	4.40	1.84	4.56	98.55	
22	Moccasin[b]	50	5	325	68.71	1.35	3.94	24.72	98.72	
22	Martinsburg[b]				73.82	0.11	2.34	22.50	98.77	
22	Martinsburg[b]				90.25	0.58	1.24	8.14	100.21	
22	Martinsburg				65.03	2.08	3.76	28.62	99.49	
22	Martinsburg[b]				12.07	0.09	11.28	73.00	96.44	
	Martinsburg[b]				85.86	0.94	1.52	11.68	100.00	Tazewell
	Martinsburg[b]				76.36	1.06	2.04	20.48	99.94	
25	Gratton	37	1–2	60	93.09	3.67	1.52	2.67	100.95	Along U. S. Route 19, about 500 feet east of Road 650, Wittens Mills
27	"Knox"			60	94.36	2.35	0.56	3.47	100.74	Just north of State Highway 61, near Marys Chapel
28	Benbolt	32	2	20	97.39	1.74	0.91	1.23	101.27	North of Road 646, near Concord Church, about 1.5 miles west of Gratton
28	Lincolnshire-Five Oaks	59	4–5	52	98.01	0.69	0.46	0.66	99.82	
28	Lincolnshire	59	7	7	88.28	7.47	1.02	1.79	98.56	
28	Lincolnshire	59	8	67	96.39	3.24	0.18	0.08	99.89	
28	Ward Cove	59	9	14	89.70	5.44	1.46	3.18	99.78	
28	Ward Cove	59	12–13	39	96.35	1.96	0.63	1.51	100.45	

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

Locality (Shown on Plate 9)	Formation	Geologic Section		Thickness	Chemical Composition					Location
		No.	Unit	(Feet)	$CaCO_3$	$MgCO_3$	R_2O_3 (Al_2O_3, Fe_2O_3)	SiO_2	Total	
28	Ward Cove	59	14–15	69	96.39	1.65	0.59	1.29	99.92	North of Road 646, near Concord Church, about 1.5 miles west of Gratton
28	Ward Cove	59	16	18	97.15	0.90	0.65	1.47	100.17	
28	Ward Cove	59	17	55	98.92	0.38	0.32	0.42	100.04	
28	Ward Cove	59	18	15	97.04	0.94	0.53	1.08	99.59	
28	Ward Cove (?)	59	20	90	94.19	3.09	0.60	2.01	99.89	
28	Peery	59	21	25	95.91	2.92	0.32	1.13	100.28	
28	Benbolt	59	25	20	97.39	1.74	0.91	1.23	101.27	
29	Ward Cove			250	97.26	0.46	0.38	0.60	98.70	Near Cave Spring, about 1.3 miles northwest of Gratton
30	Peery-Ward Cove	58	4–12	537	96.60	1.52	0.95	0.47	99.54	About 0.75 mile north-northwest of Gratton
30	Gratton	58 35	15 2	55	93.24	2.06	1.04	2.92	99.26	

34	Benbolt	31	1–2	10.1	95.92	3.70	0.50		1.11	101.23	West of cattle barn, Tazewell County Farm, 1.7 miles south of Benbolt
34	Benbolt	31	3	33.5	87.40	2.93	2.15		7.10	99.58	
34	Benbolt	31	4–6	49.5	92.51	3.34	1.13		4.61	101.59	
40	"Knox"			70	93.20	1.29	0.30		4.94	99.73	About 0.5 mile east of Creagers Mill, near State Highway 16
41	Gratton	39	1–3	44.8	94.34	1.28	1.05		3.47	100.14	Quarry of Henry Buchanan, Thompson Valley
41	Gratton	39	4–6	24.5	89.85	2.42	2.34		5.83	100.44	
42	Witten	49	2	12.2	81.60	0.02	4.92		11.53	98.07	Along State Highway 16, north of junction with Road 604, Thompson Valley
42	Witten	49	3	19.7	92.82	3.03	1.22		2.99	100.06	
42	Witten	49	4	42.5	92.38	0.02	0.85		5.32	98.57	
42	Bowen	48	1–4	36	54.70	4.01	8.88		30.40	97.99	
43	Ward Cove	9	1	60	95.52	3.22	0.35		0.70	99.79	Junction of State Highway 16 and Road 604, Thompson Valley
43	Ward Cove	9	2–4	131	88.25	3.22	0.32		3.25	95.04	
43	Gratton	40	1	104	94.04	2.21	1.20	0.20	2.08	99.73	Along State Highway 16, about 0.4 mile southeast of junction with U. S. Route 19
46	Peery	24 56	1–2 23–24	24	85.03	6.27	1.04		7.87	100.21	Quarry of Peery Lime Company, near State Highway 61, North Tazewell
46	Five Oaks	56	2	21.3	96.07	1.38	0.16	0.20	1.94	99.75	
46	Five Oaks	56	3	11	94.64	2.47	0.40	0.12	1.76	99.39	

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

Locality (Shown on Plate 9)	Formation	Geologic Section		Thickness	Chemical Composition						Location
		No.	Unit	(Feet)	$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
46	Five Oaks	56	4–7	56	97.18	1.32	0.28	0.28	0.98	100.04	Quarry of Peery Lime Company, near State Highway 61, North Tazewell
46	Lincolnshire-Ward Cove	56	8–12	50	95.07	1.94	0.32	0.08	2.28	99.69	
46	Ward Cove	56	13	2.2	66.12	2.62	2.18	1.16	24.74	96.82	
46	Ward Cove	56	14–22	36	94.87	1.91	0.08	0.16	2.52	99.54	
48	Gratton	38	3–5	57	91.05	2.73	1.24	0.28	4.60	99.90	Old lime quarry just south of Norfolk and Western Railway, North Tazewell
52	Benbolt-Peery	22	2–3	126	91.05	4.48	0.74	0.90	2.52	99.69	About 1.5 miles southwest of Pisgah
55	Gratton	41	1	57.5	96.52	1.25	1.26	0.16	0.36	99.55	Near Pisgah
58	Ward Cove[a]			70	93.76	2.85	0.08	0.20	2.64	99.53	South of the Norfolk and Western Railway, near Youngs
58	Peery	33	2	99	97.92	1.25	0.54	0.27	0.56	100.54	
58	Benbolt	33	3	15	98.08	0.82	0.12	0.12	0.60	99.74	

58	Benbolt	33	4	91	92.03	2.28	1.77	0.62	4.50	101.20	South of the Norfolk and Western Railway, near Youngs
58	Benbolt	33	5	63	92.23	5.10	0.46	0.29	2.09	100.17	
57	Gratton	42	2	67	97.98	1.78	0.22	0.20	1.27	101.45	About 0.7 mile east of Youngs
59	Benbolt	43	1	20–25	91.86	2.45	0.94	0.24	4.30	99.79	Quarry of Blue Grass Lime Company, near Maxwell
59	Gratton	43	3	37	96.70	1.23	0.76	0.34	0.75	99.78	
59	Gratton	43	4–6	23	91.37	4.61	0.67	0.33	4.19	101.17	
59	Gratton	43	7	25	93.33	1.55	0.36	0.19	5.13	100.56	
60	Peery	21	3	109	97.19	1.30	0.94	0.04	0.44	99.91	Near Maxwell
60	Peery	21	2	40	96.35	1.23	1.06	0.12	0.56	99.32	
64	Little Valley	53	1–9	92.5	64.67	5.89	5.87	1.44	23.26	101.13	Along State Highway 16, southeast of Bishop
64	Little Valley	53	11	4	66.35	17.60	2.19	1.20	9.73	97.07	
64	Hillsdale	53	12	12	89.50	2.37	1.16	0.59	6.13	99.75	
64	Hillsdale	53	13	7	42.74	4.34	5.04	2.58	42.88	97.58	
64	"Ste. Genevieve"	53	34–38	38.7	90.89	2.24	0.15	0.59	7.20	101.07	
64	"Ste. Genevieve"	53	46–52	41.3	53.42	3.08	4.94	1.83	34.25	97.52	
64	"Gasper"	53	54–58	50	79.22	8.23	4.41	1.81	7.19	100.86	
64	"Gasper"	53	59–70	65	96.05	1.13	0.48	0.41	1.17	99.24	

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

LOCALITY (Shown on Plate 9)	FORMATION	GEOLOGIC SECTION		THICKNESS (Feet)	CHEMICAL COMPOSITION						LOCATION
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
64	"Gasper"	53	98–112	86	85.74	5.78	1.37	0.56	7.49	100.94	Along State Highway 16, southeast of Bishop
67	Little Valley	54	2	76	94.80	2.77	0.59	0.50	2.32	100.98	Along Road 627, about 1.5 miles southwest of Bandy
67	Little Valley	54	4	10	92.13	2.79	0.46	1.08	4.34	100.80	
67	Hillsdale	54	5–7	41	90.29	6.08	0.83	0.52	2.28	100.00	
67	Hillsdale	54	8–13	126	94.85	2.14	0.14	0.74	3.30	101.17	
67	"Gasper"—"Ste. Genevieve"	54	14–15	61	93.60	2.68	1.28	0.26	3.74	101.56	
67	"Gasper"—"Ste. Genevieve"	54	16	22	68.33	4.20	3.59	1.87	21.36	99.35	
67	"Gasper"—"Ste. Genevieve"	54	23	4	94.13	1.46	0.70	0.62	4.71	101.62	
67	"Gasper"—"Ste. Genevieve"	54	25	8	73.36	6.69	4.04	0.99	15.98	101.06	

67	"Gasper"— "Ste. Genevieve"	54	26	4	90.72	4.35	0.93	0.45	2.37	98.82	
67	"Gasper"— "Ste. Genevieve"	54	36	15	39.47	4.00	4.07	1.99	49.62	99.15	
67	"Gasper"	54	42	7	94.02	1.98	0.45	0.40	2.14	98.99	Along Road 627, about 1.5 miles southwest of Bandy
67	"Gasper"	54	49	12	77.70	11.00	1.87	0.73	8.22	99.52	
67	"Gasper"	54	51	50	72 70	12.74	3.14	0.62	11.68	100.88	
67	"Gasper"	54	53	34	72.44	16.27	4.59	1.59	6.08	100.97	
73	Peery	12	2	60	92.89	0.69	0.63	0.30	5.35	99.86	Quarry along U. S. Route 19, east of Claypool Hill
75	Peery	14	3–4	77	95.31	1.27	0.82	0.12	1.46	98.98	About 0.8 mile west of Pounding Mill
77	Ward Cove	10 57	1 9	62 62	96.52 96.76	1.05 1.64	0.72 0.76	0.56 0.08	0.62 0.56	99.47 99.80	Main quarry at Pounding Mill
77	Ward Cove-Peery	10 57	2–3 10–13	135	92.16	4.01	0.30	0.12	2.92	99.51	
78	Peery	15 57	3 14	12	95.23	1.91	0.40	0.12	2.42	100.08	Fluxing stone quarry at Pounding Mill
78	Peery	15 57	4 15	57	96.52	1.05	1.08	0.20	0.62	99.47	
77	Benbolt	57	16–17	116	80.65	3.41	1.54	0.76	12.74	99.10	Main quarry at Pounding Mill
77	Gratton	44 57	1–2 19	37	90.11	1.47	0.88	0.52	6.92	99.90	

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

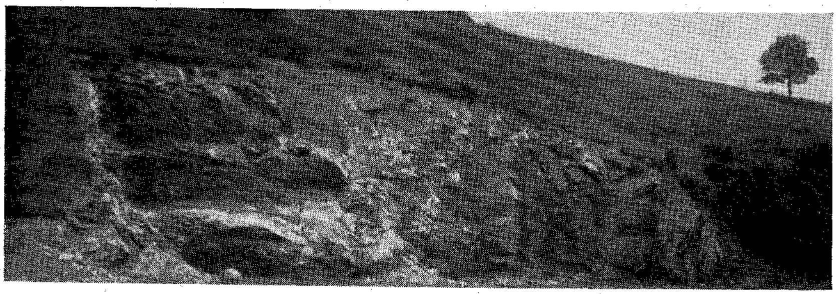
LOCALITY (Shown on Plate 9)	FORMATION	GEOLOGIC SECTION		THICKNESS	CHEMICAL COMPOSITION						LOCATION
		No.	Unit	(Feet)	$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
80	Benbolt	30	4	42.5	90.37	6.00	1.08		1.55	99.00	Along State Highway 91, near Liberty, Thompson Valley
80	Wardell	47	1	16	84.94	1.76	6.02		1.39	94.11	
81	Peery	16	2–3	106	96.94	0.85	0.36	0.32	1.36	99.83	About 0.6 mile southwest of Gillespie
82	Peery	17	3	92	96.46	1.35	0.68	0.08	1.04	99.61	Gillespie
83	Peery	18	3–4	131	96.90	1.36	1.02	0.08	0.78	100.14	About 0.4 mile east of Cliffield
85	Peery	19	1	64	96.35	1.35	1.08	0.04	0.72	99.54	About 1.1 miles northeast of Cliffield
85	Peery	19	3	95	97.28	1.33	0.74	0.12	0.64	100.11	
86	Peery	20	3	110	97.67	1.80	0.22		0.66	100.35	Near Maxwell

91	Honaker	2	6	34	58.78	8.91	4.11	0.59	27.57	99.96	
91	Honaker	2	7–12	627	56.07	42.83	0.46	0.20	0.74	100.30	
91	Honaker	2	8	118	53.99	42.18	0.74	0.23	1.19	98.33	
91	Honaker	2	9	339	53.58	42.96	0.98	0.33	3.60	101.45	
91	Honaker	2	10–11	127	56.13	42.11	0.22	0.16	1.44	100.06	
91	Honaker	2	12	8	52.77	39.95	0.32	0.37	4.73	98.14	
91	Honaker	2	13–23	217	55.27	42.53	0.58	0.28	1.46	100.12	Along State Highway 4, south of Cedar Bluff
91	Honaker	2	14–15	44.	57.11	42.21	0.59	0.24	0.75	100.90	
91	Honaker	2	16	12	57.76	39.53	trace	0.23	1.02	98.54	
91	Honaker	2	17–18	67	54.31	45.39	0.24	0.13	0.76	100.83	
91	Honaker	2	19–20	18	45.94	37.65	1.02	0.54	15.33	100.48	
91	Honaker	2	21	13	81.28	18.16	0.05	0.55	0.62	100.66	
91	Honaker	2	22–23	72	55.43	37.08	1.88	0.58	8.44	103.41	
91	Honaker	2	24	27	68.82	21.09	2.15	1.05	6.89	100.00	
91	"Knox"	4	12–19	25.6	58.53	41.22	0.22	0.49	1.35	101.81	
91	"Knox"	4	20–33	41	54.40	43.11	0.29	0.54	1.65	99.99	
91	"Knox"	4	40	3	49.27	40.40	1.79	1.18	8.42	101.06	Along State Highway 4, between Claypool Hill and Cedar Bluff
91	"Knox"	4	41–54	92	56.39	41.99	0.19	0.29	1.17	100.03	
91	"Knox"	4	35–126	538	55.57	41.41	0.60	0.28	2.32	100.18	

TABLE 3.—*Analyses of limestones and dolomites of Tazewell County, Virginia—Continued*

Locality (Shown on Plate 9)	Formation	Geologic Section		Thickness (Feet)	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
91	"Knox"	4	73–93	70	47.26	34.61	1.53	0.89	14.02	98.31	Along State Highway 4, between Claypool Hill and Cedar Bluff
91	"Knox"	4	94-126	138.4	52.63	40.70	0.92	0.40	4.46	99.11	
91	"Knox"	4	156	40	54.79	43.69	0.37	0.43	1.88	101.16	
91	"Knox"	4	179	10	55.02	40.24	0.24	0.57	5.31	101.38	
91	"Knox"	4	188–198	74	51.58	39.66	0.49	0.79	6.70	99.22	
91	"Knox"	4	202–205	29.6	54.13	41.92	0.14	0.47	2.34	99.00	
91	"Knox"	4	206–213	50.4	48.12	36.48	0.19	0.99	14.10	99.88	
92	"Knox" (?)	5	3–7	310	49.44	37.40	1.66	0.24	10.70	99.44	Along railroad, just north of the station at Cedar Bluff

[a] Analysis from Cooper, B. N., Geology and mineral resources of the Burkes Garden quadrangle, Virginia: Virginia Geol. Survey Bull. 60, pp. 254-260, 1944.
[b] Analysis from Bassler, R. S., The cement resources of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull. II-A, pp. 166-175, 1909.



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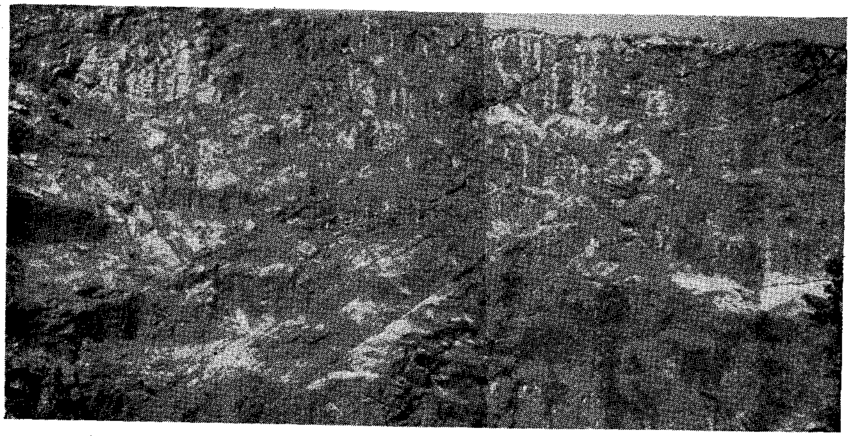
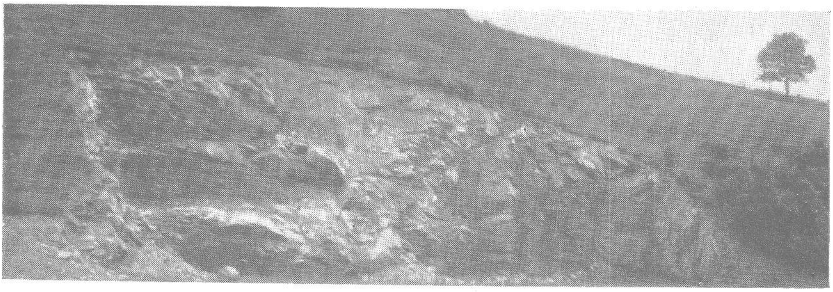


C.

A. Quarry in Honaker dolomite along U. S. Route 19 near Lebanon, Virginia. B, Quarry in limestone at top of the Honaker formation, south of Creswell, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.) C, Quarry of the Clinch River Quarries Corporation, near St. Paul, Virginia.



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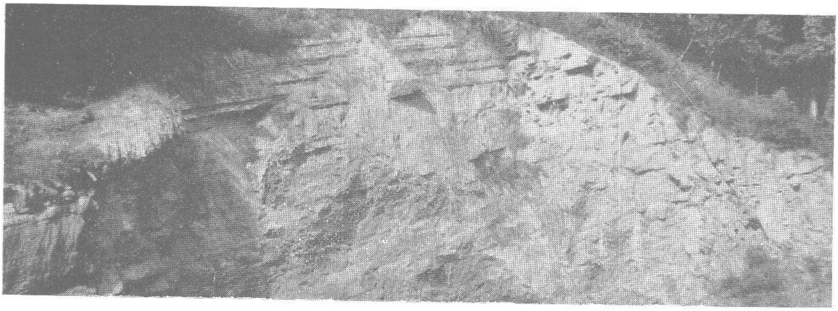

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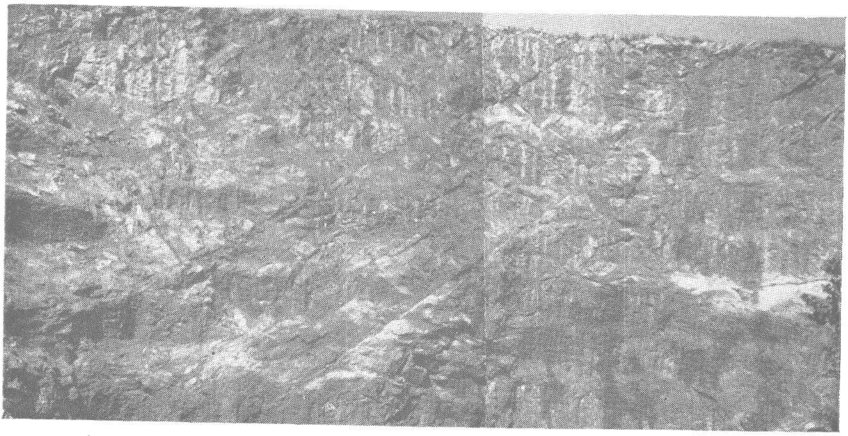
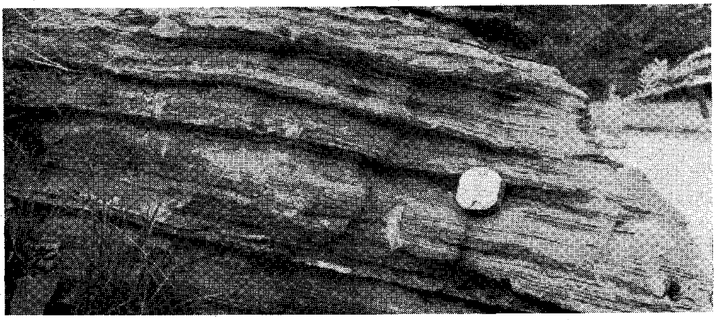


C.

A. Quarry in Honaker dolomite along U. S. Route 19 near Lebanon, Virginia. B, Quarry in limestone at top of the Honaker formation, south of Creswell, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.) C, Quarry of the Clinch River Quarries Corporation, near St. Paul, Virginia.



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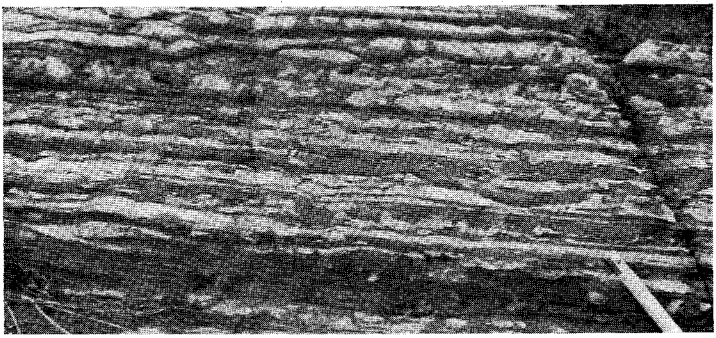

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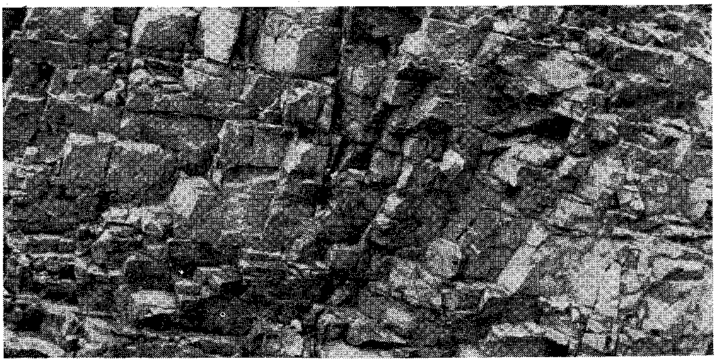
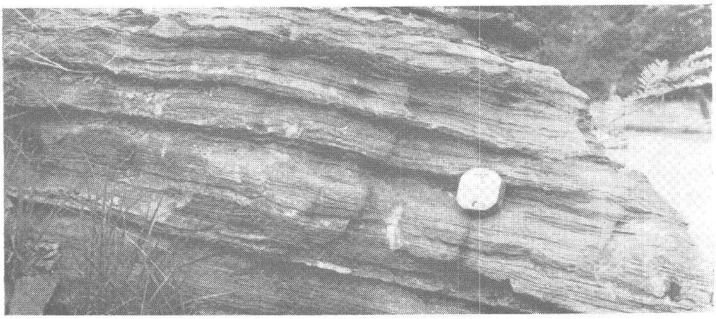


C.

A, Siliceous laminae in sandy member of the "Knox" dolomite, near Bolton, Russell County, Virginia. Photograph by R. C. Oburn. B, Banded limestone in the Nolichucky formation south of Cleveland, Russell County, Virginia. C, Close jointing in the "Knox" dolomite, near Bolton. Photograph by R. C. Oburn.



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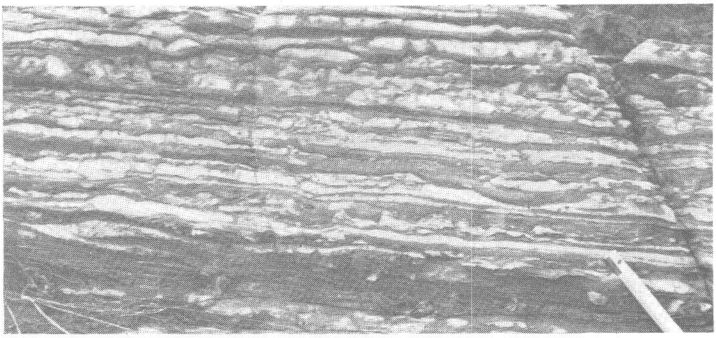

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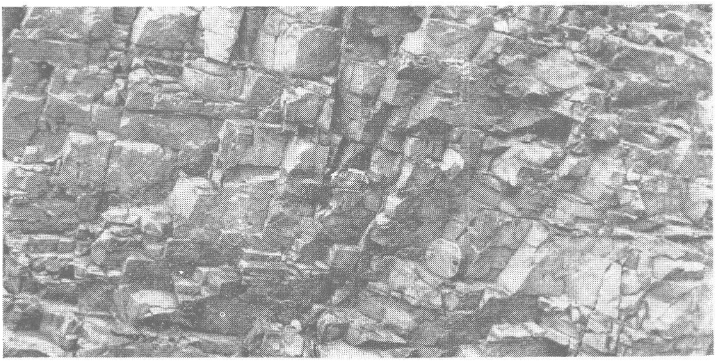


C.

A, Siliceous laminae in sandy member of the "Knox" dolomite, near Bolton, Russell County, Virginia. Photograph by R. C. Oburn. B, Banded limestone in the Nolichucky formation south of Cleveland, Russell County, Virginia. C, Close jointing in the "Knox" dolomite, near Bolton. Photograph by R. C. Oburn.

RUSSELL COUNTY

GENERAL FEATURES

As shown in Figure 1 and Plate 18, Russell County is served by the Norton division of the Norfolk and Western Railway, which passes through Swords Creek, Honaker, Cleveland, Castlewood, and St. Paul. Several branches of this railroad connect with the coal mines along Sandy Ridge. The Clinchfield Railroad, terminating at the coal mines near Dante, follows the course of Clinch River west of St. Paul, Wise County.

U. S. Route 19, the main arterial route between Bluefield, Virginia-West Virginia and Bristol, Virginia-Tennessee, passes through Elway, Lebanon, and Hansonville. It connects with U. S. Route 11 at Abingdon, Washington County, about 20 miles southeast of Lebanon. State Highways 64, 66, 71, 74, 80, 82, and 83 furnish direct access to the main occurrences of limestone and dolomite in the county.

GEOLOGY

In Russell County, the area of complexly folded strata is separated from the relatively flat-lying beds in the northwestern plateau areas by a zone containing several closely related overthrust faults. The main thrust in the western part of the county is the St. Paul fault. The principal break in the eastern part seems to be a continuation of the St. Clair fault from Tazewell County. The structural complex between Big A Mountain and Swords Creek is bordered on the east by the Russell Fork fault which defines the northeastern limit of the great Cumberland overthrust block.[13, 28] This fault swings abruptly eastward near Swords Creek and merges with the St. Clair fault near the Russell-Tazewell County line. Another thrust, known as the Honaker fault, diverges from the St. Clair fault near Gardner and extends westward beyond the Russell-Scott County line. The Copper Creek fault, which passes through Lebanon, extends northeastward nearly to the Russell-Tazewell County line, where it dies out in an anticline in the "Knox" dolomite. These faults and other structures are shown in the geologic cross sections on Plate 18. The rocks exposed in Russell County have an aggregate thickness of about 20,000 feet, of which about one-third is limestone and dolomite.

Cambrian and Ordovician dolomites (Fig. 4) crop out in a broad area between Copper Ridge and the area of Pennsylvanian rocks, and another belt occurs along Moccasin Ridge, south of the Copper Creek fault. Ordovician limestones are well displayed along the base of Clinch Mountain (Figs. 11-12), particularly in the picturesque coves in the vicinity of Elk Garden and Hansonville. Another belt of Ordovician limestone occurs along U. S. Route 19 and at the southeast base of River Ridge and House and Barn Mountain. Another extensive belt crops out at the northwest base of Moccasin Ridge and extends northeastward through Dickensonville, Blackford, and Clifton (Fig. 13.) Mississippian limestones occur in two belts along the southeastern border of the coal fields west of Finney and north of Cleveland. The best exposures are along the crest of a rolling upland known as Sinkhole Valley. Another small area of Mississippian rock occurs east of Daw at the southwestern tip of a broad syncline of upper Mississippian rocks, previously described in Tazewell County.

DOLOMITE

HONAKER FORMATION

The Honaker formation crops out in three principal belts: (1) along the Copper Creek fault in the vicinity of Lebanon; (2) along the northwest slope of Copper Ridge and Kent Ridge; and (3) along the Norfolk and Western Railway, just north of the Honaker fault between Castlewood and Gardner. At the type locality, south of Honaker, the formation is practically all high-magnesian dolomite, with an aggregate thickness of about 1,300 feet. A few limestone beds occur, mainly at the base and near the top (locality 117). As in Tazewell County the Honaker dolomites are invariably fine grained, dark-gray, and practically free of clay and siliceous impurities. Wherever well exposed, the Honaker appears to be much more thoroughly fractured than the "Knox" dolomite. The character of the Honaker is well shown in Geologic Sections 63 to 66.

In all three belts, the Honaker dolomite grades southwestward into a thick series of dark bluish-gray, banded limestones of equivalent age, which have been divided into the Rutledge limestone, Rogersville shale, and Maryville limestone.[9] West of the meridian of Castlewood only a few intercalations of typical Honaker dolomite occur in the Rutledge-Rogersville-Maryville succession. The thickest of these dolomite beds is being quarried near St. Paul (locality 197; Pl. 11C).

"KNOX" DOLOMITE

In Russell County the "Knox" occurs in two wide belts and in several smaller areas. The main belt of outcrop is on Kent Ridge and Copper Ridge, and there are good exposures of this belt along State Highway 64 northwest of Lebanon and along State Highway 80 north of Blackford. The "Knox" is almost completely exposed north and east of Hubbard Junction (Geologic Section 61). The upper part of the "Knox" is fully exposed at locality 114 along Road 624, near Hickory Junction. The upper 450 feet is prominently displayed along Road 633 and the Norfolk and Western Railway just north of Daw (locality 101).

The *oolitic member,* at the base, is about 750 feet thick and composed of medium- to coarse-grained, high-magnesium dolomite (Pl. 12C). Most of the beds are medium- to dark-gray and many layers are oolitic. Thin oolitic cherts occur in this zone in many sections but they are not particularly abundant in the exposures along the railroad north of Hubbard Junction. The lower 350 feet, at least in the Honaker-Hubbard Junction area, is almost as pure as the underlying Honaker (Geologic Sections 61 and 63).

The *sandy member* of the "Knox" in Russell County is 350 to 600 feet thick. Although there are only a few thick beds of quartz sandstone, sandy laminated dolomites (Pl. 12A) are very numerous and comprise fully half the total thickness of the member. A fine display of these beds, along State Highway 80 at locality 127, has been described by Butts.

The *lower cherty member* is about 250 feet thick north of Hubbard Junction and along State Highway 80 north of Blackford. Although these two exposures are little more than a mile apart they show striking differences in content of chert. Also there are several thin limestones exposed along State Highway 80 which are not apparent near Hubbard Junction. As shown by the analyses in Geologic Section 61, the dolomites of the lower cherty member contain about 7 per cent silica, exclusive of megascopic chert.

The *limy member* is about 80 feet thick near Hubbard Junction (locality 25) but considerably thinner at locality 114 north of Hickory Junction. The best exposure of the limestone member is along State Highway 80 north of Blackford.

The *upper cherty member* along the railroad east of Hubbard Junction contains much less chert than the beds exposed along Road 624 north of Hickory Junction (Geologic Sections 61 and 62). This member is about 250 feet thick along Copper Ridge, but probably more than 350 feet thick along State Highway 80 south of Elway. Most of the dolomite is pearl-gray and fine grained but near the top there are intercalated beds of coarse grained dolomite. The barite prospect along State Highway 80 at locality 126, north of Blackford, is in this member.

The *pink dolomite member* at the top of the "Knox" shows considerable variation in thickness. North of Hickory Junction only a few beds are referable to this member, whereas east of Hubbard Junction most of the upper 150 feet is pinkish dolomite. This member is fairly well exposed along State Highway 80 north of Blackford and at locality 188 along State Highway 64 near The Parsonage.

Geologic Section 61.—"Knox" dolomite between localities 123 and 124 near Hubbard Junction, Russell County, Virginia

	Thickness Feet
Blackford formation	
"Knox" dolomite (2,096 feet)	
Pink dolomite member (139 feet)	
52. Dolomite, pearl-gray, straticulate, fine grained	8
51. Dolomite, pearl-gray, pinkish streaks	4
50. Covered	13
49. Dolomite, pinkish and gray, fine grained, platy	18
48. Dolomite, dark-gray, medium grained, pinkish	36
47. Dolomite, pearl-gray to dark-gray with pinkish laminations	8
46. Dolomite and chert	4
45. Dolomite, dark-gray, medium grained, dense, even bedded	7
44. Dolomite, dark-gray, granular	3
43. Dolomite, pearl-gray to pinkish, fine grained	15
42. Dolomite, medium-gray, very cherty	11
41. Dolomite, greenish-gray, fine grained, pinkish blotches	12
Upper cherty member (236 feet)	
40. Dolomite, very light-gray, fine grained, compact	25
39. Dolomite, drab-gray, fine grained	14

	Thickness Feet
38. Dolomite, light-gray, fine grained	28
37. Dolomite, dark-gray, dense, fine grained	23
36. Dolomite, coarse grained, cherty	8
35. Dolomite, fine grained, straticulate, cherty	20
34. Dolomite, pearl-gray, platy	33
33. Dolomite, medium-gray, medium grained	12
32. Dolomite, pinkish and pearl-gray, fine grained	24
31. Dolomite, reddish with greenish streaks, medium to coarse grained, cherty	32
30. Dolomite, flesh-colored, medium grained; weathers saccharoidal; contains abundant chert	17
Limy member (80 feet)	
29. Limestone, dove-gray, platy; contains wavy siliceous partings	28
28. Covered; a few exposed beds of dove-gray fossiliferous limestone; mantle rock full of large blocks of chert	52
Lower cherty member (397 feet)	
27. Dolomite, mainly coarse grained	22
26. Dolomite, light-gray, cherty, fine grained, argillaceous	15
25. Dolomite, coarse grained, oolitic	15
24. Dolomite, pearl-gray, fine grained	34
23. Dolomite, gray, medium grained, cherty	85
22. Dolomite, buff-gray, medium grained, even bedded	85
Analysis of units 22 to 26; thickness sampled, 234 feet: SiO_2, 6.76; R_2O_3, 1.38; $CaCO_3$, 52.16; $MgCO_3$, 38.89; Total, 99.19.	
21. Dolomite, mottled, gray and dark-brown, medium grained	105
20. Dolomite, mottled, gray and dark-brown; chert in thin flattened nodules	18
19. Dolomite, brownish-gray	28
Sandy member (483 feet)	
18. Dolomite, brownish-gray, sandy, even bedded	102
17. Sandstone, brownish-gray, dolomitic	1

	Thickness Feet
16. Dolomite, drab-gray, medium grained, even bedded	74
15. Sandstone and sandy dolomite	38
14. Dolomite, light-gray, medium to coarse grained, irregularly bedded	35
13. Covered; mantle rock contains blocks of sandstone and sandy dolomite	180
12. Dolomite, dark bluish-gray, even bedded	52
11. Sandstone, rusty-brown	1
Oolitic member (761 feet)	
10. Dolomite, dark bluish-gray	25
9. Dolomite, drab-gray, thick bedded, oolitic	128
8. Dolomite, medium-gray to brownish-gray, even bedded	122
7. Dolomite, dark bluish-gray, medium to coarse grained	36
Analysis of units 7 to 10; thickness sampled, 311 feet: SiO_2, 5.32; R_2O_3, 1.18; $CaCO_3$, 52.65; $MgCO_3$, 40.86; Na_2O, trace; K_2O, 0.52; Total, 100.53.	
6. Dolomite and sandstone	4
5. Dolomite, bluish-gray, medium granular, irregularly bedded	27
4. Dolomite, light-gray, very coarse grained, oolitic, thick bedded	113
3. Dolomite, bluish-gray, medium grained	81
2. Dolomite, brownish-gray, even bedded	129
Analysis of units 2 to 5; thickness sampled, 350 feet: SiO_2, 1.48; R_2O_3, 0.48; $CaCO_3$, 55.90; $MgCO_3$, 41.30; Na_2O, 0.01; K_2O, 0.16; Total, 99.33.	
1. Dolomite, light-gray, fine grained, banded	96
Nolichucky formation	

Geologic Section 62.—"Knox" dolomite and associated beds north of the St. Clair fault, locality 114, north of Hickory Junction, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along St. Clair fault)	
Five Oaks limestone	
110. Limestone, fine grained, argillaceous	15.8
Elway limestone (52.6 feet)	
109. Limestone; contains nodules of black chert	8
108. Mudrock, calcareous	5.3
107. Limestone	15.8
106. Shale, gray	.3
105. Limestone, dove-gray, argillaceous, cherty	2.7
104. Limestone, cherty	20.5
Blackford formation (104.3 feet)	
103. Mudrock, calcareous	6
102. Limestone, dove-gray	.9
101. Mudrock, dove-gray, calcareous	8
100. Shale, ash-gray	1.5
99. Mudrock, calcareous, ash-gray	3.5
98. Shale, ash-gray, calcareous	2.4
97. Mudrock, ash-gray, shaly, calcareous	16.6
96. Limestone, argillaceous, thin-bedded; partings of shale	5.6
95. Mudrock, ash-gray, calcareous	4.3
94. Shale, ash-gray, interbedded with argillaceous fine-grained limestone	26
93. Shale, greenish-gray	4.7
92. Shale, red and green, mottled	1.2
91. Dolomite, red and green mottled; clastic texture; silty	1.6
90. Shale, red and green mottled; waxy luster	3
89. Dolomite, red and green mottled, silty, clastic	5
88. Shale, red and greenish gray, mottled, dolomitic	.8
87. Dolomite, red and green; clastic texture; silty; mottled	2
86. Dolomite, silty; clastic texture; green and red blotches	5

	Thickness Feet
85. Dolomite, red and green, with seams of coarse chert-conglomerate (angular fragments of chert up to 1½ inches in diameter)	6.2
"Knox" dolomite	
Pink dolomite member	
84. Dolomite, fine-grained, badly crumpled and broken by minor faults	53.2
83. Shale	.4
Upper cherty member	
82. Dolomite, light-gray, coarse grained	3.1
81. Dolomite, pearl-gray, fine grained	3.2
80. Dolomite, gray, coarse grained	.5
79. Dolomite, pearl-gray, fine grained, cherty	10.1
78. Dolomite, gray, coarse grained	.8
77. Dolomite, pearl-gray, fine grained	1.4
76. Dolomite, gray, argillaceous; clay partings which are red and green mottled	14.3
75. Dolomite, gray, coarse grained	5.9
74. Dolomite, pearl-gray, fine grained, cherty	2.7
73. Dolomite, gray, coarse grained	.8
72. Dolomite, coarse grained, banded	3.2
71. Chert, white	.2
70. Dolomite, gray, coarse grained	1.7
69. Dolomite, pearl-gray, fine grained	3.1
68. Dolomite, gray, coarse grained	1.7
67. Dolomite, medium-gray, fine grained, with floating sand grains	4.6
66. Chert, white parting	.2
65. Dolomite, pearl-gray, fine grained	7
64. Chert, white	1.3
63. Dolomite, pearl-gray, fine grained	8.3
62. Dolomite, shaly, glauconitic; contains head-size masses of white chert	1.9
61. Dolomite, gray, coarse grained	9.3
60. Dolomite, pearl-gray, fine grained	2.2
59. Dolomite, gray, coarse grained	.8
58. Dolomite, pearl-gray, fine grained	2.6
57. Dolomite, gray, very coarse grained	8.2

		Thickness Feet
56.	Dolomite, pearl-gray, fine grained	4.2
55.	Chert, white bed	1.3
54.	Dolomite, pearl-gray, fine grained	17.4
53.	Shale, gray; parting	.2
52.	Dolomite, pearl-gray, fine grained	7.6
51.	Dolomite, gray, coarse grained	1.0
50.	Dolomite, fine grained	5
49.	Dolomite, coarse grained; contains disseminated sand grains	.9
48.	Dolomite, pearl-gray, fine grained	11.9
47.	Dolomite, coarse grained, sandy, thin bedded	4.4
46.	Shale, gray	.4
45.	Dolomite, gray, coarse grained	2
44.	Dolomite, pearl-gray, fine grained	8
43.	Dolomite, silicified	2
42.	Dolomite, medium grained, cherty	2.2
41.	Dolomite, gray, coarse grained	3
40.	Dolomite, pearl-gray, fine grained	8.3
39.	Covered	1.9
38.	Dolomite, fine grained	6.8
37.	Covered	3
36.	Dolomite, medium-gray, medium grained; clay seams	5.9
35.	Dolomite, greenish-gray, speckled, fine grained, cherty	6.8
34.	Shale, gray, dolomitic; contains lenses of coarse-grained dolomite	2
33.	Dolomite, coarse grained, impregnated with white chert in the form of angular inclusions and stringers	2.9
32.	Dolomite, coarse grained; no chert; partings of green clay	3.2
31.	Dolomite, gray, coarse grained	5.4
30.	Chert, bedded	.8
29.	Shale, greenish-gray	1.2
28.	Dolomite, coarse grained	2.6
27.	Dolomite, fine grained, straticulate	6.9
26.	Dolomite, gray, coarse grained	2.2
25.	Chert, bedded	1

	Thickness Feet
24. Dolomite, very coarse grained	23.8
23. Chert, white	2.2
22. Dolomite, very coarse grained	33.9
21. Covered	8
20. Chert, bedded	1
19. Dolomite, fine grained	4
18. Dolomite, gray, coarse grained	2
17. Chert; parting	.4
16. Dolomite, pearl-gray, fine grained	15.3
15. Chert, bedded	4
Limy member (11.7 feet)	
14. Limestone, taupe-gray, very fine grained, thick bedded	7
13. Dolomite, gray, very coarse grained	2.5
12. Limestone-conglomerate, dove-gray	1.2
11. Chert, bedded	1
Lower cherty member (65.6 feet)	
10. Dolomite, gray, very coarse grained	9
9. Dolomite, pearl-gray, fine grained	3.4
8. Dolomite, gray, coarse grained	10
7. Dolomite, buff	7
6. Dolomite, shaly	2.9
5. Dolomite, coarse grained, with stringers and inclusions of white chert	3.6
4. Dolomite, coarse grained; no chert	3
3. Dolomite; contains clay galls	3
2. Chert, bedded	9
1. Dolomite, fine grained, cherty; base not exposed	3

QUARRIES

The Clinch River Quarries Corporation operates a stone quarry along Castle Branch (locality 197) south of St. Paul, which furnishes ballast for the Clinchfield Railroad. This quarry, which has been in operation for nearly 40 years, is located mainly in the thickest dolomite intercalation in the Maryville limestone. Although most of the quarry beds are typical Honaker dolomite, magnesian dolomites of similar color and texture above and below are also quarried. The working face (Pl. 11C) is about 150 feet high, 200 feet wide, and has been developed by quarrying westward for about 300 feet from the west bank of Castle Branch. The beds just above the conspicuous ledge on the north side of the quarry are thoroughly brecciated and veined with fluorite (CaF_2). Fluoride veins also occur just below the dark band in the middle of the quarry (Pl. 11C). Although these veins occur in both limestone and dolomite they are much more common in the dolomitic beds which are, as a rule, much more thoroughly fractured than any of the limestones. Although mainly used for railroad ballast the quarry rocks have been utilized for agstone during the last few years. The composition of the quarry beds is shown in Table 4.

A small quantity of dolomite has been quarried in several places for road stone; material obtained at localities 145 and 157 was used to resurface part of U. S. Route 19 and State Highway 64 near Hansonville. Numerous other roadside quarries are shown on Plate 18.

QUARRY SITES

The two belts of Honaker dolomite between Carterton and Honaker afford practically inexhaustible supplies of high-magnesium dolomite which is sufficiently low in noncarbonates for most industrial uses. The character and composition of the beds are shown in Geologic Sections 63 to 66.

Geologic Section 63.—Honaker formation at locality 117, along Blackford Spur of Norfolk and Western Railway, south of Honaker, Russell County, Virginia

	Thickness Feet
Nolichucky formation	
Honaker formation (upper 600 feet only)	
7. Limestone, dark bluish-gray, granular, banded; thin intercalated dolomites	88
6. Limestone, steel-gray, magnesian, medium grained; contains a few intercalated brownish-weathering dolomites	91
5. Dolomite, medium-gray, oolitic, granular	38
4. Dolomite, dark bluish-gray, finely granular	10

	Thickness Feet
3. Dolomite, steel-gray, granular, dense	215
2. Dolomite, medium-gray to brownish-gray; partly covered	65
1. Dolomite, brownish-gray, medium grained; base not exposed	90

Analysis of units 1 to 5; thickness sampled, 418 feet: SiO_2, 0.68; R_2O_3, 0.56; $CaCO_3$, 55.27; $MgCO_3$, 42.67; K_2O, 0.16; Total, 99.34.

Geologic Section 64.—Honaker formation along State Highway 82, between localities 180 and 181, south of Cleveland, Russell County, Virginia

	Thickness Feet
Nolichucky formation	
Honaker formation (1,418 feet)	
13. Limestone, dark bluish-gray, magnesian, oolitic; contains intercalated thin zones of dark bluish-gray dolomite	167
12. Dolomite, dark bluish-gray; weathers dark-brown; not completely exposed; SiO_2, 0.94; R_2O_3, 0.52; $CaCO_3$, 55.17; $MgCO_3$, 43.40; Total, 100.03	438
11. Dolomite, dark bluish-gray, granular; weathers dark-brown; SiO_2, 1.78; R_2O_3, 0.96; $CaCO_3$, 54.77; $MgCO_3$, 41.71; Na_2O, 0.07; K_2O, 0.42; Total, 99.71	639
10. Limestone, dark bluish-gray, banded; clayey partings	20
9. Limestone, dark bluish-gray, shaly; crumpled zone; thickness estimated	32
8. Limestone, very argillaceous, banded	55
7. Shale, greenish-gray; probably top of Rogersville shale	6
6. Limestone, dark bluish-gray, banded	8
5. Shale, greenish-gray; equivalent to the Rogersville shale	27
4. Limestone, dark bluish-gray, banded	7.5

	Thickness Feet
3. Shale, greenish-gray	8.5
2. Limestone, dark bluish-gray, banded	4
1. Shale, greenish-gray	6

Rome formation

Geologic Section 65.—Honaker formation at locality 182 along State Highway 82, south of Cleveland, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along Honaker fault)	
Honaker formation (1,239 feet; topmost beds faulted out)	
16. Dolomite, dark bluish-gray, granular	120
15. Limestone, dark bluish-gray, granular, banded, argillaceous	62
14. Dolomite, dark brownish-gray, medium grained	84
13. Dolomite and magnesian limestone, dark bluish-gray; weathers brown; poorly exposed	90
12. Limestone, dark bluish-gray, magnesian, coarse grained; contains intercalated dolomitic layers weathering dark-brown; exposed in roadside quarry	91
11. Dolomite, dark bluish-gray, fine to medium grained	280
10. Dolomite, dark bluish-gray; weathers rusty-brown	203

Analysis of units 10 and 11; thickness sampled, 483 feet: SiO_2, 1.16; R_2O_3, 1.30; $CaCO_3$, 57.09; $MgCO_3$, 39.92; Na_2O, 0.02; K_2O, 0.35; Total, 99.84.

9. Limestone, dark bluish-gray, granular, banded	34
8. Dolomite, dark bluish-gray, granular	4
7. Limestone, dark bluish-gray, magnesian; shaly partings; weathers with buff and blue bands	130
6. Shale, greenish-gray, micaeous; contains *Ehmaniella* trilobites; equivalent to the Rogersville shale	26
5. Limestone, bluish-gray, banded	11
4. Shale, calcareous, greenish-gray; intercalated bands of limestone; probably a part of the Rogersville shale	90

	Thickness Feet
3. Limestone, black, banded; shaly partings	5.9
2. Limestone, shaly, blocky argillaceous	5.8
1. Limestone, conglomeratic, argillaceous; weathers mealy	1.2

Rome formation

Geologic Section 66.—Honaker formation along Road 614, locality 178, south of Carterton, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along Honaker fault)	
Honaker formation (1,378 feet; topmost beds faulted out)	
18. Dolomite, dark bluish-gray, thoroughly fractured	140
17. Limestone, dark bluish-gray, banded, clayey	67
16. Dolomite, brownish-gray to dark bluish-gray, fine grained	130
15. Limestone, dark bluish-gray, even bedded, granular	30
14. Dolomite, dark bluish-gray, finely granular	243
13. Limestone, dark bluish-gray, granular, even bedded	123
12. Dolomite, dark brownish-gray	33
11. Limestone, dark bluish-gray, magnesian, banded	3
10. Dolomite, dark bluish-gray, fine grained	153
9. Shale, buff	42
8. Dolomite, dark bluish-gray	68
7. Dolomite and magnesian limestone interbedded, dark bluish-gray	124
6. Limestone, dark bluish-gray, thin bedded, shaly	80
5. Shale and shaly limestone, poorly exposed	100
4. Limestone, dark bluish-gray, medium grained, thick bedded	11
3. Limestone, shaly	24
2. Shale, buff-gray	4.5
1. Limestone, dark bluish-gray, banded	3.2

Rome formation

The Honaker on the northwest slope of Copper Ridge could be quarried on an extensive scale along the Blackford spur of the Norfolk and Western Railway. Adjacent Lewis Creek could furnish ample supplies of water for plant operation in this locality. The belt of Honaker between Carterton and Artrip, along the Norfolk and Western Railway, affords other equally favorable sites for large quarries (Pl. 18).

Large quantities of high-magnesian dolomite, nearly as pure as that in the underlying Honaker, ocur also in the lower part of the "Knox" dolomite, along the Blackford spur of the Norfolk and Western Railway north of Hubbard Junction (Geologic Section 61). Other satisfactory quarry sites occur east and west of Lewis Creek.

Throughout Russell County, the Honaker and "Knox" formations afford unlimited quantities of dolomite suitable for crushed stone, stone sand, and agstone. These formations are widely distributed and so readily accessible that mention of specific localities is unnecessary. It should be emphasized that the upper two-thirds of the "Knox" is so siliceous as to be unsuitable for chemical uses. Since it is unlikely that any large quarry would be started in a locality not on a railroad and equally improbable that any new operation would fail to utilize the high-grade dolomites in the Honaker and lower Knox, the sites along Lewis Creek and along the Norfolk and Western Railway between Artrip and Carterton are the only places where large quarrying operations should be contemplated.

LIMESTONE

HONAKER FORMATION AND ITS EQUIVALENTS

One of the characteristic types of rock in the Honaker formation is a dark bluish-gray, granular, banded, magnesian limestone. One persistent zone of this limestone occurring at the base of the formation and well exposed in the vicinity of Honaker, Carterton and Cleveland, represents the Rutledge limestone of Tennessee. Other thicker zones of dark bluish-gray limestone occur in the upper part of the Honaker and they become more numerous and almost entirely supplant the dolomite in western Russell County. South of St. Paul the Rutledge-Rogersville-Maryville succession, repeated by folding, crops out in a belt several miles wide. Some of these beds are being quarried along Castle Run at locality 197. The limestones are exceptionally well exposed along Road 628, along the north wall of the gorge of Clinch River near Boody. At locality 195, south of Hamlin, Wise County, the dark bluish-gray banded Maryville limestone was burned for lime many years ago. The character, thickness, and composition of representative zones of Maryville limestone are shown in Geologic Sections 63 to 67 and in Table 3. Nearly all of the limestones in the Maryville and Rutledge are slightly magnesian and the total carbonate content ranges from 60 to 90 per cent. The beds showing characteristic banding are considerably more argillaceous than the more massive beds which are especially prominent in the exposure just south of Cleveland.

NOLICHUCKY FORMATION

Limestones very similar to those occurring in the Honaker and Maryville comprise a major part of the Nolichucky formation. In the Maynardville region of eastern Tennessee, banded limestones (Pl. 12B) occur in a relatively thick zone just above the main bodies of Nolichucky shale and have been named the Maynardville limestone[25]. Since the same or equivalent limestones in adjacent sections of Virginia contain Nolichucky trilobites[5] the so-called Maynardville limestones are believed to be a facies of the typical Nolichucky shale. In Scott and Russell counties, Virginia, limestones of Maynardville type occur at several horizons, intercalated in shale. As shown in the following section, the limestones in the Nolichucky are probably too thin and impure for any commercial use.

Geologic Section 67.—Nolichucky formation at locality 170, along State Highway 64, near Creswell, Russell County, Virginia

(After Butts[5])

	Thickness Feet
"Knox" dolomite	
Nolichucky formation (459 feet)	
23. Limestone, blue, banded	45
22. Not exposed	20
21. Shale, greenish, soft	5
20. Not exposed	10
19. Limestone, banded	5
18. Not exposed	20
17. Shale, greenish, soft; contains *Lingulepis walcotti* and *Aphelaspis*	10
16. Not exposed	40
15. Shale, greenish, soft	25
14. Limestone, thick bedded	15

	Thickness Feet
13. Shale, greenish, soft; contains thin layers of limestone; some beds of edgewise conglomerate	45
12. Shale, soft, green; contains thin layers of limestone; some beds of edgewise conglomerate	30
11. Limestone, glauconitic; contains *Coosia, Oedorhachis boltonensis* and *Tricrepicephalus*	2
10. Not exposed	15
9. Limestone	2
8. Shale	5
7. Limestone, thin and thick bedded, argillaceous, banded, sandy	30
6. Sandstone similar to bed 4 but more thinly laminated and with thin layers of limestone	45
5. Not exposed	15
4. Sandstone thin bedded, fine grained; fucoidal (?) stems	25
3. Shale, greenish, finely fissile; *Agnostus, Norwoodella saffordi* and cystid plates	25
2. Limestone, blue, thin bedded, clay banded	25
Honaker dolomite	
1. Limestone, blue, evenly bedded, banded (Maryville); exposed in quarry (Pl. 11B): SiO_2, 5.54; R_2O_3, 12.38; $CaCO_3$, 77.63; $MgCO_3$, 4.32; Total, 99.87	75±

"KNOX" DOLOMITE

As in Tazewell County, the "Knox" contains a few intercalated beds of dove-gray, very fine grained, compact limestone (Geologic Section 61). Although locally prominent at locality 125 east of Hubbard Junction and in the vicinity of Christy Cliffs (locality 164), these limestones are very poorly exposed in Russell County. None of the limestones in the "Knox" are sufficiently thick to be quarried except on a very small scale.

TUMBEZ LIMESTONE

In Russell County, the Blackford formation undergoes a distinct change in facies along the Clinch Mountain belt. Southwest of Hansonville the shaly, dolomitic beds just above the Beekmantown are supplanted by predominantly coarse-grained limestone similar to the so-called Holston marble of Tennessee. Indeed, the same coarse-grained limestones have been quarried extensively for a decorative "Holston" marble at the southwest end of Clinch Mountain, near Luttrell, Union County, Tennessee. The name Tumbez limestone is here proposed for the limestone equivalent of the typical Blackford in Russell County. In the type section at locality 186, near Tumbez, interbedding of the coarse-grained limestones with typical Blackford beds is well shown. The character and thickness of the Tumbez limestone are given in Geologic Sections 76 and 77. Although some of the beds are doubtlessly high-calcium limestone, the formation as a whole is too impure for industrial uses, but it probably would be satisfactory for agstone.

ELWAY LIMESTONE

In the type section, along State Highway 80 near Blackford, the Elway limestone consists of about 40 feet of light-gray, shaly weathering beds containing an abundance of blocky, fossiliferous chert (Geologic Section 85). Although varying somewhat in thickness, the lithology and fossils of the Elway are sufficiently distinctive to render it readily identifiable in all parts of the county. Among the many fine exposures are those (1) along State Highway 64 near The Parsonage (Geologic Section 94); (2) at locality 172, south of Tumbez (Geologic Section 77); (3) along State Highway 19 at locality 166, near Hansonville (Geologic Section 74); (4) at locality 109 near Belfast Mills; (5) at locality 137 along Road 656 in Elk Garden (Pl. 17A); and (6) at locality 74, just east of Dickensonville. In a few places, particularly in the Clinch Mountain belt southwest of Hansonville, where the Elway directly underlies the cherty Lincolnshire, the two cherty, *Dinorthis*-bearing limestones can be distinguished faunally and by the fact that the Elway is invariably finer grained and weathers a lighter-gray than does the Lincolnshire (Geologic Section 77). Locally along Road 603 between Repass and Denniston, the blocky chert in the Elway has been utilized for road metal.

FIVE OAKS LIMESTONE

The Five Oaks limestone overlying the Elway is a dove-gray, fine-grained limestone with an average thickness of 10 to 20 feet. Locally in Elk Garden (Geologic Sections 69 and 71) the Five Oaks

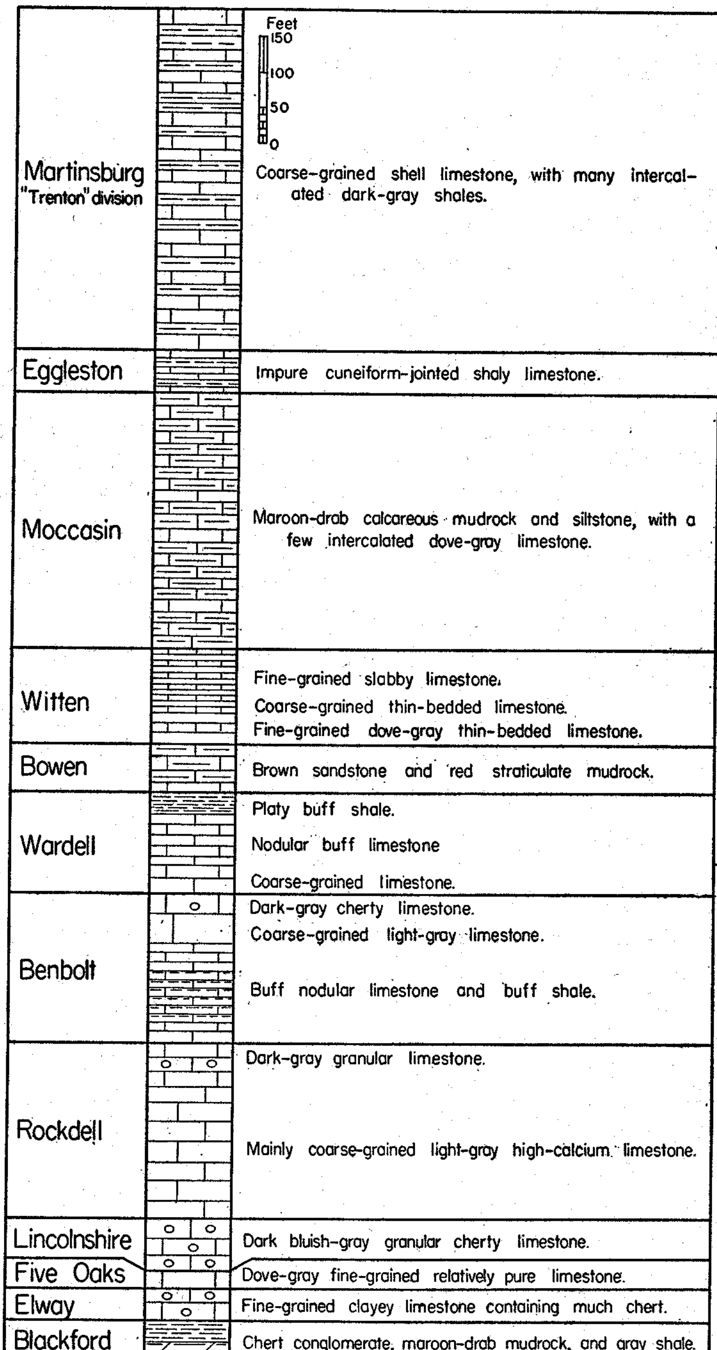


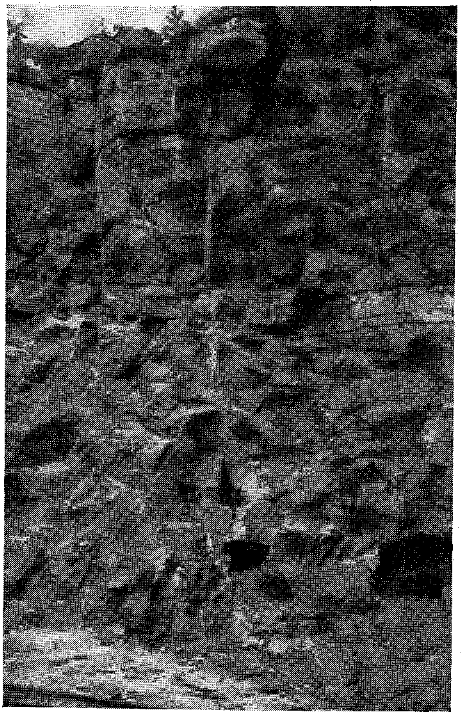
FIGURE 11.—Middle Ordovician limestones in the Rosedale and Clinch Mountain belts of eastern Russell County, Virginia.

is sufficiently thick and pure to be quarried (Pls. 15A, 17A; Fig. 14). Along the base of Clinch Mountain, the Five Oaks is readily identifiable as far southwest as Hansonville, where it is 12 feet thick (Geologic Section 74), but farther southwest it probably is absent. In the limestone belt along the southeast base of River Ridge and House and Barn Mountain, the Five Oaks consists of about 25 feet of sparsely cherty limestone (Geologic Section 81), but it is only 6 to 8 feet thick at locality 109 near U. S. Route 19, and only 10 feet thick at locality 104 near the Russell-Tazewell County line.

In the Dickensonville-Blackford belt, the Five Oaks is a prevailingly thin-bedded argillaceous limestone 10 to 30 feet thick. Northwest of Lebanon, it is sparsely cherty and almost indistinguishable from the underlying Elway (Geologic Sections 89 to 95). At locality 153, and for a distance of 1,000 feet northwestward, the Five Oaks is well exposed and is about 30 feet thick but very argillaceous. Much the same character prevails just south of Blackford (Geologic Section 85). North of the St. Clair fault, the Five Oaks forms the lower part of a relatively thick succession of dove-gray limestones, similar in character to the thick succession of dove-gray beds at St. Clair, Tazewell County. At locality 111, northeast of Swords Creek, the Five Oaks probably is represented by 38 feet of dove-gray limestone directly above the Elway (Geologic Section 96) and by the 45-foot dove-gray limestone exposed in a small abandoned quarry about 0.75 mile northwest of Swords Creek.

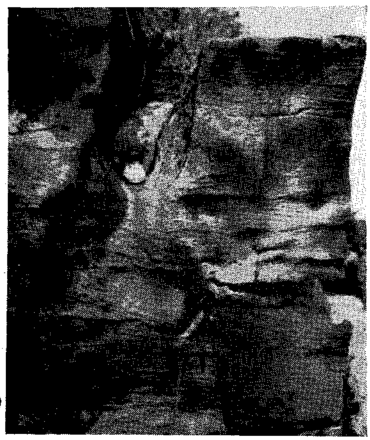
LINCOLNSHIRE LIMESTONE

As in Tazewell County, the Lincolnshire in Russell County is a dark bluish-gray granular limestone with an abundance of nodular chert. In the limestone belts southeast of Copper Ridge, the Lincolnshire is 30 to 100 feet thick, averaging 70 to 90 feet. The formation is very well exposed along State Highway 80, south of Blackford. The faulted belts of Ordovician limestone north and east of the town of Honaker very probably contain representatives of the Lincolnshire, though of a different limestone facies than is generally characteristic of the formation. Unit 2 of Geologic Section 96 is partly or wholly Lincolnshire, but the identity of the formation near Swords Creek (Geologic Section 98) is uncertain. The Lincolnshire probably is represented by dove-gray fine grained limestone between Swords Creek and Daw, but at locality 110 about a mile west of Daw the typically cherty Lincolnshire is at least 40 feet thick with the base not exposed. Except where the Lincolnshire is dove-gray, resembling the Five Oaks, it is probably too impure for any industrial use.



A.

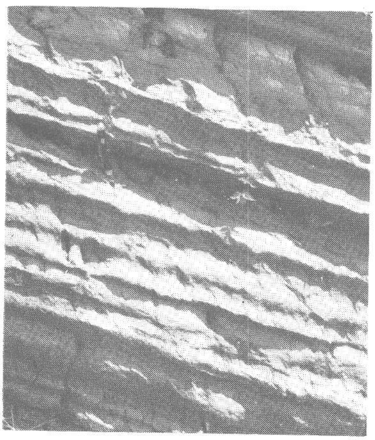
B.



C.

A, Contrasting colors of Lincolnshire and Five Oaks limestones, near Elk Garden, Virginia. Photograph by R. C. Oburn. B, Moccasin mudrock near Tazewell, Virginia. C, Cross-lamination in the Peery limestone in Ward Cove, Tazewell County, Virginia.

A.



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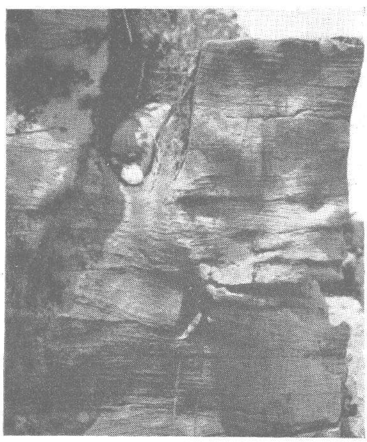
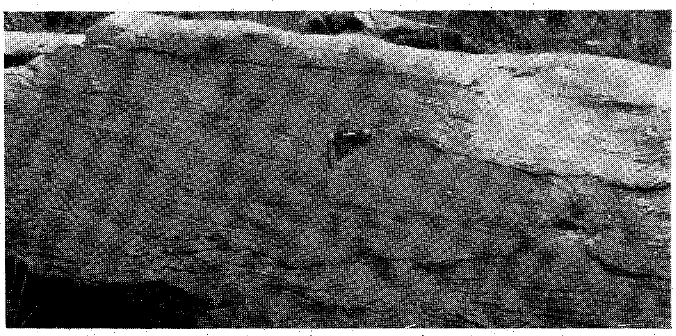


C.

A, Contrasting colors of Lincolnshire and Five Oaks limestones, near Elk Garden, Virginia. Photograph by R. C. Oburn. B, Moccasin mudrock near Tazewell, Virginia. C, Cross-lamination in the Peery limestone in Ward Cove, Tazewell County, Virginia.



A.

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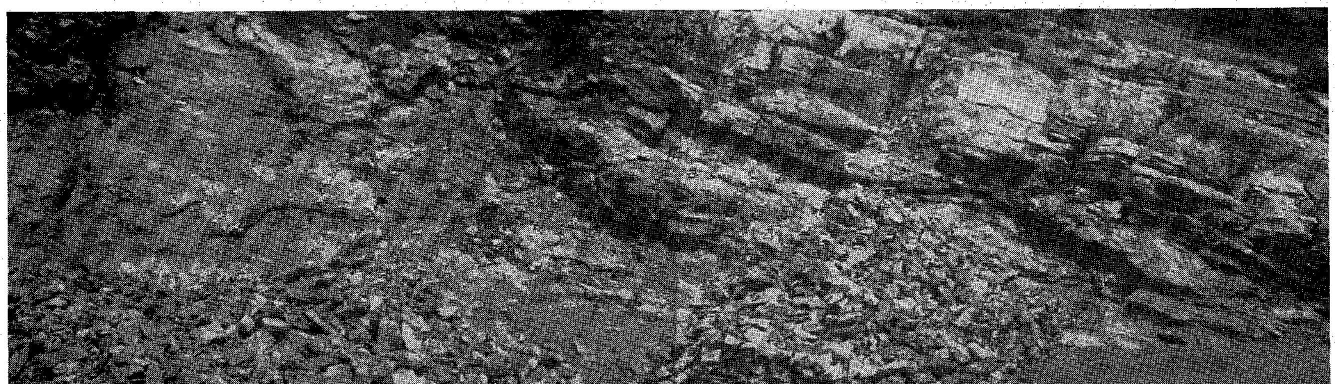
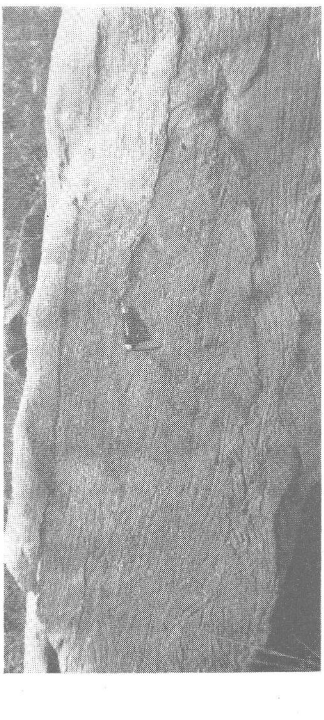
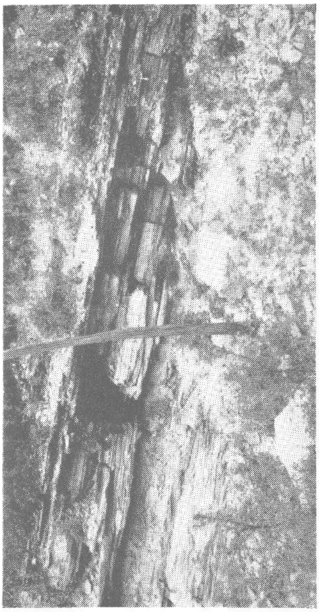


C.

A, Cross-lamination in the Rockdell limestone near Dickensonville, Russell County, Virginia. Photograph by R. C. Oburn. B, Ash-gray shale in Blackford formation in Burkes Garden, Tazewell County, Virginia. C, Quarry in limestone reef in Wardell formation, near Snowflake, Scott County, Virginia.



A.



B.

C.

A, Cross-lamination in the Rockdell limestone near Dickensonville, Russell County, Virginia. Photograph by R. C. Oburn. B, Ash-gray shale in Blackford formation in Burkes Garden, Tazewell County, Virginia. C, Quarry in limestone reef in Wardell formation, near Snowflake, Scott County, Virginia.

ROCKDELL LIMESTONE

The Rockdell limestone includes the 100 to 300 feet of beds between the Lincolnshire and the Benbolt limestone. It includes the Peery and Ward Cove limestone of Tazewell County and the name Rockdell limestone is herein used where these two formations can not be differentiated. The type section is at locality 139 (Geologic Section 71), near Elk Garden. The same beds crop out in a small elliptical area just south of Rockdell.

Along the northwest base of Clinch Mountain between Elk Garden and the Russell-Tazewell County line, the upper two-thirds of the Rockdell is a dark-gray granular cherty limestone, the lower division being coarse grained, light-gray, and free of chert (Geologic Section 70). Between Elk Garden and Hansonville, the Rockdell is composed almost wholly of coarse-grained, light-gray to pinkish limestones, averaging well above 97 per cent calcium carbonate and is 150 to 250 feet thick (Pl. 15A). In this area, reef-like beds of limestones of irregular texture and crowded with bryozoans are rather abundant (Geologic Sections 71 to 74). Southwest of Hansonville the coarse-grained limestones are somewhat thinner and are interbedded with dark-gray cherty limestones such as characterize the Ward Cove limestone in Tazewell County (Geologic Sections 8 and 9). In the Rosedale belt, the Rockdell exhibits a distinct two fold development. The upper part is nodular-weathering, earthy limestone containing *Nidulites,* and the lower, and generally thicker, part is light-gray to pinkish, coarse-grained limestone with a distinctly clastic texture. At locality 104 near the Russell-Tazewell County line the coarse-grained beds are about 85 feet thick, but at locality 109, northeast of Belfast Mills, they are about 200 feet thick and comprise all but the uppermost 20 to 30 feet of the formation, which here is shaly and contains *Nidulites.* The same zone is somewhat thinner north of Rosedale but west of State Highway 80, particularly at localities 134 and 152, northwest of Elway, the coarse-grained limestones are fully 150 feet thick and apparently very pure.

In the Dickensonville-Blackford belt, the Rockdell is mainly cherty, *Nidulites*-bearing limestone ranging in thickness from 40 to 250 feet, but between localities 177 and 172 near Dickensonville, it is mainly coarse-grained high-calcium limestone (Geologic Sections 90 to 94). Northeast of Blackford, particularly at locality 121, the topmost 20 to 30 feet, which is dove-gray fine-grained limestone, probably represents the high-calcium zone of the Peery limestone as displayed in Tazewell

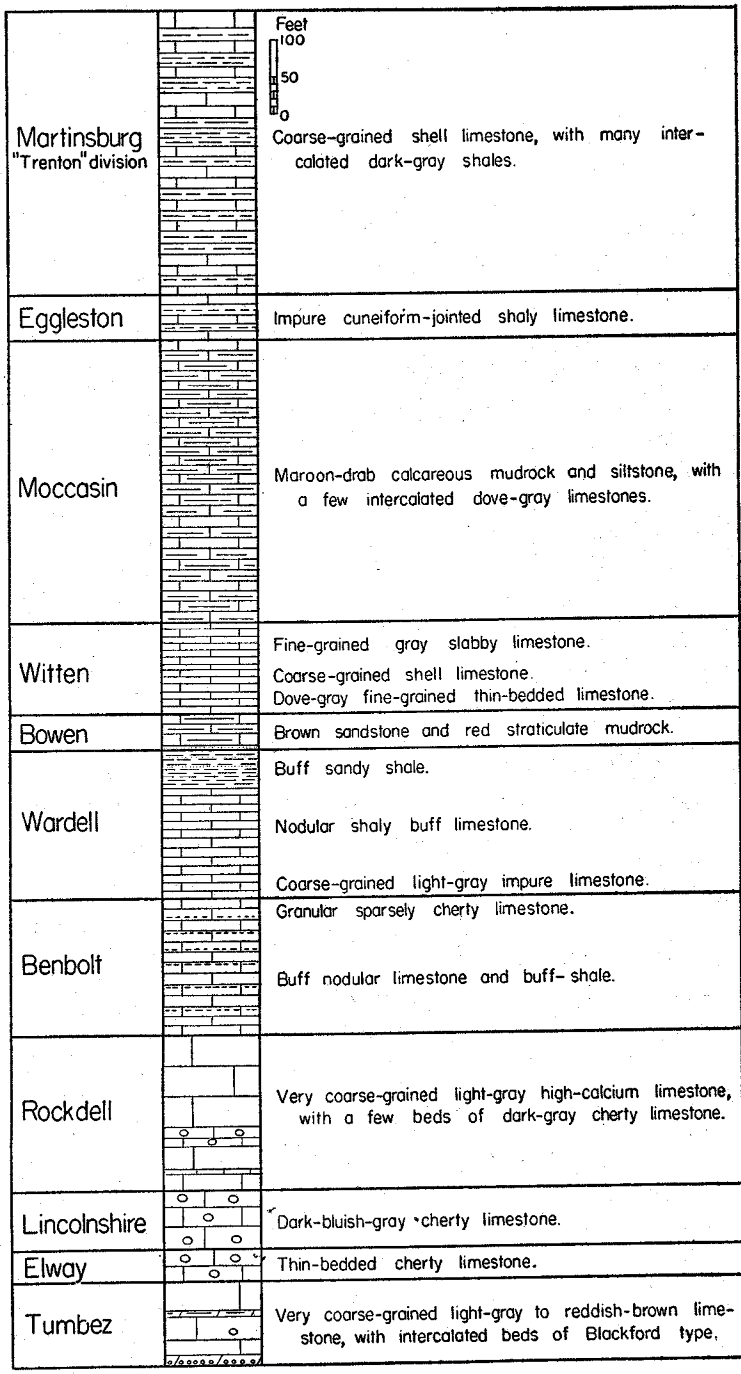


FIGURE 12.—Middle Ordovician limestones along the northwest base of Clinch Mountain, southwest of Hansonville, Russell County, Virginia.

County. North and northeast of Honaker, the Rockdell is mainly dove-gray, fine-grained limestone. This rock, well over 200 feet thick, is exposed north of Clinch River between Daw and Swords Creek (Geologic Sections 96 and 98), and is probably largely high-calcium limestone. At locality 115, about 0.75 mile northeast of Fullers Corners, the Rockdell is represented by 200 to 250 feet of dove-gray, fine-grained limestone, some of which has been burned locally for lime. The beds are not very pure, and most of the thickness contains considerably less than 95 per cent calcium-carbonate.

BENBOLT LIMESTONE

Southwest of Tazewell County, the Benbolt becomes increasingly shaly and nodular (Pl. 16B). In many places in Russell County, notably along the base of Clinch Mountain from Rockdell southwestward to the Russell-Scott County line, these buff-weathering beds dipping at a low angle to the southeast crop out in a relatively broad belt. Good exposures occur (1) along State Highway 80 about a mile south of Rockdell (Geologic Section 72); (2) along U. S. Route 19 about 0.5 mile south of Hansonville Post Office; and (3) along Road 612, south of Collinwood (Geologic Section 78). The same beds are prominent in the Dickensonville-Blackford belt, but the thickness there is considerably less than that of the buff-weathering beds along the base of Clinch Mountain. Northeast of Honaker, the Benbolt is represented locally by more than 150 feet of buff nodular limestone (Geologic Section 96).

The top and bottom of the Benbolt are generally marked by dark-gray, granular, cobbly weathering limestones which make conspicuous ledges. The uppermost layers are cross laminated and generally cherty; those at the base contain a profusion of the ball cystid, *Echinosphaerites*.

Coarse-grained, cross-laminated limestones similar to those exposed along State Highway 91 in Thompson Valley, Tazewell County, occur in the Benbolt south of Copper Ridge in Russell County, but in most localities the granular layers are separated by shale partings and by beds of nodular argillaceous limestone (Geologic Sections 72, 75, and 78). In the Dickensonville-Blackford belt, between State Highways 71 and 80, pinkish, coarse-grained limestones are intercalated in the nodular layers. Such beds are extensively displayed in the vicinity of localities 130 and 132, southwest of Blackford (Geologic Sections 86 and 88; Pl. 16A). Along

State Highway 82, northwest of Lebanon, the pinkish coarse-grained beds have been largely supplanted by nodular crumbly limestones (units 15 to 18, Geologic Section 89). Pinkish coarse-grained beds occur in the Benbolt at Dickensonville (Geologic Section 92) and also at locality 172 near The Parsonage (Geologic Section 94).

Another extensive display of the gray and pinkish, coarse-grained limestones in the Benbolt occurs at locality 113 along U. S. Route 19 and along the same highway at several places between localities 114 and 118 (Pl. 18; Table 4).

The thickness of the Benbolt varies from 100 to 300 feet, being thickest in that part of the Dickensonville-Blackford belt between State Highways 64 and 82.

WARDELL FORMATION

Like the Benbolt, the Wardell is composed chiefly of buff-weathering shales and nodular limestones. The top of the formation is composed of 15 to 60 feet of buff-weathering platy shale containing thin partings of sandstone. The middle part, 30 to 150 feet thick, is buff, nodular, shaly limestone containing numerous *Receptaculites*. The lower part varying from 10 to 150 feet thick, is a medium- to coarse-grained clastic limestone nearly every bed of which is notably shaly and crumbly. These lower beds are generally characterized by numerous corals including *Favistella*, *Lichenaria*, and *Stromatocerium*. Several excellent exposures occur along Road 640 between localities 131 and 132. In most sections studied, the granular beds of the Wardell are separated by cherty beds from similar limestones in the upper part of the Benbolt. The Wardell is well exposed along Route 19, at localities 112, 113, 146 and 158, along all the State highways crossing its outcrop and at locality 142 west of Elk Garden.

WITTEN LIMESTONE

The Witten limestone of Russell County is essentially the same as in Tazewell County and other parts of southwestern Virginia. The upper division is composed of dove-gray to golden-gray thin bedded limestone with the familiar branching sponge, *Camarocladia*. Although only 90 to 93 per cent calcium carbonate, the *Camarocladia* beds have been the most favored source for lime burning among the farmers of Clinch Valley, especially in Russell and Tazewell

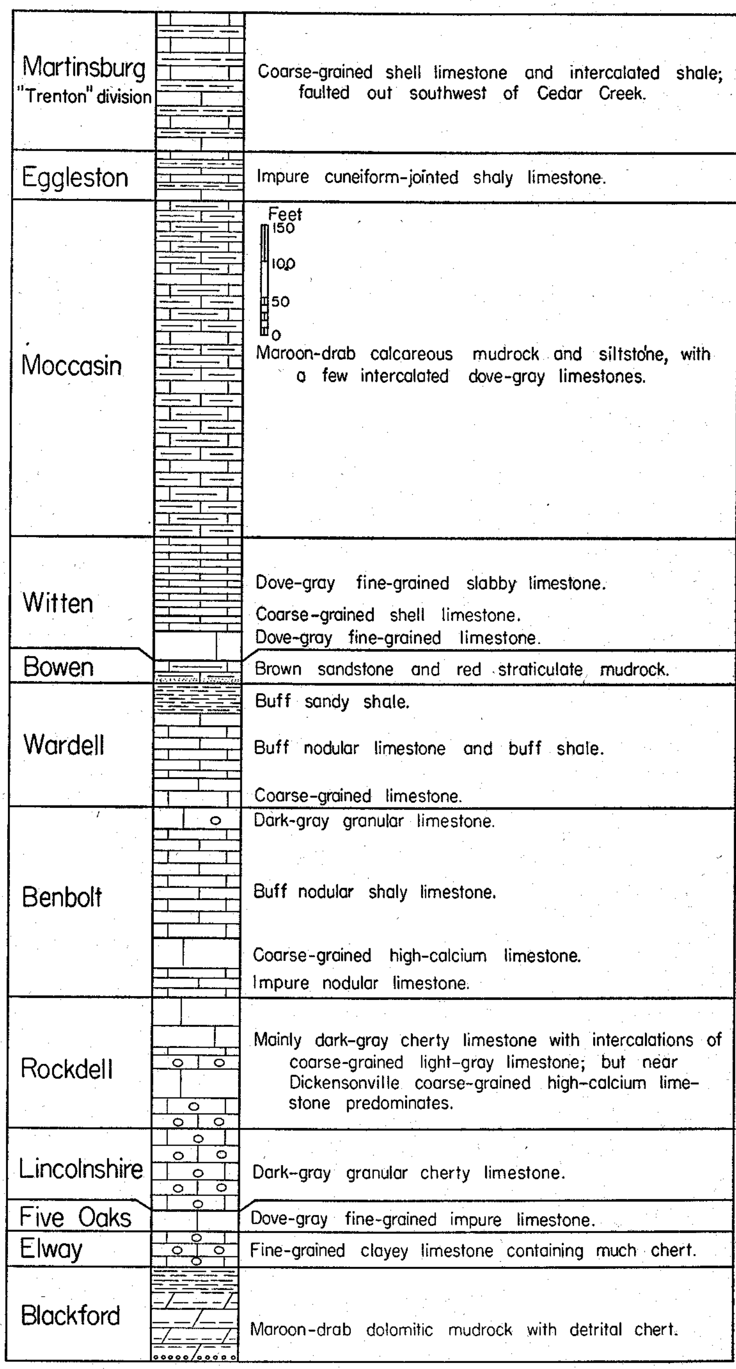


FIGURE 13.—Middle Ordovician limestones in the Dickensonville-Blackford belt in Russell County, Virginia.

counties. Because of its characteristic slabby bedding, the rock can be quarried in a small way without the use of explosives. The middle zone is everywhere coarse-grained, thin-bedded, shaly limestone and contains the characteristic *Cryptophragmus.* The upper division is composed of light-gray, even-bedded, fine-grained limestone. Excellent exposures of the Witten occur along U. S. Route 19 near the Russell-Tazewell County line, in fresh road cuts along the same highway near the Russell-Washington County line, and along the roads south of Blackford and Rockdell. The best exposure is in the quarry along State Highway 82 at locality 148, north of Lebanon. Some of this rock was burned in the kiln below the quarry. None of the Witten is pure enough for chemical uses, but would be suitable for agricultural lime and agstone.

MOCCASIN FORMATION

The Moccasin formation in Russell County is composed mainly of maroon-drab argillaceous limestones, mudrocks, and silty beds aggregating 350 to 475 feet thick. In the Dickensonville-Blackford belt a large part of the formation is olive-drab to drab-gray in color. The chemical composition of the Moccasin in Russell County is probably much the same as in Tazewell County and it is unlikely that the formation could be used industrially except for cement rock or rock wool.

MARTINSBURG AND EGGLESTON FORMATIONS

The lower 500 feet of the Martinsburg and the underlying Eggleston consist of interbedded shales and limestones, none of which are sufficiently pure for industrial uses. These beds are well exposed along State Highway 80, a mile or so north of Rosedale and along the road south of Rockdell. There are no exposures of these impure limestones close to a railroad in Russell County.

MISSISSIPPIAN LIMESTONE

Mississippian limestones occur in two belts northeast of Cleveland. The principal belt caps a broad grassy upland dotted with sinks and known as Sinkhole Valley. The structure of this belt is synclinal, and much of the upper part of the Mississippian limestone has been eroded away. The beds on the northwestern limb of this structure are well exposed near and along Road 600, where the following section was measured.

Geologic Section 68.—Mississippian limestone at locality 183 near Road 600, 1.3 miles northwest of Cleveland, Russell County, Virginia

	Thickness Feet
"Gasper" and "Ste. Genevieve" limestones (281 feet)	
20. Covered	
19. Limestone, drab-gray, fine grained; shaly partings	35
18. Limestone, greenish-gray, very argillaceous	5–10
17. Limestone, gray, reddish streaks, granular	3
16. Limestone, gray, oolitic	3.5
15. Limestone, medium grained, cherty	3.5
14. Limestone, pale reddish-gray, even bedded, argillaceous	2.5
13. Limestone, drab-gray, impure, shaly	7
12. Limestone, dove-gray, very fine grained, thick bedded	12
11. Limestone, thin bedded, argillaceous, oolitic	3
10. Limestone, light-gray, oolitic; clastic texture	5
9. Limestone, coarse grained, crinoidal; thin partings of greenish clay	5.5
8. Limestone, dove-gray, very fine grained	12
7. Limestone, greenish-gray, shaly	3
6. Limestone, dove-gray, very fine grained	14
5. Limestone, coarse grained, crinoidal; partings of greenish clay	12
4. Limestone, dull-gray, fine grained	5
Analysis of units, 4 to 12; thickness sampled, 71.5 feet: SiO_2, 4.02; R_2O_3, 1.32; $CaCO_3$, 90.11; $MgCO_3$, 3.60; Total, 99.05.	
3. Limestone, fine grained, impure; contains bituminous streaks	5
Hillsdale limestone	
2. Limestone, black to light-gray, medium grained, cherty	90–100
Little Valley formation	
1. Limestone, greenish-gray; argillaceous; geode bed at the top	30
Maccrady formation	

As in Tazewell County, the Little Valley and Hillsdale limestones in Russell County are very impure. Locally, near Cleveland (Geologic Section 68), some of the "Ste. Genevieve" and "Gasper" have been burned for lime, but probably none of the "St. Genevieve" and "Gasper" limestones in this vicinity is high-calcium limestone. The other belt of Mississippian limestone is a narrow faulted slice containing 60 to 125 feet of "Gasper" limestone. At locality 156 where this belt is best exposed, there is about 75 feet of interbedded limestone and shale. Some of the limestone layers are oolitic and granular; others fine grained and sparsely cherty.

QUARRIES

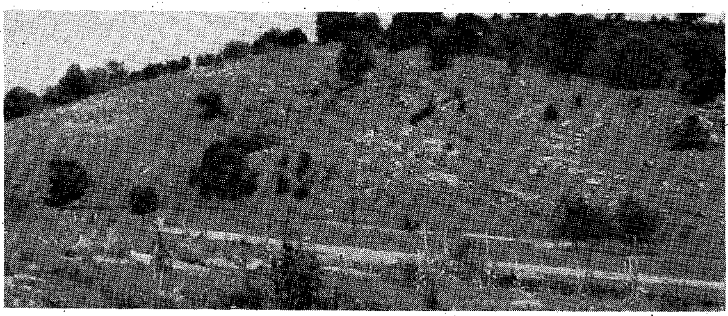
The limestones of Russell County have not been quarried except very locally for road stone and agricultural limestone. In 1942 three small quarries were in operation. A quarry in the Five Oaks limestone (Geologic Section 69; Pl. 15C) was being operated seasonally by the Elk Garden Farm Products Corporation for agstone.

Geologic Section 69.—Ordovician limestone in quarry of Elk Garden Farm Products Corporation, locality 135, Russell County, Virginia

	Thickness Feet
Lincolnshire limestone (lower part)	
3. Limestone, dark bluish-gray, granular, cherty....	12
Five Oaks limestone	
2. Limestone, dove-gray, very fine grained; SiO_2, 0.46; R_2O_3, 1.22; P_2O_5, 0.029; $CaCO_3$, 95.92; $MgCO_3$, 2.51; Total, 100.14..........	25
Elway limestone	
1. Limestone, dark-gray, fine grained, cherty; lowest exposed beds in quarry..........	12

Two small temporary quarries were being operated by the State Department of Highways. The quarry at locality 158, near Hansonville, is in the upper 40 feet of the Rockdell limestone which is dark-gray, granular, and noncherty. The other quarry at locality 170, near Creswell, is in the dark bluish-gray limestone at the top

A.



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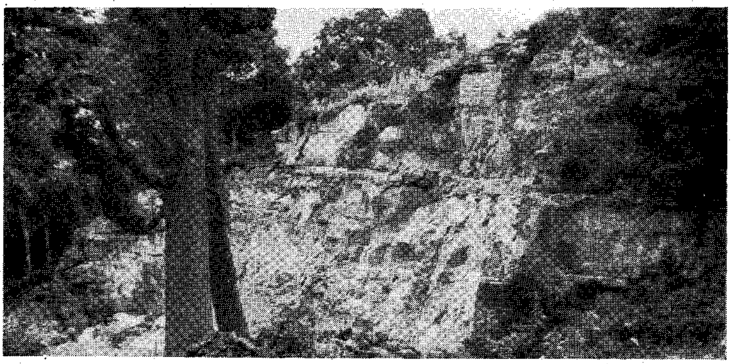
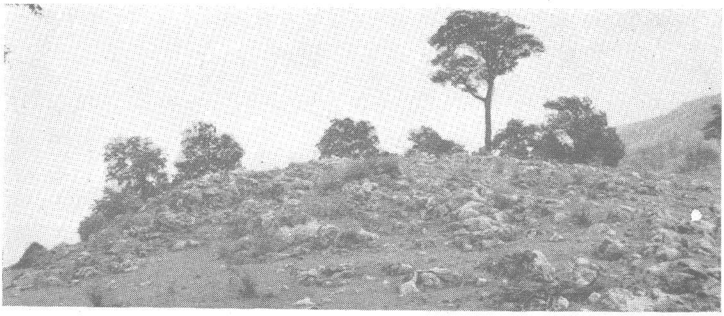


C.

A, Rockdell limestone at Elk Garden, Virginia. B, Rockdell limestone at Dickensonville, Russell County, Virginia. C, Five Oaks and Lincolnshire limestones in quarry of Elk Garden Farm Products Corporation, Elk Garden, Virginia. Photographs by R. C. Oburn.



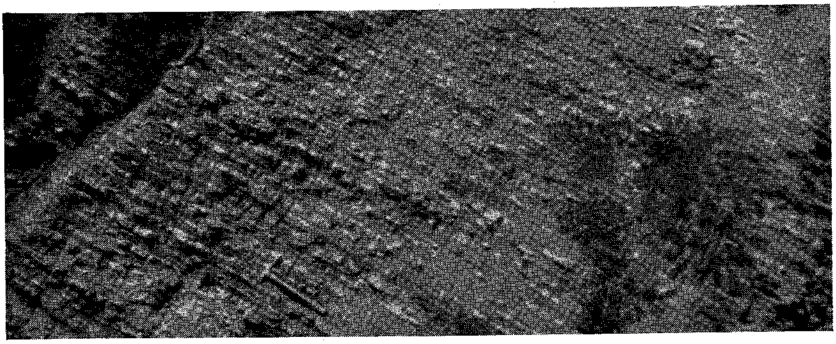
A.

B.

C.

A, Rockdell limestone at Elk Garden, Virginia. B, Rockdell limestone at Dickensonville, Russell County, Virginia. C, Five Oaks and Lincolnshire limestones in quarry of Elk Garden Farm Products Corporation, Elk Garden, Virginia. Photographs by R. C. Oburn.

A.



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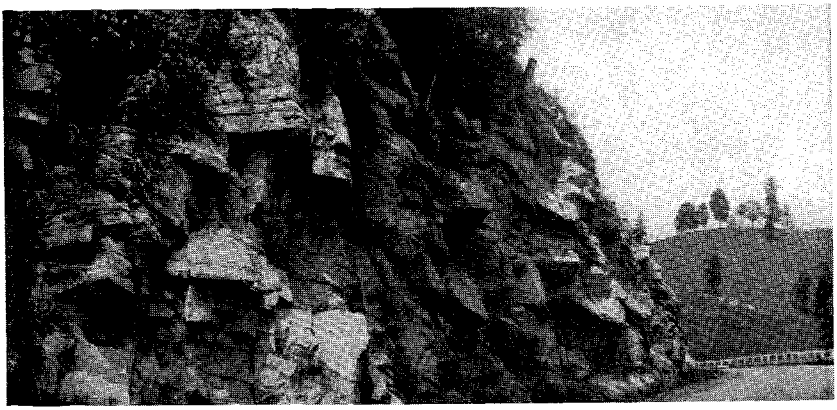
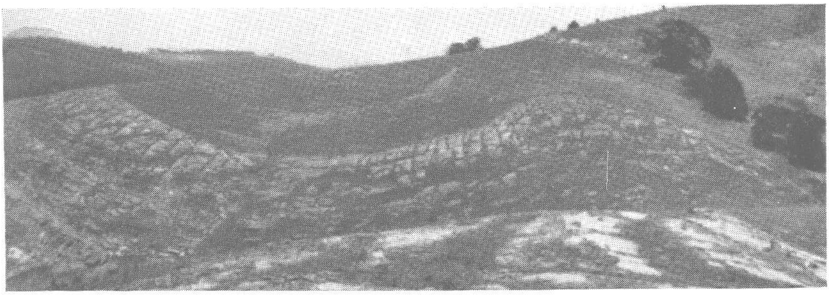
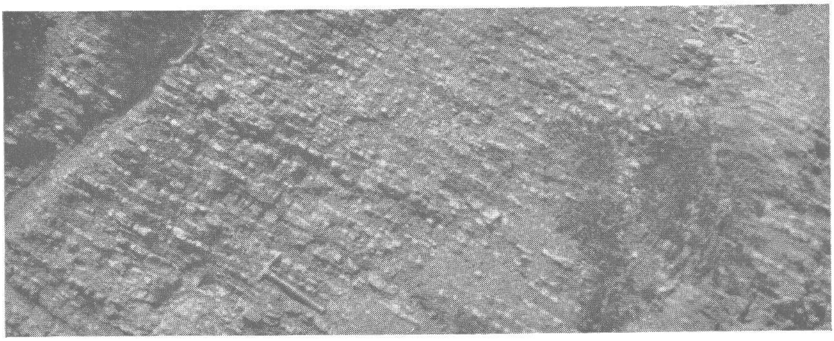


C.

A, Folds in Benbolt limestone near Blackford, Russell County, Virginia. Photograph by R. C. Oburn. B, Shaly nodular beds in Benbolt formation, near Fugates Hill, Russell County, Virginia. C, Benbolt limestone along U. S. Route 19, southwest of Wardell, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.)



A.



B.

C.

A, Folds in Benbolt limestone near Blackford, Russell County, Virginia. Photograph by R. C. Oburn. B, Shaly nodular beds in Benbolt formation, near Fugates Hill, Russell County, Virginia. C, Benbolt limestone along U. S. Route 19, southwest of Wardell, Virginia. Photograph by Charles Butts. (From Virginia Geological Survey Bulletin 52, Part 1.)

of the Honaker formation (Geologic Section 67; Pl. 11B). All the stone obtained from these quarries was being used locally in road construction. Several years ago a lime quarry in the Maryville limestone was operated at locality 195, near Hamlin, Wise County. The stone was used exclusively for agricultural lime. When the local demand for agricultural lime declined, this plant was abandoned. Other small limestone quarries which yielded road stone or material for agricultural purposes are shown on Plate 9.

QUARRY SITES

GENERAL STATEMENT

Limestones suitable for crushed stone and other physical uses are so widely distributed in Russell County that no mention of specific localities is necessary. The occurrence and character of limestone in various parts of the county can be ascertained from Plate 18 and Geologic Sections 67 to 98.

The purer limestones, particularly those containing more than 95 per cent calcium carbonate, occur locally in quantities more than adequate for large scale development. Most of these limestones are remote from a railroad, but their great thickness, extent, and high purity may in the future overshadow their unfavorable location.

CLINCH MOUNTAIN BELT

Between Denniston and the Russell-Tazewell County line (Fig. 11), the Ordovician limestones do not include any thick zones of high-calcium limestone. The coarse-grained limestones in the Rockdell and in the Wardell are high-carbonate beds. The Five Oaks limestone, reported by Woodward[30] to be relatively pure, is too thin in most places to be quarried except on a very small scale. It is not more than 20 feet thick where exposed along Road 603 southwest of Repass. The general character of the Ordovician limestone in the northeastern part of the Clinch Mountain belt of Russell County is shown in the following section.

Geologic Section 70.—Ordovician limestone at localities 106 and 107, a mile southwest of Repass, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (105 feet)	
20. Limestone, dark gray, thin bedded, slabby; contains *Camarocladia*	65
19. Limestone, coarse grained, very fossiliferous; contains *Cryptophragmus*	20
18. Limestone, buff-gray, very fine grained; contains *Tetradium*	15
17. Limestone, buff-gray, straticulate	5
Bowen formation (55 feet)	
16. Mudrock, maroon-drab, with thin intercalated beds of greenish-gray limestone	40
15. Sandstone, calcareous, weathers dark-brown	15
Wardell formation (250± feet)	
14. Shale, buff, platy	15–25
13. Limestone, light-gray, very coarse grained	35
12. Limestone, buff, nodular; contains *Receptaculites, Girvanella,* and *Rostricellula*	30–40
11. Limestone, light-gray, very coarse grained	20–30
10. Limestone, dark-gray to medium-gray, crumbly; contains *Favistella "halli", F. simplissima,* and *Stromatocerium rugosum*	120
Benbolt limestone (107 feet)	
9. Limestone, dark bluish-gray, granular	9
8. Limestone, medium-gray, coarse grained	26
7. Limestone, nodular, shaly; contains *Oxoplecia* cf. *O. gouldi, Campylorthis,* and *Öpikina*	72
Rockdell limestone (195± feet)	
6. Limestone, dark bluish-gray, cherty	20–30
5. Limestone, dark bluish-gray, cherty; contains *Nidulites*	121
Lincolnshire limestone	
3. Limestone, dark bluish-gray, cherty	65

	Thickness Feet
Five Oaks limestone	
2. Limestone, dove-gray, very fine grained; SiO_2, 0.95; R_2O_3, 0.97; $CaCO_3$, 96.55; $MgCO_3$, 2.12; Total, 100.59[30]	10
Elway limestone and Blackford formation	
1. Chert, shale, and dolomitic mudrock; poorly exposed	120

In the vicinity of Rockdell and Elk Garden, the Rockdell limestone contains 135 to 175 feet of high-calcium limestone. These beds are most prominently displayed just east of the intersection of State Highway 80 and Road 656, and just south of Rockdell (Pl. 17A).

Geologic Section 71.—Ordovician limestone, at localities 138 and 139, Elk Garden, Russell County, Virginia

	Thickness Feet
Rockdell limestone (206 feet)	
12. Limestone, dark-gray, medium grained; lower part contains *Nidulites;* thickness estimated	60
11. Limestone, light-gray, very coarse grained	60
10. Limestone, dove-gray, very fine grained; contains vugs of yellow calcite	12
9. Limestone, clastic, irregular texture; irregular masses of dove-gray fine-grained limestone in coarse-grained matrix	14
8. Limestone, dove-gray, very fine grained; vugs of yellow calcite	5
7. Limestone, gray, coarse grained	20
6. Limestone, white, very coarse grained; base of Ward Cove	35
Analysis of units 6 to 11; thickness sampled, 146 feet: SiO_2, 1.36; R_2O_3, 0.52; P_2O_5, 0.039; $CaCO_3$, 95.68; $MgCO_3$, 1.82; Total, 99.42.	
Lincolnshire limestone (30 feet)	
5. Limestone, dark-gray, granular, cherty	15
4. Limestone, dark-gray, very sparsely cherty	15

	Thickness Feet
Five Oaks limestone (65 feet)	
3. Limestone, dove-gray, very fine grained	15
2. Limestone, dark-gray to dove-gray, very fine grained; contains abundant chert in exposures directly below small quarry in the Lincolnshire limestone; same beds traced westward toward State Highway 80 are chert-free	50
Analysis of units 2 and 3 at locality 38, where no chert is present in the entire 65-foot interval: SiO_2, 0.50; R_2O_3, 0.60; $CaCO_3$, 97.13; $MgCO_3$, 1.91; Total, 100.14.	
1. Covered	
Elway limestone	

Geologic Section 72.—Ordovician limestone between localities 140 and 141 along State Highway 80, south of Rockdell, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (101 feet)	
32. Limestone, dove-gray, slabby	16
31. Limestone, buff-gray, shaly; contains *Camarocladia*	41
30. Limestone, coarse-grained; contains *Cryptophragmus*	20
29. Limestone, buff-gray, fine grained, straticulate	24
Bowen formation (48 feet)	
28. Mudrock, maroon-drab, mud cracked, columnar jointed, straticulate	24
27. Shale, buff, platy	6
26. Sandstone, irregularly bedded, conglomeratic	18
Wardell formation (367 feet)	
25. Shale, buff, platy; thin partings of sandstone	26
24. Shale; one thick sandstone bed in the middle	8
23. Shale, buff, thin sandy streaks	6
22. Limestone and shale, buff, crumbly	11

	Thickness Feet
21. Limestone, light-gray, coarse grained; shaly partings	5
20. Limestone, light-gray, coarse grained	8
19. Limestone, buff-gray, nodular	69
18. Limestone, coarse grained, thin bedded; clayey partings	31
17. Limestone, buff, nodular, shaly	35
16. Limestone, light-gray, coarse grained	17
15. Limestone, light-gray, very fine grained; contains thin intercalated partings of coarse-grained limestone	8
14. Limestone, light-gray, coarse grained, crinoidal	25
13. Limestone, buff, nodular, shaly	33
12. Limestone, dark-gray, medium grained, thick bedded; contains *Stromatocerium*	10
Benbolt limestone (186 feet)	
11. Limestone, light-gray, coarse grained	6
10. Limestone, very fine grained with thin intercalated partings of coarse-grained limestone	38
9. Limestone, buff, nodular	31
8. Limestone, argillaceous, fossiliferous, shaly; contains *Öpikina, Strophomena tennesseensis, Oxoplecia* cf. *O. gouldi,* and *Echinosphaerites aurantium*	111
Rockdell limestone (150± feet, base not exposed)	
7. Limestone, very fine grained, dove-gray	1–3
6. Limestone, very coarse grained; abundant *Girvanella*	6
5. Limestone, medium-gray, finely granular; contains *Girvanella*	8
4. Limestone, dove-gray, very fine grained	29
3. Limestone, light-gray, coarse grained	3
2. Limestone, white, very coarse grained	80
1. Limestone, light-gray, medium to coarse grained; lowest exposed beds	10–20

Analysis of units 1 to 7; thickness sampled, 150± feet: SiO_2, 0.30; R_2O_3, 1.12; $CaCO_3$, 97.54; $MgCO_3$, 1.04; P_2O_5, 0.06; Total, 100.06.

As shown in Figure 14, the dip of the Rockdell between localities 38 and 40 is not more than 10 degrees, which would facilitate extensive quarrying and underground mining between Elk Garden and Rockdell. Far in excess of 50 million tons of high-calcium limestone similar in composition to units 1 to 7 of Geologic Section 72, and units 6 to 11 of Geologic Section 72, could be obtained there at relatively low mining and quarrying costs. The rock, however, is probably much too high in phosphorus for use in the carbide industry.

At locality 142 (Pl. 15A), southwest of Rockdell, the same zone of high-calcium limestone is fully 240 feet thick, but since the dip is about 40 degrees, mining would be more difficult than at locality 140.

Geologic Section 73.—Ordovician limestone at locality 142, about 2.5 miles southwest of Rockdell, Russell County, Virginia

	Thickness Feet
Witten limestone	
Bowen formation (72 feet)	
13. Limestone, red and gray, argillaceous	25
12. Mudrock, brick-red	30
11. Sandstone, brown, and sandy mudrock	17
Wardell formation (281 feet)	
10. Shale, buff, platy, with thin intercalated sandstones	96
9. Limestone, buff, nodular; contains few intercalated beds of light-gray coarse-grained limestone	75
8. Limestone, very coarse grained to very fine grained; contains corals; reefy structures	110
Benbolt limestone (188 feet)	
7. Limestone, medium-gray, granular, cross laminated; prominent cherty bed 9 feet below the top	62
6. Limestone, medium grained	28
5. Limestone and shale; weathers buff	80
4. Limestone, gray, medium to coarse grained; weathers drab-gray; contains *Öpikina minnesotensis, Strophomena tennesseensis, Oxoplecia* cf. *O. gouldi* and *Echinosphaerites aurantium*	18

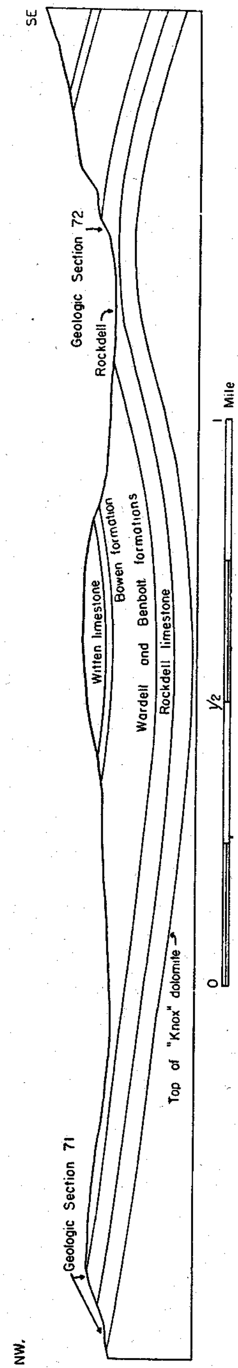


FIGURE 14.—Structure of the Rockdell limestone and associated strata between Elk Garden and Rockdell, Russell County, Virginia.

	Thickness Feet
Rockdell limestone	
3. Limestone, light-gray, coarse grained; clastic texture; contains many intercalated beds of fine-grained dove-gray limestone; two or three thin impure beds aggregating less than 2½ feet: SiO_2, 0.34; R_2O_3, 0.58; $CaCO_3$, 97.64; $MgCO_3$, 0.88; Total, 99.44	240
Lincolnshire limestone	
2. Limestone, dark bluish-gray, cherty	50
Five Oaks limestone	
1. Limestone, dove-gray, very fine grained	20
Elway limestone	

The same body of high-calcium limestone continues southwestward to the vicinity of locality 144, northeast of Hansonville, where the following section was measured.

Geologic Section 74.—Ordovician limestone in the vicinity of Hansonville, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (measured and sampled at locality 167; 256 feet).	
17. Limestone, light-gray to medium-gray, coarse grained; a few intercalations of dark brownish-gray granular limestone	76
16. Limestone, light-gray, very coarse grained, reefy	17
15. Limestone, dove-gray to dark-gray, fine grained to coarse grained; no well defined bedding; reefy	88
Analysis of units 15 to 17; thickness sampled, 180 feet: SiO_2, 1.48; R_2O_3, 0.90; $CaCO_3$, 96.12; $MgCO_3$, 1.30; Total, 99.80.	
14. Limestone, light-gray to dove-gray, interbedded coarse-grained and fine-grained layers; poorly exposed on north side of U. S. Route 19	75±

	Thickness Feet
Lincolnshire limestone	
13. Limestone, dark bluish-gray, cherty; exposed just west of Hansonville Post Office	30
Five Oaks limestone	
12. Limestone, dove-gray, very fine grained, thin bedded; exposed just west of Hansonville Post Office	12
Elway limestone (measured at locality 166; 85.1 feet)	
11. Chert, thin bedded, fossiliferous	60
Blackford formation (measured at locality 166)	
10. Limestone, ash-gray, shaly	18
9. Limestone, dark-gray, granular	2
8. Shale, ash-gray	4.5
7. Limestone, ash-gray, shaly; contains blocky chert	19
6. Chert	0.6
5. Limestone, dark-gray, splintery	11
4. Limestone, drab-gray, impure, mealy	5
3. Limestone, dove-gray, very fine grained, shaly	7
2. Limestone, light-gray, clastic texture	8
1. Shale, ash-gray	10
"Knox" dolomite	

Although the beds are not continuously exposed between localities 142 and 168, the several exposures indicate that the Rockdell limestone along this seven-mile sector of the Clinch Mountain belt averages 175 feet thick and about 97.3 per cent calcium carbonate.

Much of the relatively pure limestone at locality 167 grades southwestward within a distance of 750 feet into a much thinner development of the Rockdell, composed of 75 feet of dark-gray, *Nidulites*-bearing cobbly limestone (locality 159) and, at the base, 40 to 50 feet of coarser grained granular light-gray limestone (locality 160). As shown in the well-exposed section along U. S. Route 19, south of Hansonville, there are no other important zones of high-calcium limestone in any of the higher Ordovician limestone formations.

Geologic Section 75.—Ordovician limestone along U. S. Route 19 southeast of Hansonville Post Office, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (120.8 feet)	
27. Limestone, dove-gray, fine grained; interbedded with coarse grained fossiliferous limestone; lower beds contain *Cryptophragmus antiquatus*	90.3
26. Limestone, weathers buff, shaly; contains many gastropods	8.5
25. Limestone, golden-gray, slabby	22
Bowen formation (50.5 feet)	
24. Mudrock, reddish and greenish-drab, calcareous	24
23. Mudrock, drab-gray and brick-red	11
22. Mudrock, sandy	10
21. Sandstone, straticulate; weathers rusty-brown	5.5
Wardell formation (202 feet)	
20. Shale, buff, platy; contains thin sandy lenses	5
19. Sandstone, thin bedded, blocky, calcareous	9
18. Shale, buff, sandy, platy	25
17. Shale, platy; no sandstone	18
16. Limestone, buff, nodular	3
15. Limestone, medium-gray, cobbly	8
14. Limestone, buff, shaly, very nodular	30
13. Limestone, bluish-gray; weathers nodular	18
12. Limestone, coarse grained, medium bedded	31
11. Limestone, calcareous, buff	15
10. Limestone, medium-gray, fossiliferous; bluish-gray where fresh; weathers buff	14
9. Limestone, light-gray, blocky, coarse grained	10
8. Limestone, cobbly	9
7. Limestone, granular; contains *Stromatocerium rugosum, Favistella "halli"*, and *Girvanella*	7
Benbolt limestone (221 feet)	
6. Limestone, black, medium grained, cherty	2.5
5. Limestone, dark bluish-gray, medium grained; slabby with partings of calcareous shale; contains *Ischadites*	38

	Thickness Feet
4. Shale, buff, calcareous	18
3. Limestone, nodular, fossiliferous, shaly; contains *Öpikina minnesotensis, Strophomena tennesseensis, Campylorthis* sp., *Oxoplecia* cf. *O. gouldi, Sphaerocoryphe major, Palaeocrinus* cf. *P. striatus, Platycystites faberi; Paleostrophomena, Echinosphaerites aurantium*	54
2. Shale, weathers buff, calcareous; intercalated buff, nodular shaly limestone (Pl. 16B)	74
1. Covered to base of *Echinosphaerites* bed	35

Rockdell limestone

Between U. S. Route 19 and the Russell-Scott County line there are considerable thicknesses of coarse-grained limestone above and below the Elway-Lincolnshire cherty beds (Fig. 12). However, those in the Tumbez limestone are too cherty and shaly for chemical uses. The only zone of high-calcium limestone which could be quarried extensively is in the Rockdell limestone.

Geologic Section 76.—Ordovician limestone at locality 162, near Hansonville, Russell County, Virginia

	Thickness Feet
Benbolt limestone (75± feet)	
19. Concealed	
18. Shale, calcareous; weathers buff	30
17. Limestone, nodular, argillaceous; weathers nodular to shaly; contains *Dinorthis transversa, Oxoplecia* cf. *O. gouldi,* a large *Öpikina, Scenidioides* sp., *Campylorthis* sp., *Paurorthis* sp., *Mimella melonica, M. superba, "Camerella"* sp., *Hybocystites* sp., *Echinosphaerites aurantium,* and *Lambeophyllum* cf. *L. profundum*	25
16. Limestone, dark-gray, cobbly; contains *Echinosphaerites*	15–20
Rockdell limestone (163 feet)	
15. Limestone, light-gray, very coarse grained	5
14. Limestone, gray, medium grained; weathers cobbly	41

	Thickness Feet
13. Limestone, brownish-gray, medium grained; contains chert and *Nidulites*	20
12. Limestone, light-gray, coarse grained	5
11. Limestone, medium-gray, cobbly; very little chert	30
10. Limestone, light-gray, very coarse grained	12
9. Limestone, brownish-gray, medium grained	4.5
8. Limestone, light-gray, very coarse grained	32
7. Limestone, light-gray, fine grained	13
Analysis of units 7 to 10; thickness sampled, 65± feet: SiO_2, 1.92; R_2O_3, 0.36; $CaCO_3$, 96.28; $MgCO_3$, 0.94; Total, 99.50.	
Lincolnshire limestone	
6. Limestone, dark bluish-gray, granular, cherty	60
Elway limestone	
5. Limestone, medium-gray, granular, cherty; partly covered; estimated thickness	30
Tumbez limestone (122 feet)	
4. Limestone, light-gray, coarse grained, conglomeratic; contains plates of reddish chert and masses of algal limestone	45
3. Limestone, dark-gray, very fine grained, sparsely cherty	9
2. Limestone, light-gray and purplish, laminated, coarse-grained; clastic texture	28
1. Shale, chiefly covered; a few intercalated reddish layers	40
"Knox" dolomite	

Geologic Section 77.—Ordovician limestone at locality 185, south of Tumbez, Russell County, Virginia

	Thickness Feet
Benbolt formation (136± feet)	
24. Limestone, very argillaceous; weathers buff; contains *Oxoplecia* cf. *O. gouldi*, *Öpikina minnesotensis*, *Mimella superba*, and *Campylorthis*	125+

	Thickness Feet
23. Limestone, drab-gray, granular, cobbly; a ledge-maker; contains *Echinosphaerites*	11.5
Rockdell limestone (217 feet)	
22. Limestone, light-gray, pinkish, coarse grained	52.5
21. Limestone, dark-gray, medium grained	5
20. Limestone, medium-gray, coarse grained	43
Analysis of units 20 to 22; thickness sampled, 100 feet: SiO_2, 0.10; R_2O_3, 0.76; $CaCO_3$, 98.13; $MgCO_3$, 1.06; Total, 100.05.	
19. Limestone, dark brownish-gray, cherty; contains *Sowerbyella* cf. *S. negritus* and *Oxoplecia holstonensis*	56
18. Limestone, medium-gray, medium grained; clastic texture	61
Lincolnshire limestone	
17. Limestone, dark-gray, granular, cherty; contains *Dactylogonia* sp., *Sowerbyites triseptatus* and *Dinorthis atavoides*	80
Elway limestone (24 feet)	
16. Limestone, light-gray, thin bedded, with plates and nodules of black chert; weathers with chalky crust	11
15. Limestone, irregular texture, cherty; contains *Camerella, Mimella,* and *Dinorthis holdeni*	13
Tumbez limestone (type section, 120± feet)	
14. Limestone, coarse grained, cross laminated, cherty; contains *Solenopora* and *Mimella nucleus*	80
13. Shale, ash-gray	7
12. Limestone, pinkish, conglomeratic, cherty, coarse grained; contains *Solenopora*	17
11. Mudrock, maroon-drab, shaly	4
10. Limestone, light-gray, medium grained; clastic texture; *Valcourea* sp.	2.4
9. Shale, ash-gray	5.5
8. Limestone, light-gray, medium grained, probably cherty	40–50

	Thickness Feet
7. Covered, across bridge	10–20
6. Dolomite, light-gray, mottled; pinkish blotches; clastic texture	13
5. Limestone, greenish-gray, coarse grained	2
4. Limestone, gray and pinkish, coarse grained; clastic texture; many layers crowded with *Rostricellula pristina*	11.5
3. Dolomite, conglomeratic, speckled red and pale-green; contains small angular fragments of pinkish chert	11
2. Chert breccia; dolomitic matrix	2
1. Boulder conglomerate; large fragments of chert up to 8 inches in diameter	4

"Knox" dolomite

Geologic Section 78.—Ordovician limestone at locality 185, 2 miles northeast of Collinwood, Russell County, Virginia

	Thickness Feet
Benbolt limestone (190 feet)	
6. Limestone, coarse grained, cross laminated; cherty at top	20
5. Limestone, and shale, buff, fossiliferous	150
4. Limestone, medium grained, cobbly; contains *Echinosphaerites*	20
Rockdell limestone (130 feet)	
3. Limestone, dove-gray, fine grained, medium bedded	10
2. Limestone, light-gray to pinkish, very coarse grained	120

Analyses of units 2 to 3; thickness sampled, 130 feet: SiO_2, 0.68; R_2O_3, 0.40; $CaCO_3$, 97.59; $MgCO_3$, 1.21; Total, 99.88.

Lincolnshire limestone	
1. Limestone, dark bluish-gray, granular, cherty	60

Elway limestone

Geologic Section 79.—Ordovician limestone along Road 612, locality 184, south of Collinwood, Russell County, Virginia

	Thickness Feet
Moccasin formation (481 feet)	
23. Mudrock, maroon-drab, silty	253
22. Mudrock and argillaceous limestone, drab-gray	63
21. Mudrock, calcareous, drab-gray to maroon-drab	83
20. Limestone, dove-gray, very fine grained	4
19. Mudrock, drab-gray, calcareous; contains intercalated fine-grained limestones	78
Witten limestone (114 feet)	
18. Limestone, buff-gray to dove-gray, very fine grained, slabby; contains *Camarocladia*	70
17. Limestone, coarse grained, shaly; contains *Cryptophragmus antiquatus*	12
16. Shale, buff, many gastropods; contains thin partings of crumbly limestone	10
15. Limestone, golden-gray, very fine grained, straticulate; weathers shaly	22
Bowen formation (43± feet)	
14. Mudrock, maroon and drab-buff, calcareous; intercalated gray limestone	17
13. Mudrock, maroon-drab, columnar jointed; straticulate	2.6
12. Mudrock, red, crumbly; many straticulate beds which are columnar jointed	21–24
Wardell formation (243 feet)	
11. Shale, buff, platy	52
10. Limestone, nodular, poorly exposed; crops out in an uncommonly wide belt and therefore is probably crumpled, with repetition of beds	135
9. Limestone, medium-gray, granular	25
8. Limestone, light-gray, very coarse grained	21
7. Limestone, medium-gray, crumbly	10
Benbolt limestone (212 feet)	
6. Limestone, poorly exposed, sparsely cherty	5
5. Shale and limestone	43

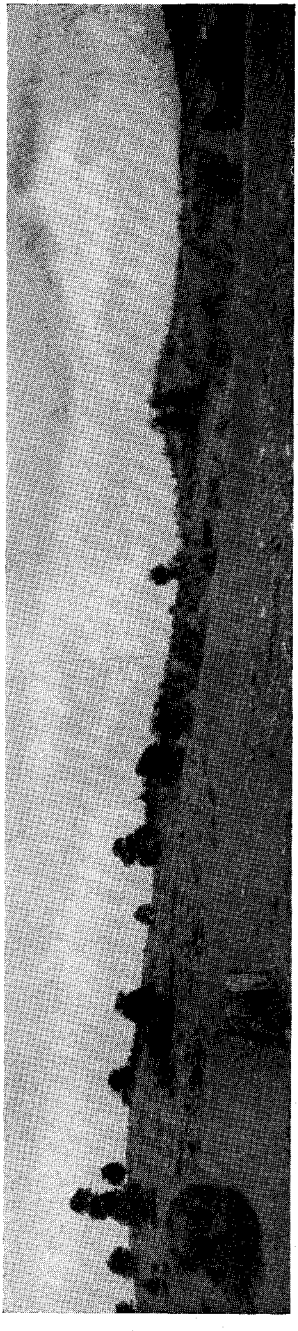
	Thickness Feet
4. Shale, bluish-gray, calcareous; weathers buff	13
3. Limestone, buff, very shaly; weathers nodular; contains *Oxoplecia*, cf. *O. gouldi, Strophomena tennesseensis, Mimella melonica, Öpikina minnesotensis*, and *Skenidioides*	47
2. Limestone, medium-gray, granular; a ledge-maker	24
1. Limestone, nodular, buff; contains *Platycystites, Lambeophyllum profundum, Echinosphaerites, Strophomena*, and *Mimella superba*	80

Rockdell limestone

This limestone, most prominently displayed in the vicinity of locality 186, averages about 150 feet thick for a distance of 3 miles to the southwest (Geologic Section 78), and is exceptionally pure. This part of Russell County is rather remote from all-weather through highways, but locality 185 (Geologic Section 78) is only three miles air line distance from Mendota, Washington County, on the Southern Railway, at the southeast base of Clinch Mountain. It might be feasible to quarry the high-calcium beds in the Tumbez-Collinwood area if a bucket line across Clinch Mountain to Mendota could be constructed to transport the stone to the railroad.

ROSEDALE BELT

The character of the Ordovician limestones in the Rosedale belt, which extends from the Russell-Tazewell County line southwestward to Cedar Creek near Lebanon, is shown in Geologic Sections 80 to 82 and in Fig. 11. There are only two zones of relatively pure limestone: one near the top of the Benbolt, averaging somewhat less than 95 per cent calcium carbonate; the other a high-calcium limestone in the Rockdell (Pl. 13B).

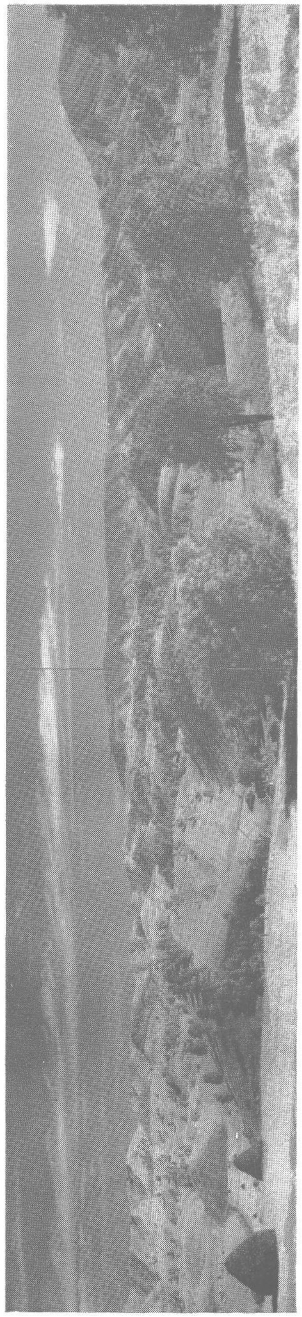


A.

B.

A, Rockdell limestone (left), Lincolnshire limestone (above kiln), and Five Oaks limestone (right center), at Elk Garden, Virginia. B, Looking toward Clinch Mountain from Hubble Hill, North Tazewell, Virginia. Photographs by R. C. Oburn.

A.



B.

A, Rockdell limestone (left), Lincolnshire limestone (above kiln), and Five Oaks limestone (right center), at Elk Garden, Virginia. B, Looking toward Clinch Mountain from Hubble Hill, North Tazewell, Virginia. Photographs by R. C. Oburn.

Geologic Section 80.—Ordovician limestones at locality 104, near Indian Creek, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (104 feet)	
15. Limestone, dove-gray to golden-gray, thin bedded, slabby; contains *Camarocladia*	70
14. Limestone, coarse grained, thin bedded, shaly; very fossiliferous; contains *Cryptophragmus* and *Rostricellula*	24
13. Limestone, light drab-gray, even bedded	10
Bowen formation (75 feet)	
12. Mudrock, maroon-drab and greenish-gray, lumpy	60
11. Sandstone, thinly laminated; weathers rusty-brown	15
Wardell formation (140 feet)	
10. Shale, buff, platy; thin sandy streaks	35
9. Limestone, very argillaceous, nodular, weathers buff; contains *Receptaculites, Öpikina,* and *Hesperorthis*	70
8. Limestone, medium- to light-gray, granular; contains *Girvanella* and *Stromatocerium*	35
Benbolt limestone (180 feet)	
7. Limestone, dark bluish-gray; sparsely cherty	60
6. Limestone, nodular, shaly; weathers buff; contains a few coarse-grained intercalations	120
Rockdell limestone (214 feet)	
5. Limestone, dark bluish-gray; contains *Sowerbyella, Multicostella,* and many *Lophospira*	64
4. Limestone, very nodular, argillaceous; abundant *Nidulites pyriformis* in some layers	75
3. Limestone, medium- to light-gray, coarse grained; clastic texture; not fully exposed; SiO_2, 0.76; R_2O_3, 0.16; $CaCO_3$, 97.88; $MgCO_3$, 0.73; Total, 99.53	75
Lincolnshire limestone	
2. Limestone, dark-gray, granular, cherty; contains *Dinorthis* and *Multicostella*	70

	Thickness Feet
Five Oaks limestone	
1. Limestone, dove-gray, fine grained; poorly exposed	10
Elway limestone	

Geologic Section 81.—Ordovician limestone at locality 152, northwest of Elway, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (200 feet)	
5. Limestone, dove-gray, fine grained	15
4. Limestone, dark-gray, fine grained	10
3. Limestone, light-gray, very coarse grained; SiO_2, 0.86; R_2O_3, 0.46; $CaCO_3$, 97.28; $MgCO_3$, 0.94; Total, 99.54	175
Lincolnshire limestone	
2. Limestone, dark bluish-gray, granular, cherty	25
Five Oaks limestone	
1. Limestone, dove-gray, fine grained, sparsely cherty	30
Elway limestone	

The upper zone of high-carbonate limestone, which is in the Benbolt formation, is fully exposed at locality 103 along U. S. Route 19 (Pl. 16C). This limestone, identified by Butts as Holston, is repeated by minor folding and crops out over a wide area a few hundred feet west of U. S. Route 19. These beds, which could be easily quarried, would be very suitable for agstone, agricultural lime, and crushed rock. The same beds crop out just northwest of U. S. Route 19 at several places between localities 4 and 9.

Geologic Section 82.—Benbolt limestone at locality 103, along U. S. Route 19, near the Russell-Tazewell County line, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (115+ feet)	
2. Limestone, dark bluish-gray, fine grained; argillaceous stringers; cherty	40

	Thickness Feet
1. Limestone, light-gray, coarse grained; SiO_2, 3.06; R_2O_3, 0.92; $CaCO_3$, 93.28; $MgCO_3$, 2.28; Total, 99.54	75

(Lower part of Benbolt concealed)

The best quarry site in the Rosedale belt is at locality 109 where the coarse-grained, high-calcium limestones crop out in the trough of a shallow syncline pitching to the northeast (Pl. 13B). Large quantities of pure limestone could be easily quarried from the axial portion and northwest flank of this structure.

Geologic Section 83.—Ordovician limestone at locality 109, along U. S. Route 19, a mile northeast of Belfast Mills, Russell County, Virginia

	Thickness Feet
Rockdell limestone (304 feet)	
10. Limestone, thin bedded, nodular, clayey and cherty; weathers buff; contains *Nidulites*	44
9. Limestone, medium-gray, medium to coarse grained	75
8. Limestone, light-gray, very coarse grained	20
7. Limestone, medium to fine grained; abundant *Girvanella*	56
6. Limestone, light-gray to white, medium to coarse grained	67
5. Limestone, gray, medium grained, crumbly	10
4. Limestone, very light-gray, very coarse grained	32
Analysis of units 4 to 9; thickness sampled, 260 feet: SiO_2, 0.50; Al_2O_3, 0.72; Fe_2O_3, 0.04; $CaCO_3$, 97.84; $MgCO_3$, 1.09; Total, 100.19.	
Lincolnshire limestone	
3. Limestone, dark bluish-gray, cherty	32
Five Oaks limestone	
2. Limestone, dove-gray, very fine grained	6–8

	Thickness Feet
Elway limestone and Blackford formation	
1. Limestone and shale, ash-gray; contains intercalated beds of chert; poorly exposed	———
"Knox" dolomite	

DICKENSONVILLE-BLACKFORD BELT

As shown in Geologic Sections 84 to 95 the Ordovician limestones in the Dickensonville-Blackford belt show considerable variation in thickness and character (Fig. 13). In the rather isolated area between Blackford and Clifton, along the northwest base of House and Barn Mountain, there are no thick deposits of high-calcium limestone suitable for quarrying. At locality 121 the *Camaroclادia* beds of the Witten limestone were formerly burned locally for agricultural lime.

Geologic Section 84.—Ordovician limestone at locality 121, about 3 miles northeast of Blackford, Russell County, Virginia

	Thickness Feet
Moccasin formation	
13. Mudrock, maroon-drab and drab-gray, silty	355
Witten limestone (111 feet)	
12. Limestone, dove-gray to golden-gray, slabby	70
11. Limestone, coarse grained; contains *Cryptophragmus*	16
10. Limestone, buff-gray, even bedded, very fine grained	15
9. Limestone, thin bedded, platy	10
Bowen formation	
8. Mudrock and sandstone	25
Wardell formation (155 feet)	
7. Shale, buff, platy	25
6. Covered	30

	Thickness Feet
5. Limestone, coarse grained; clastic texture; contains clayey partings and *Stromatocerium*	100±
Benbolt limestone	
4. Covered; a few showings of nodular argillaceous buff-weathering limestone	75±
Rockdell Cove limestone (78+ feet)	
3. Limestone, dove-gray, very fine grained	22
2. Limestone, dark bluish-gray, cherty	56
1. Limestone, dark bluish-gray, cherty; contains *Nidulites;* base not exposed	——

Geologic Section 85.—Ordovician limestone along State Highway 80 between localities 126 and 128, near Blackford, Russell County, Virginia

	Thickness Feet
Moccasin formation (458 feet)	
38. Siltstone, dark maroon-drab; weathers black	10
37. Mudrock, maroon-drab	169
36. Limestone, buff, clayey, fine grained; contains intercalated fine-grained limestone	126
35. Mudrock, pale red and buff	54
34. Mudrock and limestone; weathers buff; a few intercalated reddish layers	77
33. Mudrock, mainly bluish-gray, argillaceous	42
Witten limestone (108 feet)	
32. Limestone, dove-gray to golden-gray, very fine grained, slabby	70
31. Limestone, coarse grained, fossiliferous	22
30. Limestone, argillaceous, thin bedded	13
29. Limestone, straticulate, columnar jointed	3–6
Bowen formation (45 feet)	
28. Limestone, argillaceous; weathers shaly; intercalated beds of buff calcareous mudrock	33
27. Sandstone, rusty-brown, fine grained	12

	Thickness Feet
Wardell formation (146 feet)	
26. Shale, buff, platy	34
25. Limestone, nodular; middle part exposed in roadside quarry	100
24. Limestone, gray, medium grained, crumbly; contains *Stromatocerium rugosum, Favistella "halli," Girvanella* sp., and *Solenopora* sp.	12
Benbolt limestone (225 feet)	
23. Limestone, dark bluish-gray, argillaceous, cherty	38
22. Limestone, light-gray, coarse grained	17
21. Limestone, crumbly, nodular, argillaceous	88
20. Limestone, gray to pinkish, coarse grained	28
19. Limestone, medium-gray, granular	20
18. Limestone, crumbly, argillaceous	13
17. Limestone, brownish-gray, nodular; contains *Öpikina minnesotensis*	21
Rockdell limestone (58 feet)	
16. Limestone, brownish-gray, granular	14
15. Limestone, dark bluish-gray; contains abundant *Nidulites*	44
Lincolnshire limestone	
14. Limestone, dark bluish-gray, granular, cherty; contains *Dinorthis atavoides* and *Sowerbyites triseptatus*	102
Five Oaks limestone	
13. Limestone, dove-gray, fine grained, argillaceous	19
Elway limestone (type section)	
12. Limestone, ash-gray, impure, very cherty; beds weather to plates of chert containing *Dinorthis holdeni*	41
Blackford formation (type section; 172.5 feet)	
11. Shale, ash-gray, mealy; contains intercalated beds of fine-grained limestone	27

	Thickness Feet
10. Limestone, granular, cross laminated	1.5
9. Shale, pale reddish-drab and ash-gray; intercalated beds of nodular cherty limestone	28.5
8. Shale, ash-gray, mealy	27
7. Mudrock, mainly maroon-drab, with blotches and streaks of pale greenish-gray; dolomitic; silty (south of bridge across Clinch River)	36.5
6. Mudrock, maroon-drab, dolomitic, very crumbly, soft, shaly	12
5. Mudrock, purplish-drab and greenish-gray, blotched; conchoidal fracture; dolomitic	21
4. Dolomite, greenish-gray, mealy, even bedded	4
3. Mudrock, brick-red and apple-green; dolomitic; splintery fracture	7.9
2. Dolomite, gray, granular; one bed	1.1
1. Mudrock, maroon-drab and greenish-gray speckled; contains fragments of chert	6

"Knox" dolomite

The coarse-grained limestone in the Benbolt, along State Highway 80 south of Blackford, thickens to the southwest and between localities 130 and 132 is 50 to 65 feet thick and averages more than 96 per cent calcium carbonate. These beds crop out in a relatively wide belt on the upland above the gorge of Clinch River and are repeated by minor flexures (Pl. 16A). A short gravity bucket-line to the railroad at Hubbard Junction could provide ready access to a railway and might warrant commercial development of the high-calcium limestone in the Benbolt in this immediate vicinity. The Five Oaks limestone at Blackford and near localities 129 and 132 is too argillaceous for industrial use.

Geologic Section 86.—Benbolt limestone at locality 130, along Road 640, Hess Hollow, Russell County, Virginia

	Thickness Feet
Benbolt limestone (lower part only; 140 feet)	
3. Limestone, argillaceous, nodular, fossiliferous	50

	Thickness Feet
2. Limestone, pinkish, very coarse grained; SiO_2, 0.36; R_2O_3, 0.96; $CaCO_3$, 96.96; $MgCO_3$, 1.12; Total, 99.40	60
1. Limestone, nodular; weathers buff-gray	30

Rockdell limestone

Geologic Section 87.—Benbolt formation at locality 131, along Ball Branch, 3 miles southwest of Blackford, Russell County, Virginia

	Thickness Feet
Benbolt formation (lower part only; 130± feet)	
4. Limestone, light-gray, coarse grained	25
3. Limestone, nodular; weathers buff; very fossiliferous	50±
2. Limestone, light-gray to pinkish, very coarse grained: SiO_2, 0.56; R_2O_3, 0.26; P_2O_5, 0.030; $CaCO_3$, 97.88; $MgCO_3$, 0.86; Total, 99.59	55
1. Limestone, buff; weathers nodular and shaly	——

Rockdell limestone

The coarse-grained limestones in the Benbolt grade laterally into relatively impure beds a short distance southwest of locality 131. Along State Highways 71 and 82, northwest of Lebanon, no quarriable thicknesses of high-calcium limestone occur in any of the Ordovician formations.

Geologic Section 88.—Ordovician limestones exposed along State Highway 82 and Road 640, between localities 149 and 150, northwest of Lebanon, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (130 feet)	
36. Limestone, dove-gray to golden-gray, very fine grained; contains thin intercalated beds of coarse-grained limestone; exposed in roadside quarry (locality 148) and along State Highway 82	70

	Thickness Feet
35. Limestone, coarse grained; contains *Cryptophragmus;* shaly in lower part	27
34. Limestone, buff-gray, argillaceous, slabby; beds at top are very shaly and full of gastropod molds	33
Bowen formation (31.6 feet)	
33. Mudrock, maroon-drab, calcareous, straticulate	2.4
32. Sandstone, brown	1.2
31. Shale, dark-gray, platy, calcareous	9
30. Limestone, dark-gray, granular, shaly with sandy streaks	10
29. Sandstone, bluish-gray, concretionary; contains partings of calcareous shale	9
Wardell formation (165 feet)	
28. Shale, platy; weathers buff	20
27. Limestone, dark-gray, medium grained; weathers buff; contains *Campylorthis* and *Öpikina*	17
26. Limestone, nodular; weathers buff; contains *Receptaculites biconstrictus, Cheirocrinus* and *Hesperorthis*	96
25. Limestone, medium-gray, granular; clayey streaks; contains *Stromatocerium rugosum* and *Lichenaria*	32
Benbolt limestone (346 feet)	
24. Limestone, dark-gray, fine grained	18
23. Limestone, dark-gray, fine grained, cherty	21
22. Limestone, medium to fine grained, even bedded, fossiliferous; contains no chert	32
21. Covered; few showings of dark-gray cherty limestone	22
20. Limestone, medium grained, cross laminated; interbedded with finer grained light-gray argillaceous limestone	51
19. Limestone, nodular; weathers buff	12
18. Limestone, light-gray and pinkish, medium to coarse grained	8
17. Limestone, crumbly; weathers buff; *Dinorthis* cf. *D. transversa* abundant	36

	Thickness Feet
16. Limestone, light-gray, coarse grained	12
15. Limestone, buff, nodular	8
14. Limestone, light-gray, coarse grained	6
13. Limestone, buff, argillaceous	36
12. Limestone, coarse-grained, light-gray, crumbly; full of fragmented cystoids and bryozoans: SiO_2, 1.14; Al_2O_3, 0.20; Fe_2O_3, 0.20; $CaCO_3$, 97.08; $MgCO_3$, 1.09; Total, 99.71	30
11. Limestone, dark-gray, crumbly; weathers buff	59
10. Limestone, medium-gray, coarse grained	5
Rockdell limestone (202 feet)	
9. Limestone, dark-gray, fine grained; weathers with white chalky crust; contains many *Lophospira* gastropods	22
8. Limestone, dark-gray, granular, cherty; contains *Receptaculites* and *Nidulites pyriformis*	180
Lincolnshire limestone	
7. Limestone, dark-gray, cherty, granular; contains *Sowerbyites* and *Dinorthis atavoides*	85
Five Oaks limestone	
6. Limestone, dove-gray, fine grained	12
Elway limestone	
5. Limestone, medium-gray, fine grained; weathers with white chalky crust; blocky chert very abundant	35
Blackford formation (115 feet)	
4. Shale, ash-gray; a few intercalated cherty layers	10
3. Shale, ash-gray	20–30
2. Dolomite, gray; clastic texture; many beds conglomeratic	55
1. Mudrock, maroon-drab; some layers mottled with pale-green; contains angular pebbles of chert in basal, conglomeratic beds	25
"Knox" dolomite	

Geologic Section 89.—Ordovician limestones exposed along State Highway 64, locality 147, Russell County, Virginia

	Thickness Feet
Wardell formation (168 feet)	
25. Shale, buff, platy	23
24. Limestone, fine grained, ribbon banded, very argillaceous; contains *Öpikina septata*	10
23. Limestone, light-gray, coarse grained	10
22. Limestone, shaly; weathers buff	12
21. Limestone, buff, nodular to cobbly	77
20. Limestone, medium grained, slabby; contains *Receptaculites, Solenopora,* and *Favistella "halli"*	36
Benbolt limestone (300± feet)	
19. Limestone, dark bluish-gray, fine grained, cherty; contains many gastropods	59
18. Limestone, medium to coarse grained, cross laminated	77
17. Limestone, buff, nodular, fossiliferous	80
16. Limestone, buff, fossiliferous, shaly	16–20
15. Limestone, light-gray, coarse grained, lenticular	6.4
14. Limestone, buff, shaly, and buff shale	2.4
13. Limestone, light-gray, coarse grained, thin bedded	11
12. Limestone, buff, nodular	40
Rockdell limestone (235 feet)	
11. Limestone, light-gray, coarse grained, medium bedded, clastic texture; thin partings of shale	40
10. Limestone, medium gray, coarse grained, crumbly and shaly	15.5
9. Limestone, light-gray, coarse grained	30
Analysis of units 9 to 11; thickness sampled, 85.5 feet: SiO_2, 0.80; R_2O_3, 0.20; $CaCO_3$, 97.48; $MgCO_3$, 1.09; Total, 99.57.	
8. Limestone, dark-gray, medium grained; irregular bedding	12

	Thickness Feet
7. Limestone, dark bluish-gray, granular, cherty	96
6. Limestone, light-gray, granular, no chert	42
Lincolnshire limestone	
5. Limestone, dark bluish-gray, cherty; contains *Dinorthis atavoides, Dactylogonia* sp., *Sowerbyites triseptatus*	83
Five Oaks limestone	
4. Limestone, dove-gray, very fine grained; sparsely cherty	10
Elway limestone	
3. Limestone, light-gray, mealy and shaly; contains an abundance of fossiliferous blocky weathering chert	45
Blackford formation (55 feet)	
2. Shale, ash-gray; contains few lenses of vitreous chert	20
1. Mudrock, maroon-drab, shaly; basal layers conglomeratic	35
"Knox" dolomite	

At locality 177, about 2.5 miles northeast of Dickensonville, the only zone of high-calcium limestone in the Ordovician consists of 25 feet of coarse-grained cross-laminated limestone (Pl. 14A) at the top of the Rockdell.

Geologic Section 90.—Ordovician limestone at locality 177, about 2.5 miles northeast of Dickensonville, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (150± feet)	
23. Limestone, dove-gray and buff-gray, very fine grained, mottled, impure and shaly	75±
22. Limestone, coarse grained	10

	Thickness Feet
21. Limestone, coarse grained, very shaly; full of gastropods	22.5
20. Limestone, golden-gray, medium bedded	23
19. Limestone and mudrock, drab-gray	8
18. Limestone, dove-gray, very fine grained	7.5
Bowen formation (25± feet)	
17. Mudrock, maroon-drab, straticulate	8
16. Sandstone, calcareous, crumbly	2.2
15. Shale, bluish-gray, sandy	4.2
14. Sandstone, rusty-brown, concretionary	10
Wardell formation (85 feet)	
13. Shale, buff, platy	10.1
12. Shale, buff, platy; contains thin crinoidal layers	8
11. Limestone, bluish-gray, fine grained; weathers cobbly	12
10. Limestone, buff, shaly, nodular	37
9. Limestone, coarse grained, crumbly	5
8. Limestone, coarse grained, crinoidal	12.5
Benbolt limestone (180 feet)	
7. Limestone, dark bluish-gray, fine grained, sparsely cherty	40
6. Limestone, light-gray, medium to coarse grained, granular, platy	40
5. Limestone, nodular, poorly exposed	100±
Rockdell limestone (42 feet)	
4. Limestone, coarse grained, crinoidal; clastic texture; cross laminated (Pl. 14A)	25
3. Limestone, coarse grained, light-gray; shaly partings; weathers crumbly	17
Lincolnshire limestone	
2. Limestone, medium-gray, cherty	124
Five Oaks limestone	
1. Limestone, dove-gray, very fine grained	5–10
Elway limestone	

The coarse-grained beds of the Rockdell show a profound increase in thickness toward Dickensonville, as shown by almost continuous exposures along the northwest slope of the conspicuous hill just south of State Highway 64 (Pl. 15B). At locality 176, about 1.2 miles southwest of locality 177, the Rockdell is 125 feet thick. Some of the beds are composed of massive bryozoans and are probably bioherms.

Geologic Section 91.—Rockdell limestone at locality 176, near Dickensonville, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone	
4. Limestone, light-gray to pinkish, coarse grained; clastic texture; contains intercalated fine-grained dove-gray limestones: SiO_2, 0.14; R_2O_3, 0.68; $CaCO_3$, 96.85; $MgCO_3$, 1.80; Total, 99.47	123
Lincolnshire limestone (75+ feet)	
3. Limestone, dark bluish-gray, cherty	75
2. Covered	
Five Oaks limestone	
1. Limestone, dove-gray, fine grained	15
Elway limestone	

Near the intersections of State Highways 64 and 71 at Dickensonville, the Rockdell is about 300 feet thick and contains a 260-foot thickness of high-calcium limestone with less than 1 per cent of noncarbonates (Geologic Section 92). These beds (Pl. 15B; Fig. 15) make a prominent ridge south of State Highway 71. Overlying formations, including several granular but less pure limestones, are exposed along State Highway 64 south of Dickensonville.

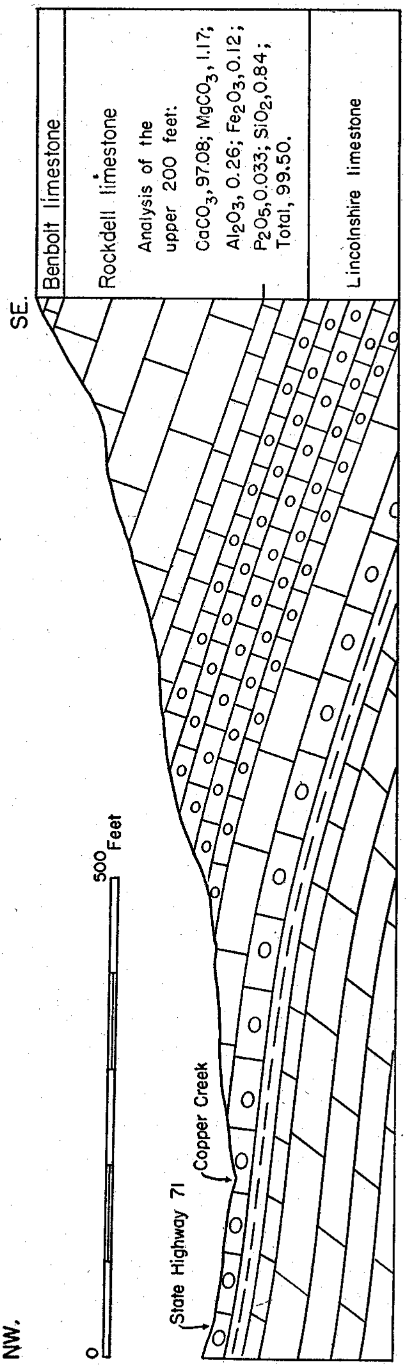


FIGURE 15.—Structure of the Rockdell limestone and associated strata at Dickensonville, Russell County, Virginia.

Geologic Section 92.—Ordovician limestone between localities 174 and 175, in the vicinity of Dickensonville, Russell County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (138 feet)	
29. Limestone, dove-gray, fine grained, slabby	75±
28. Limestone, coarse grained, shaly	28
27. Limestone, buff-gray, argillaceous, very fine grained	35
Bowen formation	
26. Shale and sandstone, poorly exposed except at base	25
Wardell formation (98 feet)	
25. Limestone, gray, granular; weathers cobbly	25
24. Limestone, buff, nodular, shaly	35
23. Limestone, fine to coarse grained; contains *Stromatocerium*	16
22. Limestone, pale-red and green, mottled, very fine grained; contains lenses of coarse-grained gray limestone with abundant plates of *Cheirocrinus*	22
Benbolt limestone (85± feet; boundaries uncertain)	
21. Limestone, nodular, buff-weathering	22
20. Limestone, pink and gray, coarse grained; weathers slabby; partings of buff shale towards the base	63
Rockdell limestone (330 feet)	
19. Limestone, dove-gray, very fine grained	10
18. Limestone, gray, coarse grained	6
17. Limestone, dove-gray, very fine grained	33
16. Limestone; poorly exposed; mostly fine grained; all exposed beds are dove-gray and pure	22
15. Limestone, coarse grained	25
14. Limestone, very coarse grained	5
13. Limestone, dove-gray, very fine grained	16

	Thickness Feet
12. Limestone, pinkish, coarse grained	26
11. Limestone, light gray, medium to very fine grained	13
10. Limestone, light-gray, very fine grained	5
9. Limestone, light-gray, very fine grained; contains irregular inclusions of coarse-grained limestone	35
8. Limestone, gray, coarse grained	4

Analysis of units 8 to 19; thickness sampled, 260± feet; SiO_2, 0.84; R_2O_3, 0.38; P_2O_5, 0.033; $CaCO_3$, 97.08; $MgCO_3$, 1.17; Total, 99.50.

7. Limestone, medium-gray, fine grained	11
6. Limestone, medium-gray, medium grained	31
5. Limestone, gray, coarse grained	8
Lincolnshire limestone (90 feet)	
4. Limestone, fine grained, sparsely cherty	75
3. Limestone, medium grained, granular, fossiliferous	15
Five Oaks limestone	
2. Limestone, light-gray, very fine grained, cherty	40
Elway limestone	
1. Shale, blocky chert, and shaly limestone	35
Blackford formation	

At locality 173, about 0.75 mile southwest of Dickensonville, the high-calcium limestone in the Rockdell is about 200 feet thick and consists mainly of coarse-grained, clastic-textured limestone. Unlike the limestone northeast of Dickensonville, the Rockdell in the belt southwest of the village is dotted with sink holes and the limestone here probably could not be quarried on a large scale.

Geologic Section 93.—Rockdell limestone at locality 173, along State Highway 71, west of Dickensonville, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (232 feet)	
5. Limestone, light-gray, coarse grained	27
4. Limestone, dark-gray, granular	41
3. Limestone, light-gray, coarse grained to fine grained	88
2. Limestone, pinkish, coarse grained	61
Analysis of units 2 to 5; thickness sampled, 217 feet; SiO_2, 0.18; R_2O_3, 1.20; $CaCO_3$, 97.84; $MgCO_3$, 1.06; Total, 100.28.	
1. Limestone, coarse grained, cobbly	15
Lincolnshire limestone	

Southeast of The Parsonage, between localities 171 and 172, the coarse-grained high-calcium beds of the Rockdell are restricted to the upper 100 feet of the formation, but even this division contains several beds which are doubtless too impure for chemical lime.

Geologic Section 94.—Ordovician limestones between localities 171 and 172 near intersection of State Highways 71 and 64, The Parsonage, Russell County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (305 feet)	
16. Limestone, dark-gray; weathers light bluish-gray; cherty at the top	24
15. Limestone, mostly light-gray, coarse grained, cross laminated, crinoidal	137
14. Limestone, nodular and shaly; weathers buff	95
13. Limestone, dark-gray, crumbly; contains *Echinosphaerites aurantium*	49

	Thickness Feet
Rockdell limestone (257 feet)	
12. Limestone, light-gray, coarse grained; contains a few impure partings	104
11. Limestone, argillaceous, medium bedded, crumbly	11
10. Limestone, light-gray, coarse grained	15
9. Limestone, brownish-gray, cobbly	23
8. Limestone, light-gray, medium grained, granular	10
7. Limestone, dark-gray to brownish-gray; some layers cherty	104
Lincolnshire limestone	
6. Limestone, dark bluish-gray to brownish-gray, granular, cherty; contains *Dinorthis* and *Dactylogonia*	84
Elway limestone	
5. Limestone, very fine grained; weathers ash-gray and mealy; full of nodules of black chert	73
Blackford formation (116 feet)	
4. Limestone and shale, ash-gray with reddish streaks, crumbly	28
3. Shale and chert, poorly exposed	30
2. Shale, maroon-drab and greenish-gray, speckled	23
1. Shale, ash-gray, mealy, crumbly	35
"Knox" dolomite	

Farther southwest at locality 187, the coarse-grained beds grade into a rather uniform succession of dark bluish-gray, cobbly weathering cherty limestone with an aggregate thickness of 250 feet. Rock of this type prevails in the Rockdell belt for several miles southwestward to the Scott-Russell County line, and there are no quarriable thicknesses of high-calcium limestone in any of the succeeding or underlying formations.

Geologic Section 95.—Ordovician limestones in the vicinity of locality 187, about 0.8 mile northeast of Masons Store, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (200 feet)	
7. Limestone, dark bluish-gray, cherty	20
6. Limestone, dark bluish-gray, granular; contains *Sowerbyella negrita, Strophomena tenuitesta;* and *Multicostella*	30
5. Limestone, medium bedded, dark-gray; contains *Nidulites;* middle part cherty	100
4. Limestone, mainly medium to dark-gray, granular, not cherty	50
Lincolnshire limestone	
3. Limestone, dark bluish-gray, granular, cherty; contains *Dinorthis atavoides* and *Sowerbyella*	96
Elway limestone (may include thin representative of Five Oaks limestone)	
2. Limestone; weathers light-gray, very cherty; contains *Calliops* and *Dinorthis*	65
Blackford formation	
1. Shale, ash-gray, mealy, dolomitic; contains intercalated zones of pale-reddish and purplish mudrock; not fully exposed	65
"Knox" dolomite	

The Rockdell belt, between localities 172 and 177, contains sufficient available high-calcium limestone for extensive quarrying. It is located along two main highways but is rather remote from a railroad. Possibly a gravity bucket line across Copper Ridge could convey the limestone of the Dickensonville area to the nearest railroad at Castlewood, a distance of 5 miles.

SWORDS CREEK BELTS

The thick succession of dove-gray fine-grained limestone northeast of Swords Creek contains, near the top, 100 to 150 feet of high-calcium limestone averaging about 98 per cent total carbonates. These beds are best exposed at locality 111 and could be quarried from there eastward for a distance of more than 3 miles. The same beds occur also at locality 110 about a mile west of Daw, but this zone is only about 90 feet thick along the Norfolk and Western Railway near the Russell-Tazewell County line. Similar fine-grained limestones occur below the relatively pure zone, but they are almost invariably cherty or shaly. About 40 feet of high-carbonate limestone, occurring about 25 feet below the base of the high-calcium zone, is exposed in a small quarry just south of Sample Branch at locality 111. Northwest of Road 633 the same zone is probably 75 feet thick.

Fine-grained dove-gray limestones are also exposed at locality 145 (Geologic Section 98) and were quarried and burned locally for lime many years ago. Fine-grained limestones with an aggregate thickness of 250 feet are exposed at locality 115 northeast of Fullers Corners and the upper 150 feet probably could be quarried for high-calcium limestone, but the available tonnage is probably small.

Geologic Section 96.—Ordovician limestones at locality 111, northeast of Swords Creek, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along St. Clair fault)	
Benbolt limestone (182+ feet)	
11. Limestone, buff, very nodular, argillaceous	171
10. Limestone, medium-gray, granular, even bedded	11
Rockdell, Lincolnshire and Five Oaks limestones (420 feet)	
9. Limestone, dove-gray, very fine grained	77
8. Limestone, very fine grained; few thin clayey layers	39
7. Limestone, dove-gray, very fine grained	23
Analysis of units 7-9; thickness sampled, 139 feet: SiO_2, 1.60; R_2O_3, 0.66; $CaCO_3$, 95.83; $MgCO_3$, 1.80; Total, 99.89.	

	Thickness Feet
6. Limestone, dove-gray, very fine grained, cherty	30
5. Limestone, light-gray, fine grained; SiO_2, 1.10; R_2O_3, 1.20; $CaCO_3$, 93.89; $MgCO_3$, 4.10; Total, 100.29	49
4. Limestone, dark-gray, cherty	26
3. Limestone, dove-gray, fine grained; some layers have been reworked into clastic limestones; beds exposed in small quarry; SiO_2, 2.54; R_2O_3, 0.54; $CaCO_3$, 93.80; $MgCO_3$, 3.10; Total, 99.98	42
2. Limestone, light-gray, finely granular; several layers contain chert nodules	96
1. Limestone, light-gray, very fine grained, no chert	38

Elway limestone

Geologic Section 97.—Ordovician limestone at locality 101 along the Norfolk and Western Railway at Daw, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along St. Clair fault)	
Rockdell, Lincolnshire, Five Oaks, and Elway limestones (349 feet)	
6. Limestone, dove-gray, fine grained	92
5. Limestone, very fine grained, cherty, poorly exposed	39
4. Limestone, light-gray, very fine grained	16
3. Limestone, fine grained, sparsely cherty, largely covered	85
2. Limestone, fine grained, mostly covered	117
1. Covered	

Geologic Section 98.—Ordovician limestone at locality 112, near Swords Creek, Russell County, Virginia

	Thickness Feet
Rome formation (overthrust along Russell Fork fault)	
Benbolt limestone (125 feet)	
5. Limestone, coarse grained, crumbly	60
4. Limestone, nodular; weathers buff-gray	65
Rockdell, Lincolnshire, and Five Oaks limestones (145 feet)	
3. Limestone, dove-gray, fine grained	25
2. Limestone, dark-gray, medium grained, sparsely cherty	75
1. Limestone, dove-gray, very fine grained; only partly exposed; some of the unit was quarried locally for lime	45
Elway limestone	

TABLE 4.—*Analyses of limestones and dolomites in Russell County, Virginia*
(Froehling and Robertson, Inc., and John H. Yoe, Analysts)

Locality (Shown on Plate 18)	Formation	Geologic Section		Thickness in Feet of Sampled Interval	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
103	Benbolt	82	1	75	93.28	2.28	0.60	0.32	3.06	99.54	Along U. S. Route 19 near the Russell-Tazewell County line
104	Rockdell	80	3	75	97.88	0.73	0.12	0.04	0.76	99.53	Near Indian Creek and Russell-Tazewell County line
107	Five Oaks[a]	70	2	10	96.55	2.12	0.97		0.95	100.59	About a mile southwest of Repass
109	Rockdell	83	4–9	260	97.84	1.09	0.72	0.04	0.50	100.19	Along U. S. Route 19, about a mile northeast of Belfast Mills
111	Five Oaks	96	3	42	93.80	3.10	0.38	0.16	2.54	99.98	
111	Rockdell (?)	96	5	49	93.89	4.10	1.04	0.16	1.10	100.29	Northeast of Swords Creek.
111	Rockdell (?)	96	7–9	139	95.83	1.80	0.46	0.20	1.60	99.89	

117	Honaker	63	1–5	418	55.27	42.67	0.40	0.16	0.68	99.18	About a mile southeast of Honaker
123–124	"Knox"	61	2–5	350	55.90	41.30	0.40	0.08	1.48	99.16	
123–124	"Knox"	61	7–10	311	52.65	40.86	0.74	0.44	5.32	100.01	Along Norfolk and Western Railway, near Hubbard Junction
123–124	"Knox"	61	22–26	234	52.16	38.89	0.94	0.44	6.76	99.19	
130	Benbolt	86	2	60	96.96	1.12	0.84	0.12	0.36	99.40	Hess Hollow, southwest of Blackford
131	Benbolt	87	2	55	97.88	0.86	0.18	0.08	0.56	99.56	Ball Branch, 3 miles southwest of Blackford
135	Five Oaks	69	2	25	95.92	2.51	1.14	0.08	0.46	100.11	Quarry of Elk Garden Farm Products Corpn., Elk Garden
138	Five Oaks	71	2–3	65	97.13	1.91	0.56	0.04	0.50	100.14	About 0.25 mile southeast of junction of Road 656 and State Highway 80
139	Rockdell	71	6–11	146	95.68	1.82	0.44	0.08	1.36	99.38	
140	Rockdell	72	1–7	143	97.54	1.04	0.92	0.20	0.30	100.00	South of Rockdell
142	Rockdell	73	3	240	97.64	0.88	0.46	0.12	0.34	99.44	About 2.5 miles southwest of Rockdell
147	Rockdell	89	9–11	85.5	97.48	1.09	0.12	0.08	0.80	99.57	Along State Highway 71, northwest of Lebanon
149–150	Benbolt	88	12	30	97.08	1.09	0.20	0.20	1.14	99.71	Along State Highway 82, northwest of Lebanon

TABLE 4.—*Analyses of limestones and dolomites in Russell County, Virginia—Continued*

Locality (Shown on Plate 18)	Formation	Geologic Section		Thickness in Feet of Sampled Interval	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
152	Rockdell	81	3	175	97.28	0.94	0.34	0.12	0.86	99.54	About 2 miles northwest of Elway
162	Rockdell	76	7–10	65±	96.28	0.94	0.16	0.20	1.92	99.50	Near Hansonville
167	Rockdell	74	15–17	180	96.12	1.30	0.78	0.12	1.48	99.80	About 1.5 miles northeast of Hansonville
170	Honaker[a]	67	1	75	77.63	4.32	12.38		5.54	99.87	Along State Highway 64, near Creswell
173	Rockdell	93	2_5	217	97.84	1.06	1.12	0.08	0.18	100.28	Near State Highway 71, west of Dickensonville
174–175	Rockdell	92	8–19	260	97.08	1.17	0.26	0.12	0.84	99.47	Dickensonville
176	Rockdell	91	4	123	96.85	1.80	0.56	0.12	0.14	99.47	East of Dickensonville
180–181	Honaker	64	11	639	54.77	41.71	0.76	0.20	1.78	99.22	Along State Highway 82, 2 miles south of Cleveland
180–181	Honaker	64	12	438	55.17	43.40	0.40	0.12	0.94	100.03	

182	Honaker	65	10–11	483	57.09	39.92	0.94	0.36	1.16	99.84	Along State Highway 82, a mile south of Cleveland
183	Mississippian	68	4–12	71.5	90.11	3.60	1.00	0.32	4.02	99.05	About 1.3 miles northwest of Cleveland
185	Rockdell	77	20–22	100	98.13	1.06	0.60	0.16	0.10	100.05	South of Tumbez
185	Rockdell	78	2–3	130	97.59	1.21	0.20	0.20	0.68	99.88	About 2 miles northeast of Collinwood
197	Honaker			75	56.69	41.85	0.38	0.16	0.52	99.60	Quarry of Clinch River Quarries Corpn., near St. Paul, Wise County
197	Maryville			75	84.98	12.19	1.26	0.44	1.48	100.35	

[a] Analysis from Woodward, H. P., Outline of the geology and mineral resources of Russell County, Virginia: Virginia Geol. Survey Bull. 49, p. 74, 1938.

SCOTT COUNTY

GENERAL FEATURES

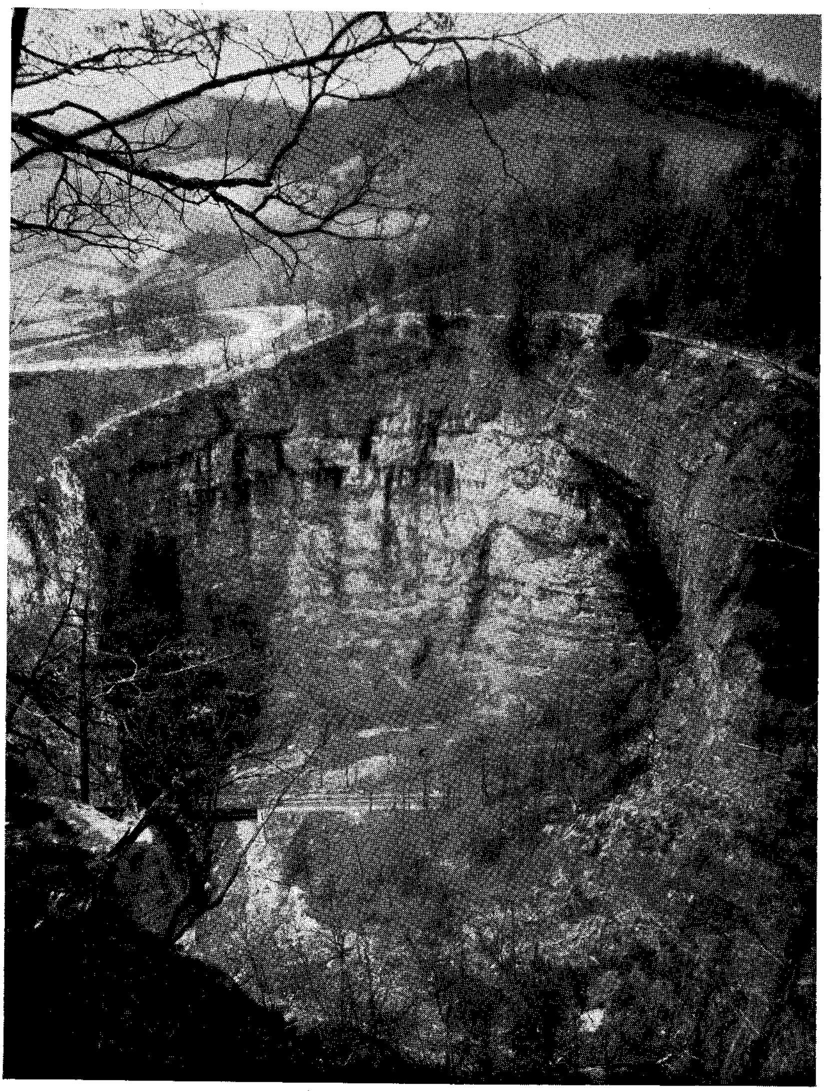
Because of its rough topography, much of Scott County (Pl. 23) has few paved roads. The main arterial highways, U. S. Routes 23 and 58, pass through Duffield, Clinchport, Speers Ferry, and Gate City, and provide connections with Bristol, Big Stone Gap, and Cumberland Gap. State Highway 71 is paved most of the way between Gate City and the Russell-Scott County line. State Highway 66, connecting with State Highway 74 near Castlewood, Russell County, is paved between Fort Blackmore and Dungannon.

The Clinchfield Railroad follows Clinch River most of the way between St. Paul, Wise County, and Clinchport, Scott County, cutting southward through Clinch Mountain by a tunnel between Speers Ferry Station and Cassard. Between Clinchport and Speers Ferry, several belts of limestone and dolomite are well exposed in cuts along this railroad. The Southern Railroad crosses all of the main limestone and dolomite belts between Horton Summit and Gate City. Between Speers Ferry and Moccasin Gap it parallels closely the principal belt of high-calcium limestone in Scott County.

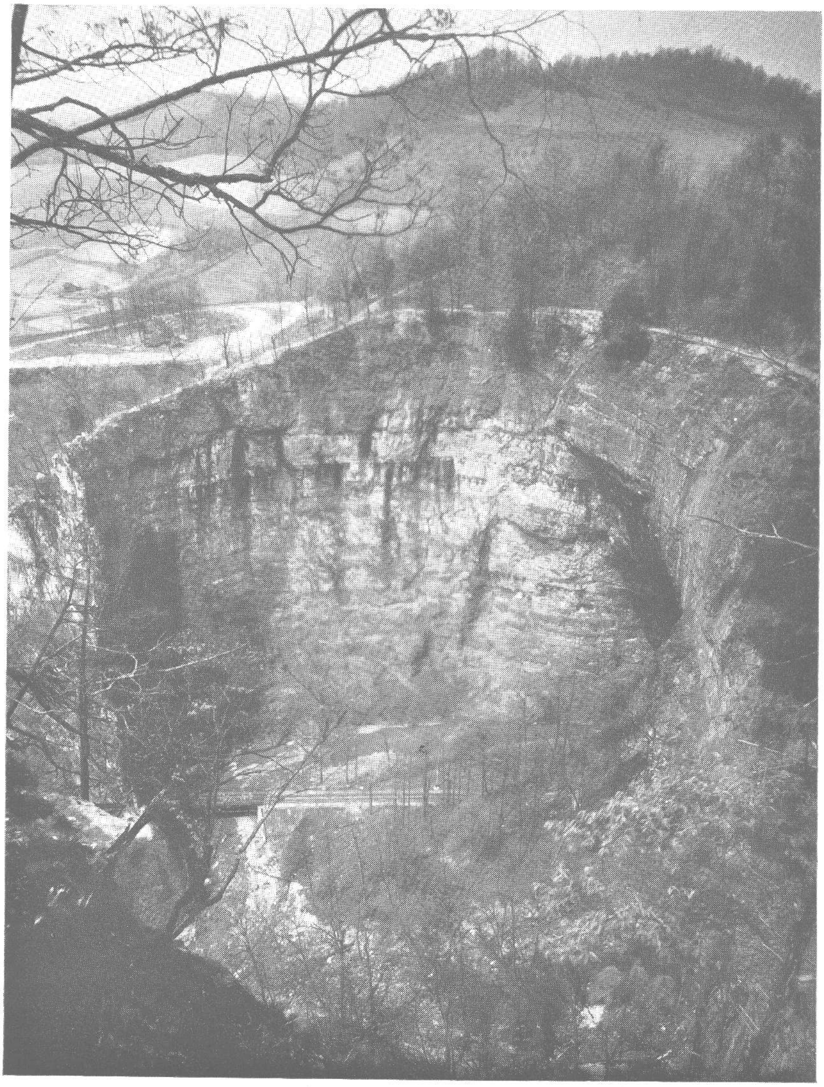
GEOLOGY

Northwest of Clinch Mountain in Scott County, dolomites (Fig. 16) occur in three principal belts. One extends along Purchase Ridge and northeastward along the north side of Rye Cove to Lano. The middle belt, broadening to the northeast, makes the hilly upland north of Copper Creek. This part of the county is relatively isolated and was not studied in any detail. The southern belt of dolomite crops out on the south flank of Moccasin Ridge southwestward as far as Speers Ferry Station, and farther westward makes Copper Ridge. This belt is fully exposed along the railroads and highways between Speers Ferry Station and the highway bridge across Clinch River. Excellent exposures of dolomite in the Purchase Ridge belt occur along the railroads and highways near Natural Tunnel (Pl. 19).

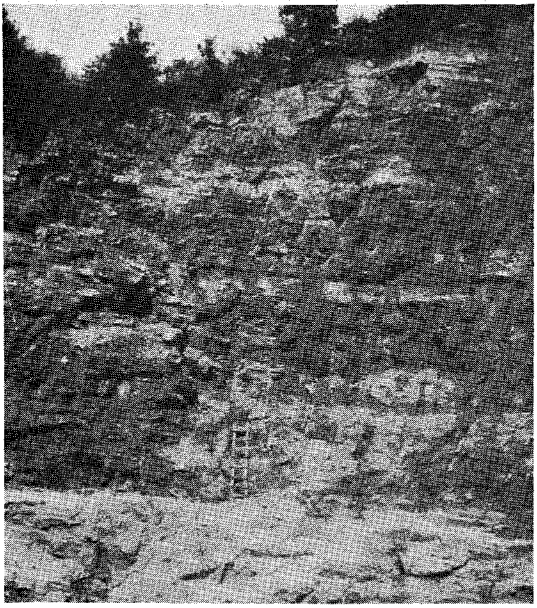
Cambrian limestone, including the Rutledge and Maryville, crop out in several belts which are fully exposed along U. S. Routes 23 and 58 south of Horton Summit and in the vicinity of Clinchport (Fig. 16). They are also prominently displayed along the northwest side of Copper Ridge. Northeast of Clinchport, the



Natural Tunnel in "Knox" dolomite, near Clinchport, Scott County, Virginia. Photograph by Jenkins Studio, Big Stone Gap.



Natural Tunnel in "Knox" dolomite, near Clinchport, Scott County, Virginia. Photograph by Jenkins Studio, Big Stone Gap.



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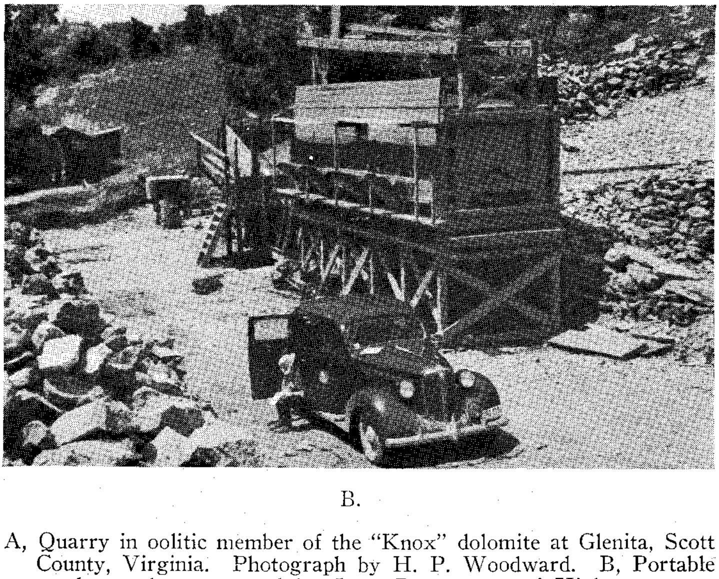
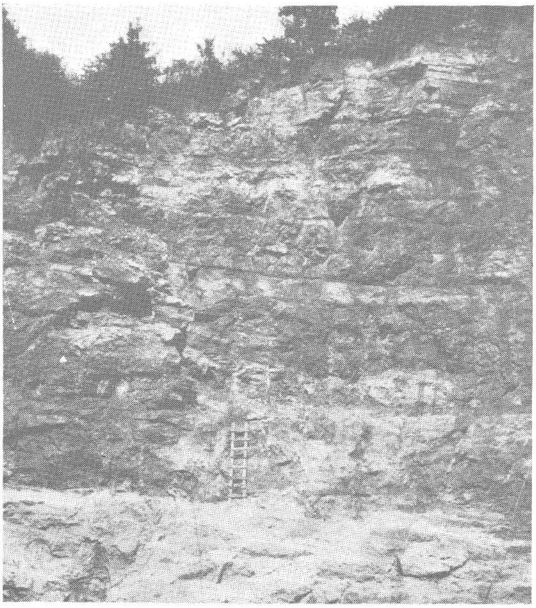


B.

A, Quarry in oolitic member of the "Knox" dolomite at Glenita, Scott County, Virginia. Photograph by H. P. Woodward. B, Portable crusher and screen used by State Department of Highways, near Snowflake, Scott County, Virginia. Photograph by R. C. Oburn.



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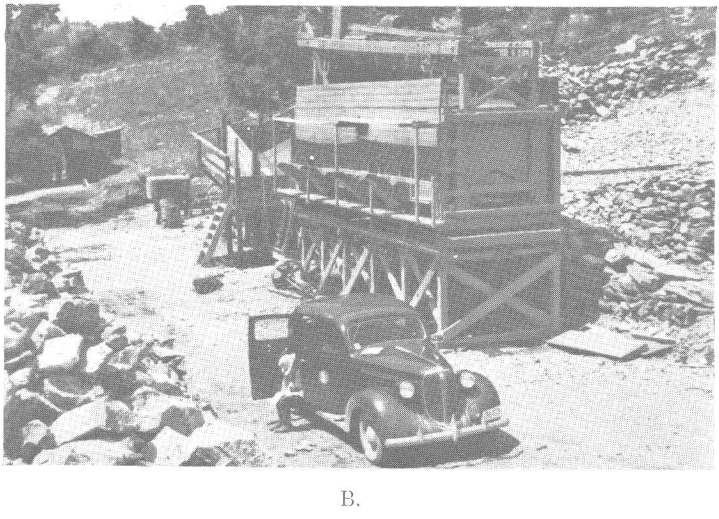


B.

A, Quarry in oolitic member of the "Knox" dolomite at Glenita, Scott County, Virginia. Photograph by H. P. Woodward. B, Portable crusher and screen used by State Department of Highways, near Snowflake, Scott County, Virginia. Photograph by R. C. Oburn.

Rutledge, capped by the Rogersville shale, makes a line of bluffs along the Clinchfield Railroad.

Ordovician limestone occurs in two belts, one along the base of Moccasin Ridge close to Copper Creek (Fig. 18), the other at the northwest base of Clinch Mountain (Fig. 17). The Copper Creek belt is well exposed along State Highway 71 southeast of Nickelsville. A number of excellent exposures of Ordovician limestone occur along the base of Clinch Mountain between Gate City and the Tennessee line to the southwest.

Mississippian limestones about 850 feet thick crop out in a discontinuous belt at the base of the Cumberland Front and form the line of cliffs visible from U. S. Route 23 between Duffield and Tito. The Mississippian limestones are also exposed just north of Horton Summit and near Dungannon.

The principal structures in Scott County are shown in the geologic cross sections on Plate 23. The Purchase Ridge syncline, the axis of which is near Natural Tunnel, is bordered on the north by the Hunter Valley fault and on the south by the Clinchport fault. Another thrust, the Copper Creek fault, occurs at the northwest foot of Moccasin Ridge. This break is offset near Clinchport by a cross fault. Movement along these overthrusts has dismembered most of the folds, so that most of the prevailing dips in the closely folded belt between Horton Summit and Clinch Mountain are to the southeast. The Clinchport fault is exposed at the north end of the trestle of the Clinchfield Railroad north of Copper Creek (locality 244), and the Hunter Valley or St. Paul fault, between the Rutledge limestone and Big Stone Gap shale, is well shown at locality 241, near Horton Summit.

DOLOMITE

"KNOX" DOLOMITE

In Scott County, the "Knox" dolomite is approximately 2,400 feet thick and is exceptionally well exposed in several belts along the railroads and U. S. highways 23 and 58 between Horton Summit and Moccasin Gap near Gate City (Fig. 16). The main belt of outcrop is along Copper Ridge. Between Speers Ferry Station and the highway bridge across Clinch River, nearly every bed of the "Knox" is exposed. The Purchase Ridge-Rye Cove belt is also well exposed along U. S. Routes 23 and 58 (Geologic Section 103) and in the gorge of Stock Creek. The precipitous walls and the

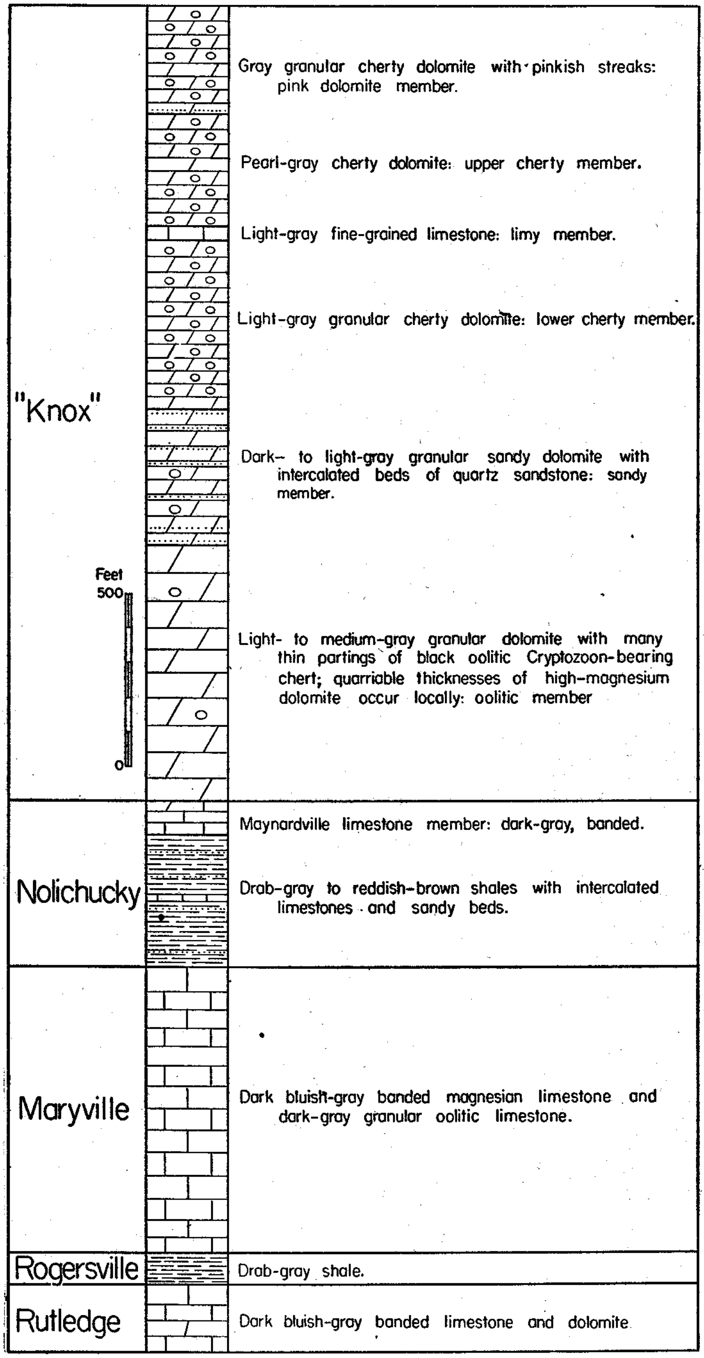


FIGURE 16.—Cambrian and Ordovician dolomite and related formations in Scott County, Virginia.

pinnacles of Natural Tunnel, one of the scenic wonders of the State, afford a spectacular display of the middle part of the "Knox" (Pl. 19). Parts of the formation are also exposed along the Clinchfield Railroad south of Clinchport (Geologic Section 100).

The *oolitic member,* comprising the lower 850 feet of the "Knox", is composed principally of dark-gray to medium-gray granular dolomites which are somewhat purer than any of the succeeding portions of the "Knox." The magnesium carbonate content is about 40 per cent and the only megascopic impurities are partings of oolitic chert. These thin layers, many of which contain *Cryptozoon,* are repeated with almost rhythmical frequency. Some of the dolomites are also oolitic, but the oolites are not easily detected with the naked eye, unless the rock is wet.

The *sandy member,* overlying the oolitic member, is about 350 feet thick and consists mainly of medium-gray cherty dolomite with many intercalated beds of quartz sandstone. Some of the dolomites contain disseminated particles of sand. The sandy member is almost fully exposed along U. S. Routes 23 and 58 north of the Southern Railway underpass and south of the highway bridge across Clinch River. In all probability this part of the "Knox" is too siliceous for any use.

Above the sandstone and sandy dolomite is a 375-foot succession of light-gray, rather fine-grained dolomite, the *lower cherty member.* Most of the chert occurs in small thin lenses in the lower part of this division. Generally the upper 200 to 300 feet contains very little chert, but even these beds contain considerable silica (Geologic Section 99). Most of the impurities are concentrated in thin wavy laminae which project on weathered surfaces. The Chepultepec fossils collected by Butts[8] at Natural Tunnel occur about the middle of this member.

The *limy member,* above the lower cherty member, varies in thickness from 25 to 100 feet, averaging somewhat less than 50 feet. The most conspicuous beds are very fine-grained compact limestones which weather light-gray, in contrast to the dark weathering granular dolomites above and below. In almost every exposure of the limy member, the limestone beds are closely associated with or grade into coarse-grained dolomites. Some of the limestone beds are mottled with intersecting stringers of coarse-grained dolomite. The limestone beds almost invariably contain an abundance of gastropods belonging to the genus *Lecanospira.* Probably much of the

Lecanospira-bearing, "cauliflower chert" is formed secondarily by replacement of the limestone.

The *upper cherty member,* 450 to 500 feet thick, is composed mainly of pearl-gray, rather fine-grained dolomite containing an abundance of chert, much of which occurs in beds 6 inches to 8 feet thick. Weathered surfaces of this member are characteristically furrowed (Pl. 21A). This member is very well exposed along the Southern Railway north of Speers Ferry Post Office. In the Copper Creek belt chert is so abundant as to make this rock unsuitable for any use.

The *pink dolomite member* at the top of the "Knox" is a very distinctive zone of fine- to medium-grained dolomite which is distinctly pinkish. Some layers are mottled, others rather evenly laminated with gray and pink. A few beds are very light-gray, exceedingly fine grained, and notably sandy. Chert is not very abundant in fresh exposures (Geologic Section 100), but where deeply weathered a spongy-textured chert is abundant in the mantle rock. Hollow oolites occur in some of the cherts and in flesh-colored magnesian limestone beds near the base of the pink member. Very probably the fossiliferous chert is derived from replacement of the limy beds. The pink member is notably siliceous, even in fresh exposures (Geologic Section 100). Variations in thickness of the pink member probably result from erosion and removal of some of the upper beds soon after their deposition. However, in Scott County the surface of unconformity probably has much less relief than that in Russell and Tazewell counties.

In summary, the "Knox" dolomite is notably siliceous and most of the formation contains more than 6 per cent of noncarbonates. The purest beds occur in the belts north of Clinchport, in the lower 450 feet of the formation (Geologic Section 101).

Geologic Section 99.—"Knox" dolomite at locality 247, along the Clinchfield Railroad, the Southern Railway, and U. S. Highways 23 and 58, south of Speers Ferry Bridge across Clinch River, Scott County, Virginia

	Thickness Feet
Tumbez limestone	
"Knox" dolomite (2,387.5 feet)	
Pink dolomite member (258 feet)	
186. Dolomite, medium-gray, granular; pinkish streaks	33

		Thickness Feet
185.	Dolomite, steel-gray, medium grained; contains 8-inch chert bed	33
184.	Dolomite, pearl-gray with reddish streaks	12
183.	Shale, red	5
182.	Dolomite, pearl-gray with pinkish streaks, fine grained; SiO_2, 4.72; R_2O_3, 0.96; $CaCO_3$, 55.60; $MgCO_3$, 39.00; Total, 100.28	175

Cherty dolomite member (354.5 feet)

181.	Dolomite, pearl-gray, brecciated	16
180.	Dolomite, bluish-gray, very cherty	9.5
179.	Chert, white	6.5
178.	Dolomite, pearl-gray, fine grained	47
177.	Dolomite, coarse grained; veins of barite ($BaSO_4$)	4.5
176.	Chert, white	8
175.	Dolomite, powder-blue with reddish streaks	28
174.	Dolomite, thoroughly fractured	10.5
173.	Chert bed, banded	8
172.	Dolomite, gray and buff speckled	5.5
171.	Dolomite, light bluish-gray	8
170.	Dolomite, pearl-gray to pinkish, very cherty	35
169.	Chert	1.5
168.	Dolomite, medium-gray, medium grained, very cherty	5.5
167.	Dolomite, thoroughly fractured, pearl-gray	17
166.	Dolomite, pearl-gray to pinkish, very sandy	7
165.	Dolomite, pearl-gray, fine grained	137

Limy member (23 feet)

164.	Limestone, dove-gray, fine grained, interbedded with dolomitic layers	12
163.	Dolomite-limestone conglomerate, light-gray, medium grained; matrix is sandy	11

Analysis of units 163 to 181, exclusive of chert beds; thickness sampled, 375± feet: SiO_2, 7.68; R_2O_3, 1.54; $CaCO_3$, 51.55; $MgCO_3$, 38.15; Total, 98.92.

	Thickness Feet
Lower cherty member (539 feet)	
162. Dolomite, very light-gray, fine grained	250
161. Dolomite, bluish-gray, fine grained	35
160. Dolomite, pearl-gray, fine grained with thin cherty streaks	25
159. Dolomite, light-gray, mottled with buff	6
158. Dolomite, very light-gray, thick bedded, fine grained	22
157. Dolomite, medium-gray, medium grained	27

Analysis of units 157 to 162; thickness sampled, 365 feet; SiO_2, 7.20; R_2O_3, 1.34; $CaCO_3$, 55.63; $MgCO_3$, 36.00; Total, 100.17.

156. Covered interval	86
155. Dolomite, steel-gray with thin lenses of chert	3
154. Dolomite, dove-gray, very fine grained, laminated	85
Sandy dolomite member (350.6 feet)	
153. Dolomite, dark-gray	8
152. Dolomite, very sandy	2.5
151. Dolomite, pearl-gray, sandy	8
150. Dolomite, light buff-gray	7.5
149. Dolomite, sandy, laminated	2
148. Dolomite, light-gray, fine grained; contains many vugs	4
147. Dolomite, gray, laminated, cherty	11
146. Dolomite, brownish-gray, medium grained	5.5
145. Dolomite, dark bluish-gray	4.5
144. Dolomite, bluish-gray, cherty	9.5
143. Dolomite, steel-gray	7.6
142. Chert	1±
141. Dolomite, buff-gray, sandy	2
140. Sandstone, rusty-brown	0.5
139. Dolomite, steel-gray, cherty	13.5
138. Dolomite, dark-gray; weathers mealy	2.6
137. Dolomite, sandy	0.6
136. Sandstone, rusty-brown	0.6
135. Dolomite, light-gray, fine grained	9.3
134. Dolomite, sandy; chert at the top	2.6

		Thickness Feet
133.	Dolomite	0.5
132.	Dolomite, bluish-gray, blocky, shaly	7.4
131.	Dolomite, bluish-gray, medium grained	5.4
130.	Dolomite, light-gray	15
129.	Sandstone	0.3
128.	Dolomite, light-gray, medium grained	6
127.	Dolomite, bluish-gray	8
126.	Dolomite, light-gray	21
125.	Dolomite, dark-gray, fine grained, brecciated	4.5
124.	Dolomite, steel-gray, fine grained	8
123.	Sandstone	0.4
122.	Dolomite, light-gray, medium grained	0.4
121.	Sandstone, rusty-brown	0.4
120.	Dolomite, smoky-gray	0.9
119.	Conglomerate; edgewise slivers in a sandy matrix	0.6
118.	Dolomite, bluish-gray, medium grained	8
117.	Dolomite, dark-gray; contains thin sandy streaks	1.4
116.	Dolomite, light bluish-gray	2
115.	Sandstone	2.5
114.	Dolomite, light-gray, fine grained	6
113.	Sandstone, coarse grained	3
112.	Dolomite, dark-gray, medium grained	1
111.	Dolomite, light-gray, coarse grained	1.5
110.	Dolomite, bluish-gray, fine grained	2
109.	Dolomite, buff-gray, very coarse grained	7.5
108.	Dolomite, very light-gray, fine grained	18.8
107.	Dolomite, light-gray, coarse grained	1.1
106.	Dolomite, light-gray, sandy	12
105.	Dolomite, light bluish-gray, shaly	3
104.	Sandstone and sandy dolomite	3.8
103.	Dolomite, pearl-gray, very fine grained	19
102.	Sandstone and sandy dolomite	2
101.	Dolomite, light-gray, fine grained	8
100.	Dolomite, medium-gray	7.5
99.	Dolomite, light-gray, fine grained	7.5
98.	Dolomite, brownish-gray	14.5
97.	Limestone, light-gray; contains sandy streaks	25.5

	Thickness Feet
96. Sandstone, cross bedded	1.1
95. Dolomite; contains sandy streaks	1.3
Oolitic member (862.9 feet)	
94. Chert	0.2
93. Dolomite, white	0.5
92. Dolomite, fine grained, light-gray	16
91. Dolomite, coarse grained	2.5
90. Dolomite, fine grained	2.5
89. Dolomite, coarse grained	4
88. Dolomite, fine grained	2.5
87. Dolomite, very light-gray, sparsely cherty	4
86. Dolomite, light-gray, thin bedded, laminated	11.4
Analysis of units 86 to 111, exclusive of sandstone and chert; thickness sampled, 180 feet: SiO_2, 8.16; R_2O_3, 1.26; $CaCO_3$, 50.14; $MgCO_3$, 39.52; Total, 99.08.	
85. Covered interval; a few beds exposed in creek west of road	175
84. Dolomite, light-gray, fine grained	2.5
83. Dolomite, medium grained, oolitic	1.5
82. Dolomite, light-gray, fine grained	14.5
81. Dolomite, bluish-gray, mottled	70
80. Dolomite, brownish-gray, dense	4
79. Dolomite, light-gray, irregularly laminated	7.5
78. Dolomite, brownish-gray	7.6
77. Dolomite, gray, cherty	2.6
76. Dolomite, dark bluish-gray	40
75. Chert and shale	0.3
74. Dolomite, light-gray	0.5
73. Chert	0.1
72. Dolomite, light bluish-gray	2.6
71. Dolomite, medium-gray, very cherty	2
70. Dolomite, light brownish-gray, blocky, fine grained	2.6
69. Chert	0.1
68. Dolomite, light brownish-gray, fine grained	5
67. Dolomite, bluish-gray	8

		Thickness Feet
66.	Dolomite, dark bluish-gray, sandy	1.4
65.	Dolomite, dark bluish-gray, oolitic	1.1
64.	Chert	0.5
63.	Dolomite, light-gray, shaly	14
62.	Dolomite, drab-gray, fine grained	2.4
61.	Dolomite, bluish-gray, cherty	7.5
60.	Dolomite, bluish-gray, finely laminated	3.3
59.	Dolomite, cherty	0.1
58.	Dolomite, light-gray; contains sandy streaks	0.5
57.	Dolomite, light bluish-gray, thin bedded	2.4
56.	Dolomite, light-gray, laminated, cherty	5.5
55.	Dolomite, medium-gray, fine grained; contains many vugs	5.5
54.	Chert, oolitic	0.5
53.	Dolomite, medium-gray, medium grained	2.4
52.	Chert, oolitic	0.1
51.	Dolomite, dark bluish-gray	0.5
50.	Dolomite, steel-gray, medium grained	8.5
49.	Dolomite, light-gray, medium grained; contains many vugs	9.3
48.	Dolomite, dark bluish-gray	14
47.	Dolomite, light brownish-gray	2.4
46.	Dolomite, medium-gray, fine grained	14.5
45.	Chert, black, oolitic	0.1
44.	Dolomite, medium-gray, fine grained	2
43.	Dolomite, bluish-gray	10.5
42.	Dolomite, light-gray, fine grained	7
41.	Dolomite, medium-gray, very compact	3.8
40.	Dolomite, bluish-gray, fine grained	12
39.	Dolomite, light-gray, fine grained	3.3
38.	Dolomite, medium grained	5.4
37.	Dolomite; contains stringers of chert	0.4
36.	Chert, oolitic	12
35.	Dolomite, light bluish-gray, cherty	24
34.	Chert, oolitic	0.1
33.	Dolomite, pearl-gray, fine grained	6
32.	Dolomite, bluish-gray, very cherty, blocky	16.5
31.	Dolomite, light-gray, fine grained	1
30.	Dolomite, brownish-gray, fine grained	1.8
29.	Chert, oolitic	1.0

	Thickness Feet
28. Dolomite, light-gray	1.0
27. Residual clay	0.6
26. Dolomite, bluish-gray, medium grained	5.4
25. Dolomite, light-gray	5
24. Dolomite, steel-gray, medium grained	4.5
23. Dolomite, medium grained, mottled	2.5
22. Dolomite, light-gray	4
21. Dolomite, coarse grained, medium-gray	2.4
20. Dolomite, light-gray, medium grained	6
19. Dolomite, dark bluish-gray	4
18. Dolomite, light-gray	11.5
17. Dolomite, brownish-gray	26
16. Limestone, light-gray, very fine grained	1.4
15. Dolomite, light-gray, fine grained	24
Analysis of units 15 to 63; thickness sampled, 298.6 feet: SiO_2, 4.4; R_2O_3, 1.34; $CaCO_3$, 52.17; $MgCO_3$, 41.32; Total, 99.23.	
14. Dolomite, cherty	1.4
13. Dolomite, bluish-gray, coarse grained	4.6
12. Chert, black, oolitic	0.1
11. Dolomite, light-gray	2
10. Dolomite, light bluish-gray, cherty, straticulate	2.4
9. Chert	0.2
8. Dolomite, banded	3.8
7. Dolomite, medium-gray, medium grained	32.4
6. Covered	100±
5. Dolomite, bluish-gray, cherty; contains a 6-inch *Cryptozoon* bed at base	11.5
4. Dolomite, dark bluish-gray, cherty, straticulate	7.6
3. Dolomite, light-gray; sandy streaks; straticulate	10.8
Nolichucky formation (35+ feet)	
Maynardville limestone member (35.3 feet)	
2. Limestone, magnesian; finely straticulate; contains large mud cracks which cause beds to weather into columns	20
1. Limestone, bluish-gray, dolomitic; contains discontinuous ribbon-bands and argillaceous nodules; units 1 to 5 measured one-fourth mile southwest of Speers Ferry Bridge	15.3

Geologic Section 100.—"Knox" dolomite between localities 245 and 246, along the Clinchfield Railroad 1 mile south of Clinchport, Scott County, Virginia

	Thickness Feet
Blackford formation	
"Knox" dolomite (upper part only; 872 feet)	
16. Covered interval; mainly light-gray to pinkish dolomite	250
15. Dolomite, light-gray, fine grained; contains several beds of chert 6 to 12 inches thick	70
14. Sandstone, dolomitic	4
13. Dolomite, light-gray, fine grained	65
12. Dolomite, pearl-gray with pinkish streaks, very fine grained	46
11. Dolomite, very pinkish, dense, medium grained	76
10. Dolomite, pearl-gray, streaked with pink, very sparsely cherty	60
9. Dolomite, pearl-gray to pinkish, medium grained; contains several thin beds of pink chert	23
8. Dolomite, gray, fine grained	48
7. Dolomite, light-gray, fine grained	11
6. Dolomite, coarse grained, saccharoidal	19
5. Dolomite, salt- and pepper-colored, coarse grained	96
Analysis of units 5 to 13; thickness sampled, 444 feet: SiO_2, 8.00; R_2O_3, 1.50; $CaCO_3$, 56.29; $MgCO_3$, 34.80; Total, 100.59.	
4. Chert, light-gray, banded	5
3. Dolomite, pearl-gray, medium grained, dense, cherty	26
2. Dolomite, pinkish, medium grained	38
1. Dolomite, medium grained, shaly	38
(Beds not exposed north of railway cut)	

QUARRIES

In 1942 and 1943, J. A. Holmes, of Big Stone Gap, operated the stone quarry in the "Knox" dolomite at Glenita (Pl. 20A). When last visited in the spring of 1944, operations had been suspended temporarily because of the war-time labor shortage. The quarry is at the south portal of the gorge of Stock Creek, about 0.5 mile from the southern entrance to Natural Tunnel. The quarry face, about 100 feet high, shows rather prominent banding, which is produced by alternations of light- and dark-gray zones. The darker beds are 8 to 15 feet thick; the lighter colored layers 1.5 to 5 feet thick. Thin oolitic chert layers occur at several horizons. Oolitic dolomite occurs a few feet above the quarry floor. The beds in the quarry are about 400 feet above the base of the "Knox". A system of solution joints is prominently developed on the quarry floor, and there is some evidence that the rock is cavernous below surface level. The beds are nearly flat, being located near the axis of the Purchase Ridge syncline. Topographic conditions are ideal for extensive quarrying in this locality, but the nearness to Natural Tunnel would probably make any great expansion of the present quarry undesirable.

The stone quarried at Glenita was used chiefly in highway construction, but some of it was ground for agstone. An analysis of the beds in the quarry is given in Table 5.

QUARRY SITES

The three principal belts of the "Knox" adjacent to railroads and U. S. Highways 23 and 58 afford many excellent sites for large-scale quarrying. However, all except the lower few hundred feet of the formation is too siliceous for chemical uses. The most favorable site for large-scale quarrying of high-magnesium dolomite, suitable for both chemical and constructional uses, is in the vicinity of locality 259 (Geologic Section 101). There, a 300-foot zone averages less than 4 per cent noncarbonates and occurs in practically inexhaustible quantities.

Geologic Section 101.—Lower part of the "Knox" dolomite at locality 259, along U. S. Routes 23 and 58, near Natural Tunnel, Scott County, Virginia

	Thickness Feet
"Knox" dolomite (upper part not measured)	
7. Dolomite, brownish-gray, coarse grained	63
6. Dolomite, taupe-gray, medium to coarse grained	112
5. Dolomite, light-gray and dark-gray, interbedded, medium to fine grained; some beds thoroughly	

	Thickness Feet
fractured and weathered to a rubble of small angular blocks	118
Analysis of units 5 to 7; thickness sampled, 293 feet: SiO_2, 1.78; R_2O_3, 1.62; $CaCO_3$, 54.39; $MgCO_3$, 42.04; Na_2O, 0.01; K_2O, 0.24; Total, 100.08.	
4. Dolomite, gray, rather fine grained; straticulate at the base	45
3. Dolomite, dark-gray, fine grained, thin bedded	31
2. Dolomite, light-gray to brownish-gray, fine grained; shaly towards the base	141
Analysis of units 2 to 4; thickness sampled, 217 feet: SiO_2, 8.52; R_2O_3, 1.64; $CaCO_3$, 50.13; $MgCO_3$, 39.41; Total, 99.70.	
1. Limestone and dolomite, thin bedded	20

Nolichucky shale

LIMESTONE

MARYVILLE AND RUTLEDGE LIMESTONES

In Scott County, the 1,000-foot interval between the Rome and Nolichucky shales is composed almost entirely of dark bluish-gray limestone comprising the Rutledge and Maryville limestones (Fig. 16). A prominent zone of shale about 200 feet above the base of the limestone succession apparently represents the Rogersville shale of Tennessee. The Rutledge limestone below it is a dark bluish-gray, banded rock, some beds of which are generally dolomitic and weather dark rusty-brown. Most of the Rutledge is distinctly argillaceous and weathers into thin plates. The Rutledge limestone forms a long line of bluffs along the Clinchfield Railroad northeast of Clinchport and is well exposed along U. S. Routes 23 and 58 just south of the St. Paul fault, along which the Rutledge has been thrust over Mississippian formations.[12]

The Maryville limestone, above the Rogersville shale, is composed mainly of argillaceous, magnesian, and banded limestones but many beds are thick, granular, and oolitic. The banded beds are well exposed along all of the roads crossing Copper Ridge, particularly along

State Highway 72 south of Dungannon and along U. S. Routes 23 and 58 at localities 249, 252, 260, and 261. Generally the purest beds in the Maryville occur in a 50- to 120-foot zone at the top of the formation.

Two of the best exposures of the Rutledge-Maryville succession are at locality 250, southwest of Clinchport and along U. S. Routes 23 and 58 south of Horton Summit.

Geologic Section 102.—Cambrian limestone at locality 250, about 3 miles southwest of the Speers Ferry Bridge across Clinch River, Scott County, Virginia

	Thickness Feet
Nolichucky formation	
Maryville limestone (724 feet)	
22. Limestone, dark bluish-gray; clastic texture; slightly oolitic	60
21. Limestone, dark bluish-gray, fine grained, argillaceous, ribbon banded	123
20. Limestone, black, dolomitic, medium grained; weathers rusty-brown	53
19. Limestone, medium grained; relatively few argillaceous bands	37
18. Limestone, dark bluish-gray, ribbon banded	19.5
17. Limestone, medium grained, thick bedded	18.5
16. Limestone, dark bluish-gray, ribbon banded; weathers buff and light-gray	25
15. Limestone, dark bluish-gray, medium grained	7
14. Limestone, dark bluish-gray, ribbon-banded	7.5
13. Limestone, dark bluish-gray, medium grained, not banded	5.3
12. Limestone, dark bluish-gray, ribbon banded, argillaceous	12.5
11. Limestone, dark bluish-gray, oolitic, thick bedded	5
10. Limestone, dark bluish-gray, argillaceous, ribbon-banded	95

Analysis of units 10 to 21; thickness sampled, 407 feet: SiO_2, 1.56; R_2O_3, 0.62; $CaCO_3$, 84.75; $MgCO_3$, 12.60; Total, 99.53.

	Thickness Feet
9. Limestone, dark bluish-gray, oolitic	15
8. Limestone, dark bluish-gray, ribbon banded, argillaceous	120
7. Limestone, dark bluish-gray, fine grained; contains disseminated oolites	4.2
6. Limestone, dark bluish-gray, granular, oolitic; contains wavy discontinuous argillaceous partings	25
5. Limestone, dark bluish-gray, ribbon banded; contains argillaceous partings	92
Analysis of units 5 to 9; thickness sampled, 256.2± feet: SiO_2, 2.08; R_2O_3, 0.42; $CaCO_3$, 92.26; $MgCO_3$, 4.86; Total, 99.62.	
Rogersville shale	
4. Shale, bluish-gray; weathers drab-gray; some beds glauconitic; contains *Ehmaniella* fauna	70
Rutledge limestone (200 feet)	
3. Limestone, dark bluish-gray; discontinuous partings; weathers striped	62.5
2. Limestone, very dolomitic; weathers rusty-brown	82
1. Limestone, bluish-gray, granular, dense	55
Rome formation	

Geologic Section 103.—Cambrian limestone between localities 260 and 261, along U. S. Routes 23 and 58, near Horton Summit, Scott County, Virginia

	Thickness Feet
Nolichucky formation	
Maryville limestone (1371 feet)	
10. Limestone, dark bluish-gray, oolitic	9
9. Limestone, dark bluish-gray, ribbon banded; some beds weather shaly	143
8. Limestone, dark bluish-gray, oolitic	38
7. Limestone, dark bluish-gray, argillaceous, ribbon banded	288
6. Limestone, dark bluish-gray, oolitic; contains intercalated beds of edgewise conglomerate	55

	Thickness Feet
5. Limestone, dark bluish-gray, ribbon banded, argillaceous	600
4. Covered interval; shale or shaly limestone	88
3. Limestone, dark bluish-gray, ribbon banded	150
Analysis of units 3 to 10; thickness sampled, 1,371 feet: SiO_2, 5.06; R_2O_3, 1.44; $CaCO_3$, 85.79; $MgCO_3$, 7.09; Total, 99.38.	
Rogersville shale (?)	
2. Shale, bluish-gray to olive-drab; no fossils seen	35
Rutledge limestone	
1. Dolomite, and limestone, dark bluish-gray, interbedded, ribbon banded	50–60
Mississippian black shale (below Hunter Valley fault)	

TUMBEZ LIMESTONE

The Tumbez limestone occurs only in the Clinch Mountain belt (Fig. 17), being represented in the other belts by the Blackford formation. In Scott County, the character of the Tumbez is much the same as it is in western Russell County. The dovetailing relations of the coarse-grained Tumbez limestones with the argillaceous Blackford beds are well shown at locality 200 along Road 613, near the Russell-Scott County line (Geologic Section 128). Northeast of Gate City, all or nearly all of the formation is too cherty for chemical uses but farther southwest, particularly at Marcem (Geologic Section 126) a 30- to 60-foot zone of high-calcium limestone occurs in the upper part of the formation. This limestone is generally crowded with *Solenopora,* and is the "lower marble" quarried at Marcem (Pl. 22B). It is prominent at locality 221, near Lane School and in Robinette Valley southwest of Speers Ferry (Geologic Sections 139 and 140). Locally half a mile northwest of Melvin, the Tumbez contains a prominent zone of ferruginous sandstone and chert conglomerate.

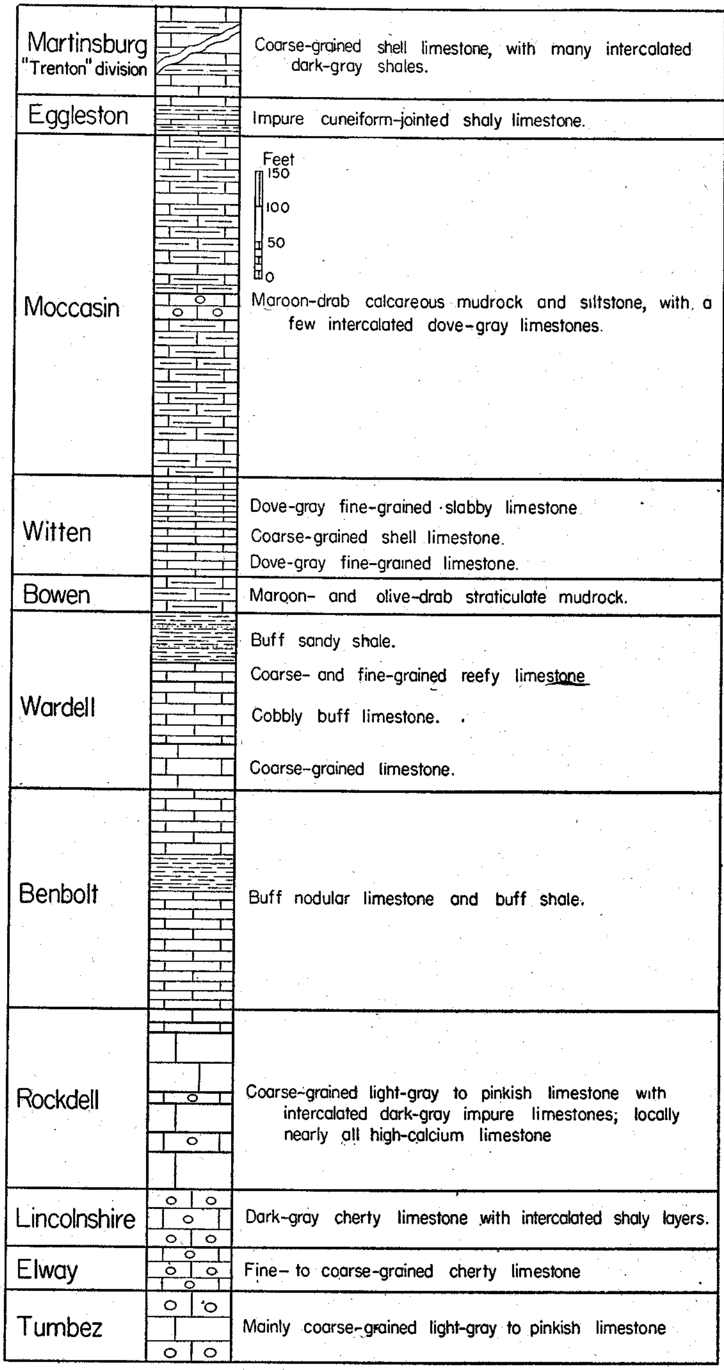


FIGURE 17.—Middle Ordovician limestones along Clinch Mountain in Scott County, Virginia.

Geologic Section 104.—Tumbez formation 0.5 mile northwest of Melvin, Scott County, Virginia

	Thickness Feet
Elway limestone	
Tumbez formation (28 feet)	
4. Limestone, light-gray, coarse grained, cherty	40
3. Shale, ash-gray; thickens and thins locally	20
2. Sandstone, reddish-brown, coarse grained, ferruginous	23
1. Chert conglomerate and chert breccia; ferruginous	5
"Knox" dolomite	

In most places the full thickness of the Tumbez is not exposed. Probably nowhere is the formation less than 50 feet thick and locally it may be more than 200 feet thick. The upper boundary of the Tumbez west of Gate City is not distinct, and in all probability the upper part of the *Solenopora*-bearing "marble" is a facies of the overlying Elway.

ELWAY LIMESTONE

In the Rye Cove and in the Copper Creek belts, the Elway is a very fine-grained dove-gray to dark bluish-gray limestone 35 to 75 feet thick and characterized by fossiliferous chert which weathers into rectangular blocks. In most places the limestone is concealed beneath a thick cherty mantle. Exposures near locality 234, along State Highway 71 southwest of Nickelsville, are typical (Geologic Section 142). The best exposure of the fresh rock occurs in a roadside quarry at locality 255 about 3.5 miles northeast of Clinchport.

Geologic Section 105.—Elway limestone at locality 255, along Road 648, about 3.5 miles northeast of Clinchport, Scott County, Virginia

	Thickness Feet
Lincolnshire limestone	
5. Limestone, brownish-gray, medium grained, cherty	20+
Five Oaks limestone	
4. Limestone, light-gray, fine grained	12

	Thickness Feet
Elway limestone (32.5 feet)	
3. Limestone, medium-gray, granular, very cherty	27
2. Limestone, dove-gray, fine grained; weathers with white chalky rust	5.5
Blackford formation	
1. Shale and shaly limestone, ash-gray; weathers crumbly; base not exposed	11±

In the Clinch Mountain belt the Elway is much the same in character as far southwest as locality 210, near New Bethel Church. Farther southwestward the typical Elway is largely supplanted by light-gray, coarse-grained limestones indistinguishable from those in the underlying Tumbez. The upper part of the *Solenopora*-bearing limestone below the Lincolnshire in the quarry of the Pennsylvania-Dixie Cement Corporation at Marcem (Geologic Section 126) probably is of Elway age. The Elway age of a similar limestone along the Southern Railroad at Speers Ferry Station is indicated by *Dinorthis holdeni,* which occurs in intercalated cherty beds. The average thickness of the Elway is about 50 feet, but precise measurements can be made in relatively few localities.

FIVE OAKS LIMESTONE

In the Copper Creek belt and also in Rye Cove, the fine-grained cherty limestones of the Elway are succeeded by a few feet of dove-gray fine-grained limestone containing very little chert, which resembles the Five Oaks limestone of Russell County, Virginia. The character and thickness of the Five Oaks are given in Geologic Sections 141 to 145.

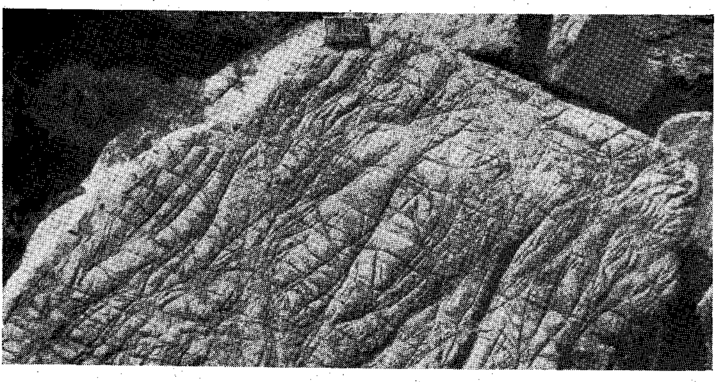
LINCOLNSHIRE LIMESTONE

The Lincolnshire limestone throughout most of Scott County is a dark bluish-gray cherty limestone. Locally, near Nickelsville, the greater part of the formation is coarse-grained limestone and the typically cherty beds are much reduced in thickness (Geologic Section 145). In Rye Cove (Geologic Section 145) the Lincolnshire is a medium- to coarse-grained limestone which weathers crumbly. Between Clinchport and Dorton Fort the Lincolnshire varies in thickness from

10 to 165 feet. In the Clinch Mountain belt northeast of Gate City the average thickness is 35 to 40 feet, but southwest of Marcem the formation is locally more than 100 feet thick. The two best exposures are at locality 210, near New Bethel Church, and in the quarry at Marcem where the Lincolnshire separates the lower and upper zones of high-calcium limestone (Pl. 22 and Geologic Section 216). Throughout the Clinch Mountain belt the Lincolnshire is an important "key" bed and is directly succeeded by the principal formation of high-calcium limestone.

ROCKDELL LIMESTONE

In Rye Cove, the Rockdell is represented by less than 100 feet of medium- to coarse-grained impure crumbly limestone, which is rather extensively exposed about 0.25 mile northwest of Rye Cove School. In the Copper Creek belt northeast of Clinchport, the Rockdell is 150 to 275 feet thick and consists of zones of coarse-grained, light-gray to pinkish limestone varying markedly in thickness within relatively short distances and separated by beds of dark bluish-gray impure limestone 10 to 40 feet thick. The best exposures are at localities 234, 238, and 242 (Geologic Sections 142 to 144, respectively). Along Clinch Mountain, the Rockdell is mainly a light-gray, coarse-grained, high-calcium limestone. Intercalated beds and thin zones of dark bluish-gray limestone are much thinner and of more local occurrence than they are in the Copper Creek belt. The lenticular character of the dark-colored beds is well shown at Marcem. Along the western rim of the quarry of the Pennsylvania-Dixie Cement Corporation (Pl. 22) the 160-foot interval between the Lincolnshire and Benbolt contains two conspicuous zones of dark-gray limestone; the lower one about 35 feet thick and near the base, the upper impure bed about 9 feet thick and 25 feet below the top. At the eastern end of the quarry, the Lincolnshire is succeeded by at least 250 feet of gray and pinkish, coarse-grained limestone apparently without any trace of intercalated dark limestone. Similar thicknesses of coarse-grained limestone occur also at other localities between Marcem and Speers Ferry (Geologic Sections 135 and 136). The Rockdell is also well exposed in the old quarry near Speers Ferry Post Office (Geologic Section 127), along Road 613 between Mt. Hagan School and Antioch Church (Geologic Sections 129 to 132), and in the east environs of Gate City (Geologic Section 133). Between the Russell-Scott County line and Speers Ferry Post Office the purer beds of the Rockdell are the prominent ledgemakers along Road 613 and U. S. Routes 23 and 58.



A.

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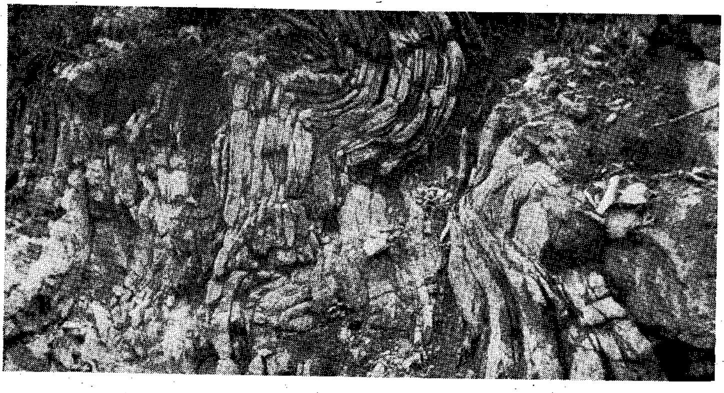
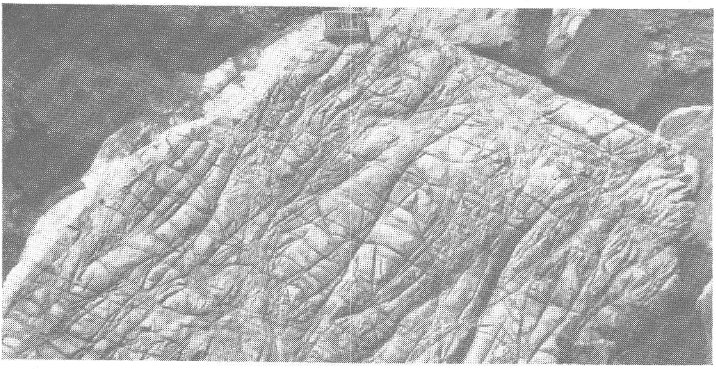


C.

A, Furrowed surface of weathered "Knox" dolomite, near Cedar Point School, Scott County, Virginia. Photograph by R. C. Oburn. B, Mudcracks in the Bowen formation along U. S. Routes 23-58, near Speers Ferry Post Office, Scott County, Virginia. C, Folds in the Witten limestone near Wayland, Scott County, Virginia.



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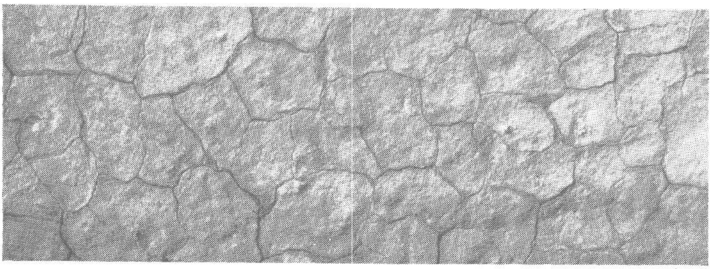

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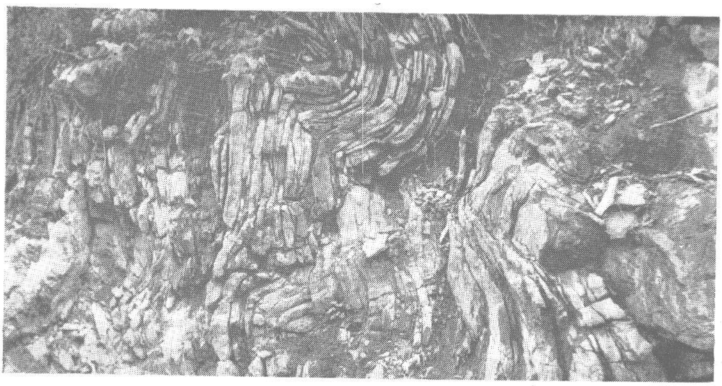
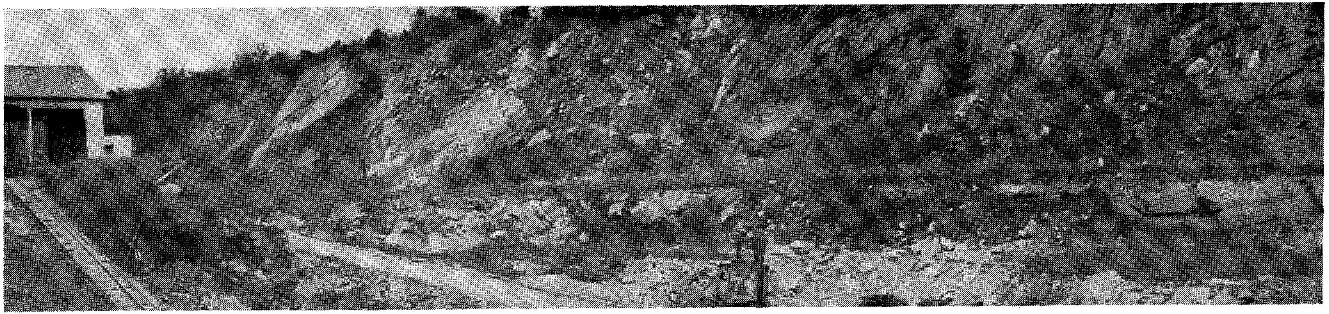


C.

A, Furrowed surface of weathered "Knox" dolomite, near Cedar Point School, Scott County, Virginia. Photograph by R. C. Oburn. B, Mudcracks in the Bowen formation along U. S. Routes 23-58, near Speers Ferry Post Office, Scott County, Virginia. C, Folds in the Witten limestone near Wayland, Scott County, Virginia.



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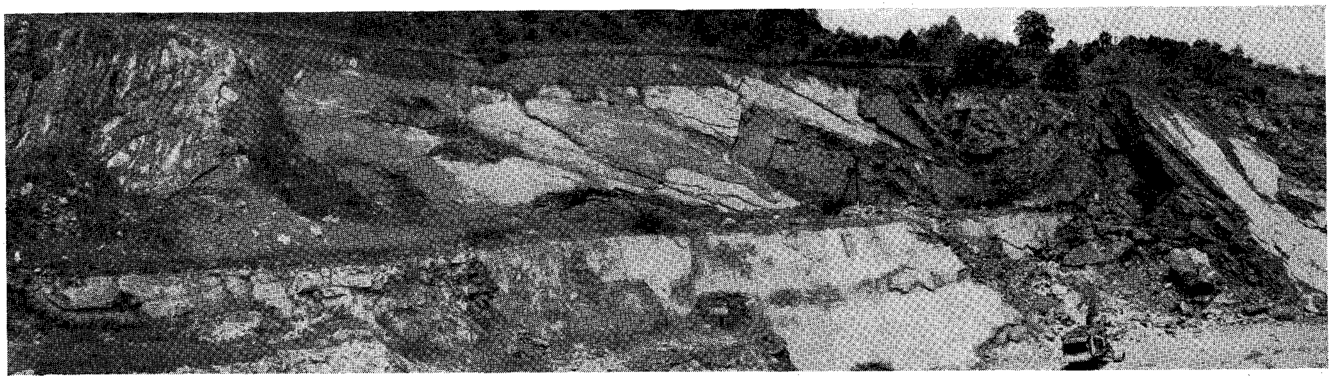
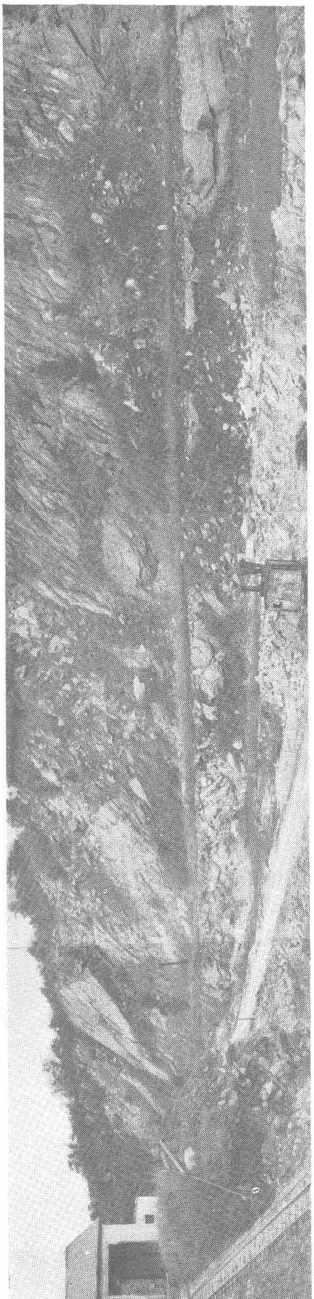


B.

A, West wall of quarry of the Pennsylvania-Dixie Cement Corporation, Marcem, Scott County, Virginia. B, Central part of same quarry showing footwall of Tumbez limestone and projecting ledges of Lincolnshire limestone. Photographs by R. C. Oburn.



A.

B.

A, West wall of quarry of the Pennsylvania-Dixie Cement Corporation, Marcem, Scott County, Virginia. B, Central part of same quarry showing footwall of Tumbez limestone and projecting ledges of Lincolnshire limestone. Photographs by R. C. Oburn.

BENBOLT FORMATION

The Benbolt in Scott County is a nodular argillaceous limestone and buff shale. In the Clinch Mountain belt the thickness is 300 to 400 feet and there are no intercalated zones of coarse-grained relatively pure limestone such as occur in the formation in Russell and Tazewell counties. Most of the beds weather readily and form broad bare glady slopes. The best exposures are between Mt. Hagan School and locality 210 east of Snowflake. The Benbolt is also well exposed near locality 326 and westward to Speers Ferry Station and at locality 231 south of Palmer School in Robinette Valley.

Geologic Section 106.—Benbolt limestone 0.3 mile east of Cedar Point School, at locality 201, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt formation (287 feet)	
7. Limestone, dark-gray, fine grained, cherty; contains large *Receptaculites*	8
6. Limestone, buff, fine grained, cobbly; contains abundant *Sowerbyella*	32
5. Limestone, medium-gray, crumbly, argillaceous	38
4. Limestone, medium to coarse grained, argillaceous; full of fragmented fossils; makes conspicuous ledge	24
3. Limestone, buff, nodular, fossiliferous; weathers buff	17
2. Limestone, buff, argillaceous, nodular; intercalated buff calcareous shale	82
1. Limestone, buff, nodular, shaly, medium to coarse grained; contains many well preserved fossils, including *Echinosphaerites aurantium, Platycystites faberi, Campylorthis* sp., *Mimella melonica, Oxoplecia* cf. *O. simulatrix, Paleostrophomena* sp., *Orthambonites* sp., *Leptellina* sp., and *Cyrtonotella* sp.	75
Rockdell limestone	

Geologic Section 107.—Benbolt limestone near locality 226, about 2 miles east of Speers Ferry Post Office, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (386 feet)	
8. Limestone, dark bluish-gray; weathers cobbly; sparsely cherty	5–10
7. Shale and shaly limestone; *Tetradium* sp.	35
6. Limestone, medium grained, very argillaceous, nodular; weathers buff; contains *Dinorthis transversa* and *Mimella superba*	59
5. Shale, weathers buff; a few intercalated nodular argillaceous limestones	172
4. Shale, buff, interbedded with nodular fossiliferous limestone which contains *Campylorthis, Öpikina, Dinorthis transversa,* and *Platycystites faberi*	92
3. Limestone, thin bedded, coarse grained, composed largely of fragmented cystoids	2
2. Shale with lenses of coarse-grained limestone	3.3
1. Limestone, argillaceous, granular; contains *Echinosphaerites aurantium, Scenellopora radiata, Palaeocrinus striatus, Camerella* sp., and *Sowerbyella*	18
Rockdell limestone	

Geologic Section 108.—Benbolt limestone at locality 331, south of Palmer School, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (313 feet)	
4. Limestone, buff-gray, shaly; weathers cobbly; contains many bryozoans and brachiopods, particularly *Öpikina, Mimella,* and *Campylorthis*	97
3. Shale, mealy; weathers buff-gray	61
2. Limestone, bluish-gray, cobbly; some intercalated shaly nodular limestones in the upper part; con-	

	Thickness Feet
tains *Echinosphaerites, Dinorthis transversa,* and many *Sowerbyella*	91
1. Limestone, nodular, argillaceous; weathers buff-gray	64

Rockdell limestone

Southwest of Nickelsville along State Highway 71, near Dorton Fort, the nodular Benbolt is well exposed and abundantly fossiliferous. There and elsewhere in the Copper Creek belt (Geologic Sections 109 and 110) the thickness is about 150 feet.

Geologic Section 108a.—Benbolt formation along State Highway 71, near Dorton Fort, locality 235, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone	
3. Limestone, bluish-gray, sparsely cherty	
2. Shale, calcareous; weathers buff	
1. Limestone, buff, argillaceous, nodular; contains *Campylorthis, Ischadites, Sowerbyella, Mimella superba, Dinorthis transversa, Platycystites faberi,* and *Echinosphaerites*	
Rockdell limestone	

Geologic Section 109.—Benbolt limestone between localities 238 and 239, about 4 miles northwest of Gate City, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt limestone (143 feet)	
5. Shale and nodular limestone	70
4. Limestone, medium to coarse grained, very argillaceous, shaly; contains *Sowerbyella* and *Ancistrorhyncha costata*	20
3. Limestone, dark bluish-gray, cherty	2–3

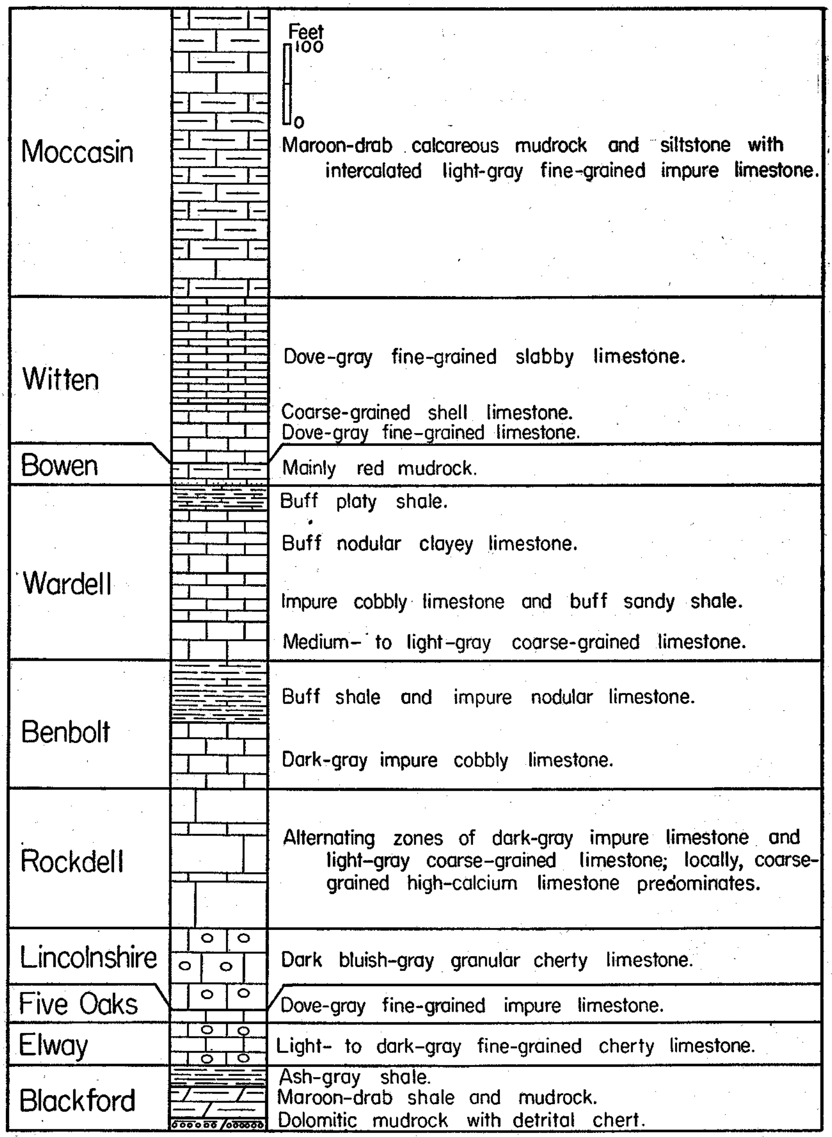


FIGURE 18.—Middle Ordovician limestones in the Copper Creek belt in Scott County, Virginia.

	Thickness Feet
2. Limestone, very argillaceous, shaly; contains *Receptaculites, Ischadites,* and *Dinorthis transversa*	33
1. Limestone, medium grained, argillaceous; contains many fragmented fossils; probably *Echinosphaerites* beds	17

Rockdell limestone

Geologic Section 110.—Benbolt formation between localities 241 and 242, about 2 miles northeast of Speers Ferry Bridge across Clinch River, Scott County, Virginia

	Thickness Feet
Wardell formation	
Benbolt formation (136 feet)	
6. Limestone, gray, granular; weathers cobbly	45
5. Shale, buff	29
4. Limestone, very light-gray, coarse grained	8
3. Limestone, buff, nodular and shaly; contains *Dinorthis transversa* and *Mimella superba*	13
2. Limestone, light-gray to pinkish	13
1. Limestone, nodular, shaly	28

Rockdell limestone

In Rye Cove, nearly all of the Benbolt is nodular, buff-weathering limestone but the total thickness is somewhat less than 100 feet. Because of the prevailingly low dips in that area, the Benbolt, although only about 100 feet thick, crops out in exceptionally wide belts.

In all three belts of outcrop, the lower 20 to 40 feet of the formation is generally somewhat less argillaceous than the overlying beds and makes prominent ledges.

WARDELL FORMATION

Like the Benbolt, much of the Wardell is mainly a buff-weathering nodular limestone and shale and in most localities the two formations can be distinguished only by their characteristic fossils.

In Rye Cove the lower half of the Wardell is a nodular limestone with one or two gray cobbly weathering ledgemakers. The upper part, 50 to 60 feet thick is dove-gray, fine grained, and laminated. A prominent *Stromatocerium* bed occurs about the middle of this zone.

In the Copper Creek belt the Wardell is 75 to 150 feet thick and generally contains several zones of coarse-grained crinoidal limestone. It is unlikely that any of these coarse beds are sufficiently pure for chemical uses. The Wardell is faulted out southwest of locality 243 near Clinchport.

Geologic Section 111.—Wardell formation between localities 238 and 239, 4 miles northwest of Gate City, Scott County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (208 feet)	
8. Shale, buff, platy	35
7. Limestone, dove-gray, fine grained; contains *Öpikina septata*	7.5
6. Limestone, fine grained; intercalated coarse-grained fossiliferous limestones containing *Rostricellula* and *Sowerbyella*	25
5. Limestone, coarse grained; thin partings of buff shale	20
4. Limestone, light-gray, coarse grained, crinoidal	2.5
3. Limestone, bluish-gray with intercalated zones of buff-weathering sandy shale	58
2. Limestone, nodular, argillaceous; contains one 3-foot coarse-grained limestone bed with *Ancistrorhyncha costata*, *Sowerbyella*, and *Hesperorthis*	15
1. Limestone, medium to coarse grained, wavy bedded; contains corals and *Girvanella*	45
Benbolt formation	

The Wardell is 150 to 250 feet thick in the Clinch Mountain belt and consists mostly of nodular buff-weathering limestone. The top is generally made by a zone of buff-weathering sandy shale. Near the base are a few coarse-grained crinoidal layers which generally make conspicuous ledges. The most striking feature of the Wardell are the reefy limestones which are particularly well displayed at locality 209 southeast of Snowflake.

Geologic Section 112.—Ordovician limestone at locality 209, about 1 mile southeast of Snowflake, Scott County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (245 feet)	
13. Shale, platy, buff-weathering; contains intercalated sandy layers	40
12. Limestone, buff-gray, nodular; very poorly exposed	30–50
11. Limestone, coarse grained; clastic texture; argillaceous; contains great abundance of *Favistella "halli"*, *Lichenaria*, *Receptaculites biconstrictus*, *Solenopora compacta*, *Girvanella* sp., and *Stromatocerium rugosum;* the most prolific occurrence of corals known in Clinch Valley	10–12
10. Limestone, light-gray to pinkish, fine grained; contains many *Stromatocerium*, *Solenopora*, and *Dystactospongia*, and a few *Tetradium cellulosum;* texture irregular; reefy structure	13
9. Limestone, massive and almost devoid of bedding; contains lenses and pockets of coarse-grained pinkish limestone, but main body is rather fine grained; contains *Stromatocerium* and *Dystactospongia*, very abundant	20
8. Limestone, very fine grained with streaks and pockets of coarse-grained pinkish limestone; reefy structure; contains *Tetradium cellulosum* and *T. fibratum*	16
7. Limestone, pink and gray, very fine grained; thin greenish siliceous partings	3.5
6. Limestone, mottled gray and pinkish, coarse grained	3
5. Limestone, pink and gray, very fine grained; contains *Solenopora* and *Girvanella*	5

Analysis of units 5 to 10; thickness sampled, 60± feet: SiO_2, 3.16; R_2O_3, 2.22; $CaCO_3$, 91.86; $MgCO_3$, 1.83; Total, 99.07.

	Thickness Feet
4. Limestone, coarse grained, very fossiliferous, argillaceous	21
3. Limestone, crumbly; irregular texture; contains abundant *Girvanella*	9
2. Limestone, light-gray to pinkish, coarse grained; lower half contains intercalated 5-foot bed of dove-gray, fine-grained limestone	24
1. Covered interval to approximate base of Wardell	28

Benbolt limestone

The bioherm in the upper part of the Wardell, which has been quarried for road stone (Pl. 14C), is a locally thickened body of high-carbonate limestone. Some of the reef rock is very similar to the "cedar-red marbles" of Tennessee. Similar reefy beds are also exposed at localities 216 and 218 between Marcem and Speers Ferry.

Geologic Section 113.—Wardell formation at locality 227, about 2 miles east of Speers Ferry Post Office, Scott County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (162 feet)	
9. Shale, buff, platy; contains thin intercalated sandstones	13
8. Limestone, coarse grained, crinoidal, thin bedded; contains *Girvanella, Stromatocerium,* and *Favistella*	7
7. Limestone, bluish-gray, medium grained, thin bedded	6.5
6. Limestone, medium to coarse grained, thin bedded; sandy streaks; cherty layer at the top	12
5. Shale, buff, platy	55
4. Limestone, medium grained, very shaly; weathers buff; contains crinoids, *Receptaculites occidentalis, Campylorthis* sp., and *Hespororthis* sp.	12
3. Limestone, gray, coarse grained, cross bedded	23

	Thickness Feet
2. Limestone, buff, thin bedded, nodular; clastic texture; contains abundant *Solenopora*	22
1. Limestone, medium grained, thin bedded; clastic texture; buff clayey stringers; contains *Girvanella* and *Solenopora*	11
Benbolt limestone	

Geologic Section 114.—Wardell formation at locality 231, south of Palmer School, Scott County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (240 feet)	
5. Limestone, buff-gray, nodular	7
4. Shale, buff, platy; weathers buff; contains 1- to 2-inch intercalations of limestone conglomerate	68
3. Limestone, buff-gray, coarse grained, slabby	24
2. Limestone, buff, nodular, shaly; contains bryozoans and abundant *Öpikina*	57
1. Limestone, medium to coarse grained, slabby; contains *Lichenaria* and *Stromatocerium*	84
Benbolt formation	

Geologic Section 115.—Wardell formation 0.3 mile east of Cedar Point School, locality 204, Scott County, Virginia

	Thickness Feet
Bowen formation	
Wardell formation (214 feet)	
6. Limestone, impure, argillaceous; contains abundant *Foerstephyllum "halli," Solenopora, Girvanella,* and many ribbon bryozoans	16
5. Limestone, bluish-gray, shaly; contains *Öpikina septata, Girvanella,* and *Receptaculites*	17
4. Shale, buff, platy; contains thin sandstone partings and lenses of coarse-grained limestone	68

	Thickness Feet
3. Limestone, nodular, argillaceous; contains very large *Ischadites* and a large *Campylorthis* with unequal striae	55
2. Limestone, coarse grained; clastic texture	9
1. Limestone, medium grained, crumbly; contains large *Receptaculites, Stromatocerium,* and *Dystactospongia*	49

Benbolt formation

BOWEN FORMATION

The Bowen formation consists of 30 to 60 feet of maroon-drab and buff calcareous mudrocks which are characterized by the prolific development of mudcracks (Pl. 21B). In the Copper Creek belt the Bowen is mainly buff shale. In Rye Cove the member probably is represented by a few feet of maroon-drab mudrock exposed at locality 256 near Rye Cove School. Although relatively thin the Bowen is extensively exposed along U. S. Routes 23 and 58 between Danlboone Yard and Speers Ferry Post Office.

WITTEN LIMESTONE

In the Clinch Mountain and Copper Creek belts in Scott County the Witten is essentially the same as in Russell and Tazewell counties, but northeast of Clinchport it is somewhat thicker than in other areas to the east and south. In Rye Cove the formation probably is 200 feet thick, and the lower part contains many layers of edgewise conglomerate. The best exposures are at the north entrance of the railway tunnel near Speers Ferry Post Office, at locality 220 east of Danlboone Yard, along Road 660 at locality 237 near Wayland (Pl. 21C), and at localities 239 and 241 just north of the Copper Creek fault northwest of Gate City. The following sections are typical of the Witten in Scott County.

Geologic Section 116.—Witten limestone at locality 241, about 2 miles northeast of Speers Ferry Bridge across Clinch River, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (235 feet)	
5. Limestone, light-gray, thin slabby bedded; contains *Camarocladia*	132
4. Limestone, light-gray, coarse grained	20
3. Limestone, very shaly; weathers buff; contains many gastropods	15
2. Limestone, dove-gray, very fine grained, argillaceous, shaly	37
1. Limestone, light bluish-gray, medium bedded; contains *Zygospira* and *Escharopora*	31
Bowen formation	

Geologic Section 117.—Witten limestone at locality 239, about 4 miles northwest of Gate City, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (190 feet)	
3. Limestone, golden-gray, mostly fine grained, with abundant *Camarocladia*, and many thin intercalated coarse-grained layers with *Pionodema minuscula*	155
2. Limestone, coarse grained; contains abundant *Zygospira recurvirostris* and *Cryptophragmus*	15
1. Limestone, very fine grained, argillaceous, slabby	20
Bowen formation	

Geologic Section 118.—Witten limestone at locality 235, along State Highway 71, near Dorton Fort, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (125 feet)	
3. Limestone, dove-gray, fine grained, slabby; contains *Camarocladia*	65
2. Limestone, coarse grained, fossiliferous; contains *Cryptophragmus*	20
1. Limestone, drab-gray, argillaceous, very fine grained	40
Bowen formation	

Geologic Section 119.—Witten limestone 0.3 mile east of Cedar Point School, at locality 204, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (149 feet)	
5. Limestone, dove-gray to golden-gray, thin bedded, fine grained; weathers slabby; abundant *Camarocladia*	65
4. Limestone, coarse grained, shaly; contains *Cryptophragmus*	13
3. Limestone, light-gray, fine grained, argillaceous; contains lenses of edgewise conglomerate	10
2. Mudrock, buff, calcareous	12
1. Limestone, dove-gray, very fine grained; contains *Tetradium*	49
Bowen formation	

Geologic Section 120.—Witten limestone at locality 220, southeast of Danlboone Yard, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (112 feet)	
3. Limestone, dove-gray to golden-gray; weathers slabby	54

	Thickness Feet
2. Limestone, coarse grained, thin bedded, shaly; contains *Cryptophragmus antiquatus*	28
1. Limestone, fine grained, buff-gray, even bedded	40

Bowen formation

Geologic Section 121.—Witten limestone at locality 231, south of Palmer School, Scott County, Virginia

	Thickness Feet
Moccasin formation	
Witten limestone (144 feet)	
5. Limestone, golden-gray to dove-gray, thin bedded, slabby	80
4. Limestone, coarse grained; poorly exposed; contains *Cryptophragmus antiquatus*	10
3. Limestone, olive-drab to buff-gray, lumpy	18
2. Limestone, light bluish-gray, even bedded, very fine grained	22
1. Limestone, buff-gray, crumbly	14

Bowen formation

MOCCASIN FORMATION

The Moccasin is very well exposed along Clinch Mountain particularly at Moccasin Gap near Gate City, where it was first described by Campbell.[14] In Scott County, it is predominantly maroon-drab calcareous mudrock with a few intercalated beds of dove-gray limestone. Southwest of Speers Ferry it contains a zone of cherty limestone which persists southward into Tennessee. In Rye Cove only the upper half of the Moccasin is red, the lower bed being drab-gray calcareous mudrock. The thickness in all three belts is from 400 to 500 feet. The Moccasin is faulted out near the Russell-Scott County line and southwest of locality 241. The Moccasin is so impure (Table 4) that it could be used only for making Portland cement and rock wool.

Geologic Section 122.—Moccasin formation at locality 220, southeast of Danlboone Yard, Scott County, Virginia

	Thickness Feet
Moccasin formation (435 feet)	
6. Mudrock, dark maroon-drab, silty, noncalcareous; weathers black	235
5. Limestone, greenish-gray, bluish-gray, slabby	61
4. Mudrock, mottled red and green, slightly calcareous	68
3. Limestone, bluish-gray; shaly partings	11
2. Limestone, brick-red, argillaceous, platy	2
1. Mudrock, light brick-red; intercalated greenish-gray limestone	58
Witten limestone	

Geologic Section 123.—Moccasin formation at locality 231, south of Palmer School, Scott County, Virginia

	Thickness Feet
Moccasin formation (479 feet)	
9. Mudrock and siltstone, maroon-drab	36
8. Mudrock, maroon-drab, silty; intercalations of drab-gray limestone	24
7. Mudrock, brick-red, crumbly; contains a few thin drab-gray limestones	100
6. Mudrock, maroon-drab, crumbly, splintery	94
5. Limestone, drab-gray, fine grained, cherty	30
4. Mudrock, yellowish-gray; a few intercalated limestone beds	45
3. Mudrock, red, crumbly	79
2. Limestone, light bluish-gray	4
1. Mudrock, red, crumbly	67
Witten limestone	

MARTINSBURG FORMATION

The lower fourth of the Martinsburg formation along Clinch Mountain is composed of thin-bedded, granular limestones and buff-weathering shales. Individual limy layers contain up to 91.5 per cent calcium carbonate, but because of the prevalence of shaly intercalations quarriable zones of limestone containing more than 85 per cent calcium carbonate do not occur. In Rye Cove coarse-grained shell limestones cap Cedar Ridge and are sufficiently free of shale to be suitable for agstone. However, this occurrence is too small and remote to be developed. Analyses of limy beds of the Martinsburg are given in Table 5.

MISSISSIPPIAN LIMESTONE

The Mississippian limestones in Scott County crop out in a discontinuous belt at the eastern base of the Cumberland Front (Stone Mountain) and north of the Hunter Valley fault. Between locality 264, near Dungannon, and Horton Summit the Mississippian limestone is mostly concealed by wash from the higher sandstone formations. North of Ka and east of Stony, the Mississippian limestone is concealed by overthrust Cambrian rocks. Much of the 800-foot thickness of Mississippian limestone is impure and weathers to a shaly rubble. The purer beds occurring in zones up to 75 feet thick are of various types, including oolitic, crinoidal, and very fine-grained layers. The oolitic beds seem to be the purest. There are also intercalated magnesian limestones which are not readily distinguishable in the field.

The purest limestone at Horton Summit, and the only zone of quarriable thickness suitable for extensive development, is the oolitic zone exposed at locality 262.

Geologic Section 124.—Oolitic beds in the Mississippian limestone at locality 262, Horton Summit, Scott County, Virginia

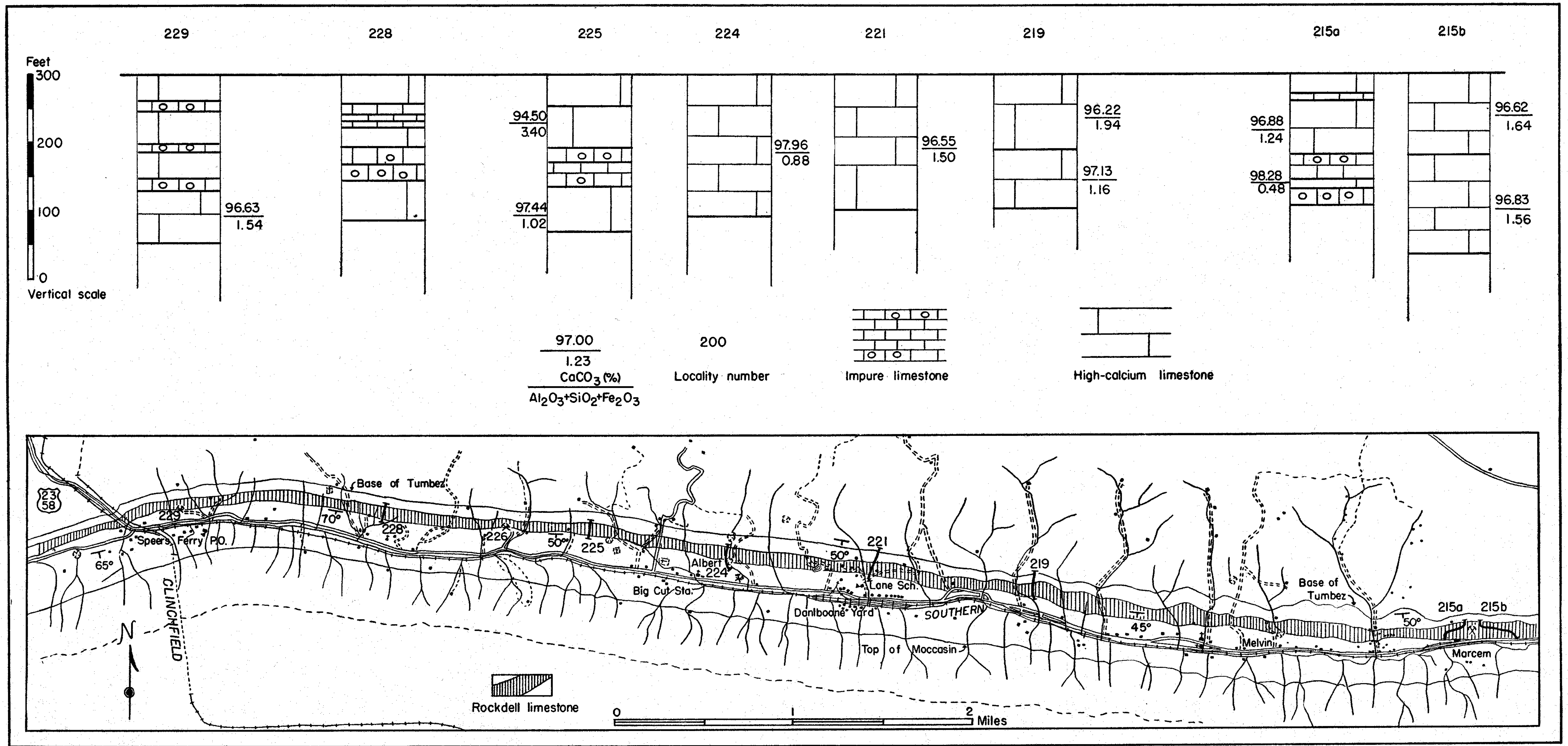
	Thickness Feet
3. Limestone, drab-gray to greenish-gray, shaly; thickness undetermined	
2. Limestone, medium-gray, thick bedded, oolitic; SiO_2, 1.60; R_2O_3, 1.10; $CaCO_3$, 94.40; $MgCO_3$, 1.98; Total, 99.08	60
1. Limestone, fine grained, slightly argillaceous, medium bedded; thickness undetermined	

Between localities 264 and 265, near Dungannon, a similar oolitic zone contains about the same percentage of noncarbonates, but it is notably higher in magnesium carbonate. The lower, fine-grained limestone has about the same composition as do similar appearing fine-grained dove-gray Mississippian limestones in Tazewell County (Geologic Section 53, unit 78).

Geologic Section 125.—Mississippian limestone at locality 264, northwest of Dungannon, Scott County, Virginia

	Thickness Feet
"Ste. Genevieve" and "Gasper" limestone (330.3 feet)	
11. Covered	
10. Limestone, medium-gray, cherty	20
9. Limestone, granular, oolitic; contains thin beds of dove-gray, fine-grained limestone	122
8. Limestone, red and green, argillaceous	8
7. Shale, brick-red	5
6. Limestone, fine grained, oolitic; SiO_2, 2.44; R_2O_3, 0.84; $CaCO_3$, 84.97; $MgCO_3$, 11.00; Total, 99.25	87
5. Limestone, argillaceous; weathers rusty-brown	3.3
4. Limestone, light-gray, oolitic; thin zones of very fine-grained, dove-gray limestone; relatively pure; SiO_2, 1.32; R_2O_3, 1.42; $CaCO_3$, 91.86; $MgCO_3$, 5.06; Total, 99.66	85
Hillsdale limestone	
3. Limestone, dark-gray, cherty; very poorly exposed	32
Maccrady formation (42 feet)	
2. Sandstone, white, coarse grained	12
1. Mudrock, maroon-drab, shaly	30
Price formation	

Exposures of Mississippian limestones are so poor that in most places it was not feasible to distinguish the various formations. Since the same belt at Big Stone Gap contains the Little Valley, Hillsdale, "Ste. Genevieve," "Gasper," and "Glen Dean" limestones, it is reasonable to suppose that these formations occur also in Scott County.



High-calcium limestones between Speers Ferry and Marcem, Scott County, Virginia.

QUARRIES

MARCEM

The present quarry of the Pennsylvanian-Dixie Cement Corporation, at Marcem, is the only large quarry now being operated in Scott County (Pl. 22). As shown on Plate 22, the quarry is mainly in the Rockdell limestone, but some of the coarse-grained *Solenopora*-bearing limestone below the Lincolnshire has also been worked. The quarry which has been in continuous operation since 1918 is about 1,400 feet long and the present opening is now 60 to 70 feet below the original quarry floor. There is considerable seepage of ground water and pumps have to be operated continuously. All of the material is shipped to the company's cement plant at Kingsport, Tennessee.

Abrupt variation in thickness and character of the Rockdell is well shown in the Marcen quarry. Along the west side the 160-foot succession between the Lincolnshire and the Benbolt contains two zones of impure cherty limestone, separating the light-gray high-calcium limestones into 8-, 47-, and 25-foot zones. At the eastern end of the quarry the Lincolnshire is overlain by at least 250 feet of coarse-grained, high-calcium limestone apparently with no intercalated beds of dark-gray impure limestones (Plate 24).

Geologic Section 126.—Ordovician limestone at locality 215, Marcem quarry, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
12. Limestone and shale, buff	
11. Limestone, buff, shaly, nodular; contains *Ischadites, Oxoplecia,* and *Mimella*	20
10. Limestone, gray, granular; weathers cobbly; contains *Echinosphaerites*	55
Rockdell limestone (152 feet; exposed along west side of quarry)	
9e. Limestone, light-gray, very coarse grained	25
9d. Limestone, dark bluish-gray, nodular, cherty	9
9c. Limestone, very light-gray, coarse grained; SiO_2, 1.04; R_2O_3, 0.48; $CaCO_3$, 96.88; $MgCO_3$, 1.56; Total, 99.96	77

	Thickness Feet
9b. Limestone, dark bluish-gray, nodular, sparsely cherty; weathers drab-gray	30
9a. Limestone, light-gray, very coarse grained; SiO_2, 0.44; R_2O_3, 0.28; $CaCO_3$, 98.28; $MgCO_3$, 0.89; Total, 99.89	11
Rockdell limestone (258 feet; exposed along east side of quarry)	
8b. Limestone, light-gray to pinkish; coarse grained: SiO_2, 0.80; R_2O_3, 0.84; $CaCO_3$, 96.62; $MgCO_3$, 1.02; Total, 99.28	113
8a. Limestone, light-gray, coarse grained; a few pinkish beds: SiO_2, 0.36; R_2O_3, 1.20; $CaCO_3$, 96.83; $MgCO_3$, 1.59; Total, 99.98	145
Lincolnshire limestone (97 feet)	
7. Limestone, dark bluish-gray to black, granular; some layers shaly and bituminous, others cherty	67
6. Limestone, dark gray, cherty, granular; contains *Dinorthis atavoides*	28.5
5. Limestone, very shaly; contains many ribbon bryozoans, *Dinorthis atavoides*, and a few other brachiopods, including *Camerella*	1.5
Elway and Tumbez limestones (99 feet)	
4. Limestone, light-gray, coarse grained	11
3. Limestone, pinkish; contains abundant *Solenopora* (base not exposed)	18
2. Limestone, medium to dark-gray, coarse grained	45
Analysis of units 2 to 4; thickness sampled, 74 feet: SiO_2, 1.92; R_2O_3, 1.60; $CaCO_3$, 94.19; $MgCO_3$, 1.92; Total, 99.63.	
1. Limestone, gray, irregularly bedded; makes north wall of quarry; base not exposed	15–25

SPEERS FERRY

The abandoned quarry at locality 229, near Speers Ferry, was operated by the Pennsylvania-Dixie Cement Corporation from 1910 to 1918, when it was abandoned in favor of the site at Marcem. As shown in Geologic Section 127 the high-calcium limestone of the Rockdell contains three cherty zones with an aggregate thickness of 47 feet. The upper impure bed lenses out to the west and is apparently absent in the west end of the quarry. The hill in which the quarry is located declines rather abruptly to the east and no large additional quantities of limestone could be obtained there.

Geologic Section 127.—Ordovician limestone at locality 229, about 0.2 mile east of Speers Ferry Station, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (286 feet)	
13. Limestone, light-gray to pinkish, coarse grained	40
12. Limestone, medium-gray, rather fine grained and compact; contains sparse chert and many wavy siliceous, bituminous partings	11
11. Limestone, white with pink mottlings, coarse grained	14
10. Limestone, light-gray to pinkish, thick bedded; texture very irregular	28
9. Limestone, dark-gray, coarse grained, sparsely cherty	18
8. Limestone, medium-gray, coarse grained, wavy; siliceous partings; lower third sparsely cherty	57
7. Limestone, light-gray to pinkish, coarse grained	9
6. Limestone, light bluish-gray, fine grained, wavy bedded	4
5. Limestone, light-gray, medium grained, medium bedded	12
4. Limestone, white, coarse grained	16
3. Limestone, light-gray, fine grained; contains many *Girvanella*	10
2. Limestone, light-gray, coarse grained, stylolitic	22

Analysis of units 2 to 7; thickness sampled, 73 feet: SiO_2, 0.38; R_2O_3, 1.16; $CaCO_3$, 96.63; $MgCO_3$, 1.14; Total, 99.31.

	Thickness Feet
Lincolnshire limestone	
1. Limestone, dark bluish-gray, shaly, cherty; contains abundant ribbon bryozoans and *Dinorthis atavoides*	45
Elway limestone	

NEAR SNOWFLAKE

For several years the State Department of Highways operated a quarry in the Wardell formation at locality 309 southeast of Snowflake (Pl. 14C). The limestone in the quarry, underlain and overlain by very argillaceous beds, is a lenticular bioherm or reef extending but a few hundred feet east of the quarry face. As shown in Geologic Section 112, the reef rock is too impure for most chemical uses, but it would be suitable for agricultural limestone. Most of the stone obtained from this quarry was used in road construction between Nickelsville and Gate City.

NEAR MANVILLE SCHOOL

W. B. Fulton, of Gate City, operated a small quarry in the ash-gray shale and red mudrock of the Blackford formation at locality 246, west of Manville School. All of the material obtained from this quarry was sold as agstone. The operation was abandoned early in 1942 because the beds which were being quarried averaged less than 85 per cent carbonates, which is the minimum Federal standard for agstone.

QUARRY SITES

CLINCH MOUNTAIN BELT

The Rockdell limestone in the Clinch Mountain belt could be quarried on a large scale for high-calcium limestone. Near the Russell-Scott County line the coarse-grained pure limestones of the Rockdell are separated into several relatively thin zones by intercalations of dark-gray cherty limestones (Geologic Section 128).

Geologic Section 128.—Ordovician limestone along Road 613 at locality 200, near the Russell-Scott County line, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (176 feet)	
30. Limestone, light-gray, coarse grained	8
29. Limestone, dark bluish-gray, sparsely cherty	40
28. Limestone, medium-gray, medium grained, cobbly, sparsely cherty	41
27. Limestone, light-gray, coarse grained, medium grained	11
26. Limestone, medium grained, cobbly, sparsely cherty	13
25. Limestone, light-gray, coarse grained; contains *Clitambonites* sp.	33
24. Limestone, pinkish, medium grained to coarse grained; contains large *Multicostella* sp.	30
Lincolnshire limestone	
23. Limestone, gray, medium granular; contains black chert with *Dinorthis atavoides*	53
Elway limestone	
22. Limestone, thin bedded, coarse grained, very cherty; contains abundance of *Dinorthis holdeni*	27
Tumbez limestone (143 feet)	
21. Limestone, light-gray, coarse grained, very compact	17
20. Chert and covered interval	34
19. Shale, ash-gray, mostly covered	24
18. Mudrock, red and green, mottled	2
17. Limestone, light-gray, coarse grained; contains *Rostricellula pristina*	6
16. Limestone, greenish-gray, cherty	6.5
15. Limestone, red and greenish laminated, coarse grained, cross bedded; contains detrital chert	4
14. Shale, ash-gray	44
13. Dolomite, light-gray; weathers mealy	15
12. Conglomerate, dolomitic; contains chert and dolomite; partly covered	1

	Thickness Feet
11. Dolomite, medium-gray, silty	5
10. Dolomite, yellowish-gray; contains abundant angular pebbles of chert	3
9. Mudrock, pale-purplish blotched with greenish-gray; conchoidal fracture	0.5
8. Shale, light-gray, mealy	0.5
7. Mudrock, red and green, mottled; fragments of chert in upper 2 feet	4
6. Dolomite, light-gray, shaly	2
5. Mudrock, red and green, mottled	6
4. Mudrock, light-gray, shaly; weathers buff	1
3. Dolomite, silty; contains angular pebbles of chert	2
2. Mudrock, pale reddish-brown; contains large pebbles of chert	0.5
1. Conglomerate, light-gray; matrix granular dolomite, pebbles of bluish-gray dolomite and reddish chert	7

"Knox" dolomite

At locality 201, west of Mt. Hagan School, the main body of coarse-grained limestone is about 150 feet thick and contains only one very thin intercalation of impure rock. Other thinner zones of coarse-grained limestone occur also below the dark bluish-gray *Nidulites*-bearing beds, but they are too close to stream level to be successfully quarried.

Geologic Section 129.—Rockdell limestone and associated beds at locality 201 about 0.3 mile west of Mt. Hagan School, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone (252 feet)	
19. Limestone, light-gray, coarse grained, thick bedded	37
18. Limestone, gray, medium grained; contains *Girvanella*	24

	Thickness Feet
17. Limestone, gray, light bedded, nodular weathering; contains large *Maclurites*	7
16. Limestone, light-gray, coarse grained; clastic texture; very pure	16
15. Limestone, light-gray, pinkish, coarse grained, partly oolitic	25
14. Limestone, medium grained; irregular texture; some reefy beds	25
Analysis of units 14 to 19; thickness sampled, 134 feet: SiO_2, 0.72; R_2O_3, 0.76; $CaCO_3$, 97.40; $MgCO_3$, 0.88; Total, 99.76.	
13. Limestone, dark-gray, medium to fine grained, cherty; contains *Receptaculites* and *Nidulites*	28
12. Limestone, light-gray, coarse grained; clastic texture	23
11. Limestone, medium- to dark-gray, fine grained; weathers cobbly	8
10. Limestone, dove-gray, very fine grained; interbedded with coarse-grained clastic-textured limestone	20
9. Limestone, medium- to dark-gray, granular, thin bedded	11
8. Limestone, light-gray to pinkish, coarse grained; contains thin bands of dove-gray fine-grained limestone	28
Lincolnshire limestone	
7. Limestone, black, medium grained, cherty; contains *Maclurites, Sowerbyites,* and *Dinorthis atavoides*	37
Elway limestone	
6. Limestone, light-gray, shaly; contains fossiliferous blocky chert	50
Tumbez limestone (130± feet)	
5. Limestone, light-gray, medium grained; nodules of reddish chert and inclusions of fine-grained flesh-colored algal limestone beds	7
4. Limestone, light-gray to greenish-gray, buff; contains abundance small *Mimella*	32
3. Shale, ash-gray; contains thin lenses of chert	9

	Thickness Feet
2. Limestone, gray to greenish-gray, thick bedded, banded with dark-red; some layers crowded with small *Mimella* and *Rostricellula* cf. *R. pristina*	11
1. Limestone, greenish-gray and maroon laminated; abundantly cherty	50–75
"Knox" dolomite	

Between localities 203 and 208 in the vicinity of Cedar Point School the Rockdell is exceptionally well exposed and conditions are favorable for quarrying and mining of a 125- to 140-foot zone of coarse-grained limestone averaging well above 97 per cent calcium carbonate. If this area were developed systematically, reserves of premium-grade stone would be more than ample for a very large operation.

Geologic Section 130.—Rockdell limestone and associated beds 0.3 mile east of Cedar Point School, locality 206, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone (248 feet)	
15. Limestone, pinkish, light-gray, coarse grained; contains intercalated fine-grained layers	34
14. Limestone, medium-gray, granular	18
13. Limestone, light-gray, coarse grained, thick bedded	12
12. Limestone, dove-gray, mainly fine grained; irregular texture	11
11. Limestone, light-gray, medium grained	7
10. Limestone, very light-gray, coarse grained	44
Analysis of units 10 to 15; thickness sampled, 126 feet: SiO_2, 0.28; R_2O_3, 0.98; $CaCO_3$, 97.54; $MgCO_3$, 1.00; Total, 99.80.	
9. Limestone, gray, shaly, fossiliferous; contains numerous ribbon bryozoans, *Multicostella* and *Strophomena*	37
8. Limestone, light-gray, coarse grained	9.5

	Thickness Feet
7. Limestone, light-gray, fine grained	4.5
6. Limestone, pinkish, coarse grained	24
5. Limestone, light-gray, coarse grained	17
4. Limestone, medium to coarse grained; abundant *Girvanella*	30

Analysis of units 4 to 8; thickness sampled, 85 feet: SiO_2, 0.62; R_2O_3, 0.98; $CaCO_3$, 97.13; $MgCO_3$, 1.20; Total, 99.93.

Lincolnshire limestone	
3. Limestone, cherty; contains *Dinorthis atavoides*	23
Elway limestone	
2. Limestone, light-gray, fine grained, cherty	20±
Tumbez limestone	
1. Limestone, coarse grained, conglomeratic, cherty	30±

West of locality 208, the thickness of the principal zone of high-calcium limestone in the Rockdell decreases sharply and at locality 210 is only 65 feet thick. Another 50-foot zone of coarse-grained relatively pure limestone occurs along Moccasin Creek, but conditions for quarrying are locally unsatisfactory.

Geologic Section 131.—Ordovician limestone at locality 210, near New Bethel Church, Russell County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (187 feet)	
13. Limestone, mainly light-gray, medium granular; contains a few thin dark impure layers	16
12. Limestone, light-gray, fine grained; contains *Solenopora*	18
11. Limestone, light-gray to pinkish	16
10. Limestone, light-gray, coarse grained, thin bedded	16
9. Limestone, light bluish-gray, fine grained, sparsely cherty; contains *Sowerbyella* and *Receptaculites*	11

	Thickness Feet
8. Limestone, bluish-gray, medium to fine grained, granular; contains *Oxoplecia holstonensis*	23
7. Limestone, light-gray, granular, fine grained	28
6. Limestone, dark-gray, nodular, cherty, fine grained	6
5. Limestone, light-gray, coarse grained; exposed on both sides of Moccasin Creek	53
Lincolnshire limestone	
4. Limestone, dark-gray, cherty, granular; contains abundance of *Sowerbyites triseptatus, Dinorthis atavoides,* and *Multicostella saffordi*	30
Elway limestone	
3. Limestone, fine grained; weathers light-gray; mainly covered; contains abundance of blocky chert with *Dinorthis holdeni* and *Calliops* sp.	71
Tumbez limestone (50± feet)	
2. Limestone, reddish, coarse grained, conglomeratic; contains *Solenopora*	25
1. Shale, shaly limestone, and chert conglomerate; poorly exposed	20–30

Between localities 211 and 212 the upper coarse-grained limestone of the Rockdell, cropping out just south of Road 613, is about 65 feet thick and favorably situated for extensive quarrying or mining.

Geologic Section 132.—Rockdell limestone and associated formations at locality 211, near Antioch Church, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (237 feet)	
13. Limestone, coarse grained, light-gray, poorly exposed	15
12. Limestone, coarse grained, light-gray	53

Analysis of units 12 to 13; thickness sampled, 68 feet: SiO_2, 1.88; R_2O_3, 0.42; $CaCO_3$, 95.88; $MgCO_3$, 1.45; Total, 99.63.

	Thickness Feet
11. Limestone, dark-gray, thin bedded, cobbly-weathering	4
10. Limestone, light-gray, coarse grained	10
9. Limestone, dark bluish-gray, granular, cherty	56
8. Limestone, light-gray, coarse grained	5
7. Limestone, dark-gray, granular; weathers cobbly	12
6. Limestone, light-gray, fine grained; speckled with vugs of white calcite	9
5. Limestone, dark-gray, granular, crumbly	26
4. Limestone, light-gray, coarse grained	47
Lincolnshire limestone	
3. Limestone, dark bluish-gray, cherty	20–35
Elway and Tumbez limestones (131 feet)	
2. Limestone, coarse grained, light-gray to pinkish, cherty; poorly exposed	125
1. Limestone and shale, ash-gray	6
"Knox" dolomite	

From locality 212 southwestward to Gate City much of the exposed Rockdell limestone seems to be somewhat impure and probably could not be developed extensively for chemical uses. Much of the formation is exposed at locality 213, but between there and the west environs of Gate City the Rockdell is almost wholly concealed.

Geologic Section 133.—Rockdell limestone and associated strata at locality 213, about 0.4 mile northeast of the intersection of State Highway 71 and U. S. Route 23, Gate City, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone (225 feet)	
6. Limestone, light-gray, coarse grained	22.5
5. Limestone, fine grained, crumbly	30
4. Limestone, dark bluish-gray, medium-grained; weathers nodular	43

	Thickness Feet
3. Limestone, dark-gray, medium grained to fine grained, impure	56
2. Limestone, mottled gray, fine grained; many veins of calcite	22
1. Limestone, light-gray, coarse grained; base not exposed	52

Between Gate City and Marcem, the Rockdell appears to be 260 feet thick and all or nearly all premium-grade limestone.

The most favorable site for extensive development of high-calcium limestone in the Clinch Mountain belt is in the 2-mile sector between localities 219 and 224, west of Melvin (Pl. 24). There, the Rockdell consists of 200 feet of coarse-grained limestone averaging more than 97 per cent calcium carbonate and less than 2 per cent of noncarbonates. Well over 25 million tons of limestone could probably be obtained by shallow quarrying in the area between these localities.

Geologic Section 134.—Rockdell limestone and associated strata at locality 219, about 1.0 mile northeast of Lane School, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
14. Limestone, nodular, shaly; weathers buff-gray	
13. Limestone, bluish-gray, granular; weathers cobbly; contains *Echinosphaerites*	15
Rockdell limestone (194 feet)	
12. Limestone, light-gray, mottled with pink, coarse grained: SiO_2, 1.24; R_2O_3, 0.7; $CaCO_3$, 96.22; $MgCO_3$, 0.77; Total, 98.93	110
11. Limestone, pinkish and gray, coarse grained	50
10. Limestone, light-gray to pinkish; interbedded coarse and fine-grained layers	34

Analysis of units 10 and 11; thickness sampled, 84 feet: SiO_2, 0.16; R_2O_3, 1.00; $CaCO_3$, 97.13; $MgCO_3$, 1.09; Total, 99.38.

	Thickness Feet
Lincolnshire limestone	
9. Limestone, dark bluish-gray, argillaceous, sparsely cherty; weathers nodular; contains *Dinorthis atavoides*	56
Elway limestone (120± feet)	
8. Limestone, coarse grained, crumbly; contains *Solenopora*	41
7. Limestone, light-gray, coarse grained	7
6. Limestone, dark- to medium-gray, granular, sparsely cherty; chert contains poorly preserved *Calliops*	18
5. Limestone, pinkish, coarse grained; contains *Solenopora*	9
4. Limestone, light-gray to dark-gray, coarse grained, impure, shaly and cherty; contains poorly preserved *Dinorthis*	30–50
Tumbez limestone (70 feet)	
3. Limestone, coarse grained, pinkish and gray; some beds conglomeratic and cherty	33
2. Limestone, light-gray, very shaly	7
1. Covered interval; abundance of chert and blocks of chert conglomerate in mantle rock	30
"Knox" dolomite	

Geologic Section 135.—Rockdell limestone and associated strata at locality 221, Lane School, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone	
7. Limestone, light-gray to pinkish; coarse grained; SiO_2, 0.88; R_2O_3, 0.62; $CaCO_3$, 96.55; $MgCO_3$, 1.30; Total, 99.35	193
Lincolnshire limestone	
6. Limestone, dark bluish-gray, slabby to shaly, cherty; contains *Dinorthis atavoides*	63

	Thickness Feet
Elway limestone	
5. Limestone, dark-gray, granular, argillaceous and cherty	37
Tumbez limestone (108 feet)	
4. Limestone, light-gray, granular, cross laminated	29
3. Mudrock, pale reddish-drab, dolomitic; conchoidal fracture	5
2. Limestone, light-gray to pinkish, coarse grained; some beds conglomeratic; chert very abundant	67
1. Chert conglomerate; poorly exposed	5–7
"Knox" dolomite	

Geologic Section 136.—Ordovician limestone at locality 224, about 0.7 mile west of Lane School, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone	
2. Limestone, light-gray, pinkish, coarse grained; not fully exposed but no impure layers noted; SiO_2, 0.18; R_2O_3, 0.70; $CaCO_3$, 97.96; $MgCO_3$, 0.82; Total, 99.66	202
Lincolnshire limestone	
1. Limestone, bluish-gray, cherty, shaly	40–60
Elway limestone	

West of Big Cut Station, the Rockdell contains much less high-calcium limestone. A quarriable zone 60 to 65 feet thick at the base of the formation averages about 97.5 per cent calcium carbonate. Because of its relatively steep dip, this thin zone would have to be quarried for considerable distances along the strike in order to yield a large tonnage. Between localities 225 and 228 conditions are not very favorable for extensive quarrying. At locality 229 near Speers Ferry, a 40-foot zone at the top of the Rockdell is also high-calcium limestone (Geologic Section 127).

Geologic Section 137.—Rockdell limestone and associated strata at locality 225, about 1.5 miles northwest of Lane School, Scott County, Virginia

	Thickness Feet
Benbolt limestone (20+ feet)	
9. Limestone, buff, shaly, nodular	
8. Limestone, dark-gray, granular, cobbly; contains *Echinosphaerites*	20
Rockdell limestone	
7. Limestone, light-gray, coarse to fine grained; contains 3 to 5 feet of argillaceous limestone 43 feet below the top; SiO_2, 2.68; R_2O_3, 0.72; $CaCO_3$, 94.50; $MgCO_3$, 1.33; Total, 99.23	103
6. Limestone, dark bluish-gray, cherty; contains *Receptaculites* and *Sowerbyella*	21
5. Limestone, dark-gray, granular, crumbly; weathers cobbly	35
4. Limestone, light-gray to pinkish, coarse grained; SiO_2, 0.22; R_2O_3, 0.80; $CaCO_3$, 97.44; $MgCO_3$, 0.79; Total, 99.25	68
Lincolnshire and Elway limestones	
3. Limestone, dark bluish-gray, cherty; incompletely exposed	133
Tumbez limestone	
2. Limestone, light-gray, coarse grained	10
1. Covered	
"Knox" dolomite	

Geologic Section 138.—Rockdell limestone at locality 228, about 1.4 miles east of Speers Ferry Post Office, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (211 feet)	
9. Limestone, light-gray, medium to fine grained, mottled gray and reddish	41

	Thickness Feet
8. Limestone, medium-gray, granular; clastic texture; shaly and crumbly	15
7. Limestone, light-gray, coarse grained, pure	9.5
6. Limestone, dark-gray, granular; weathers cobbly	8
5. Limestone, light-gray, coarse grained	30
4. Limestone, light-gray, rather fine grained; contains thin clayey partings	18
3. Limestone, dark-gray, slabby	7
2. Limestone, dark-gray, rather fine grained, sparsely cherty	25
1. Limestone, light-gray, coarse grained; clastic texture	58
Lincolnshire limestone	

In Robinette Valley, southwest of Speers Ferry, the Rockdell contains considerable high-calcium limestone but in zones generally less than 100 feet thick. The two best exposed sections are at localities 230 and 232.

Geologic Section 139.—Rockdell limestone and associated strata at locality 230 near Palmer School, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone (248 feet)	
14. Limestone, light-gray to pinkish	60
13. Limestone, drab-gray, medium grained, thin bedded, impure	33
12. Limestone, dark bluish-gray, nodular, sparsely cherty	44
11. Limestone, dark-gray, coarse grained, thin bedded	24
10. Limestone, medium to light-gray, coarse grained	12
9. Limestone, dark bluish-gray, nodular, crumbly	12
8. Limestone, light-gray, coarse grained	63
Lincolnshire limestone	
7. Limestone, shaly, nodular, sparsely cherty; contains *Dinorthis atavoides*	91

	Thickness Feet
Elway and Tumbez limestones (158 feet)	
6. Limestone, light-gray, argillaceous, coarse grained; abundant *Solenopora*	47
5. Limestone, light-gray, coarse grained	24
4. Shale, ash-gray, crumbly	3
3. Limestone, gray, coarse grained	4
2. Limestone, light-gray, granular, cherty; intercalated beds of ash-gray shale	45
1. Mudrock, silty, dolomitic; conchoidal fracture; weathers brownish-gray; typical Blackford lithology	30–40
"Knox" dolomite	

Geologic Section 140.—Rockdell limestone and associated strata at locality 232, about 1.9 miles southwest of Palmer School, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (252 feet)	
14. Limestone, light-gray, coarse grained	46
13. Limestone, nodular, crumbly, coarse grained, impure	32
12. Limestone, gray, granular	7
11. Limestone, dark bluish-gray, fine grained, cherty; contains bryozoans and *Receptaculites*	42
10. Limestone, light-gray to pinkish, coarse grained	50
9. Limestone, dark-gray, granular, sparsely cherty	11
8. Limestone, light-gray, coarse grained	64
Lincolnshire limestone	
7. Limestone, dark-gray, nodular, cherty; contains abundance of *Dinorthis atavoides*	57
Elway limestone (32 feet)	
6. Limestone, light-gray, coarse grained	13
5. Limestone, dark-gray, fine grained, cherty; weathers with whitish chalky crust	19

	Thickness Feet
Tumbez limestone (175 feet)	
4. Limestone, light-gray streaked with pink; *Solenopora* very abundant	23
3. Shale, ash-gray; interbedded with gray and pinkish streaked coarse-grained cherty limestone	63
2. Limestone, light-gray, coarse grained; contains *Rostricellula*	4.5
1. Shale, shaly limestone, and blocky chert; very poorly exposed	85
"Knox" dolomite	

In summary, the Rockdell limestone along Clinch Mountain in Scott County contains relatively great thicknesses of coarse-grained high-calcium limestone which could be developed for industrial uses on a large scale. Northeast of Gate City, the best locality for quarrying and mining is near Cedar Point School about 9 miles from Moccasin Gap. The most favorable locality for a large quarry is west of Gate City, in the vicinity of Lane School.

COPPER CREEK AND RYE COVE BELTS

Practically all of the premium-grade limestone in the Copper Creek belt of Scott County is remote from a railroad and only a few of the localities are on or near all-weather roads. Because of its unfavorable location, the Copper Creek belt was not studied in much detail. The most favorable site for obtaining large quantities of high-calcium limestone in this belt is in the vicinity of locality 233 near the Russell-Scott County line.

Geologic Section 141.—Ordovician limestone at locality 233, about 2.8 miles east of Nickelsville, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (377 feet)	
11. Limestone, light-gray, coarse grained; thin argillaceous parting causes beds to weather slabby	8

	Thickness Feet
10. Limestone, dark bluish-gray, medium grained; weathers cobbly	18
9. Limestone, light-gray, coarse grained	33
8. Limestone, dark bluish-gray, medium grained; weathers cobbly	26
7. Limestone, light-gray to medium-gray, coarse grained; a few pinkish layers; SiO_2, 0.14; R_2O_3, 0.98; $CaCO_3$, 97.54; $MgCO_3$, 1.19; Total, 99.85	145
6. Limestone, dark bluish-gray, granular; weathers cobbly	137
Lincolnshire limestone (117 feet)	
5. Limestone, dark-gray; weathers cobbly; sparsely cherty	76
4. Limestone, light-gray, coarse grained	39
3. Limestone, dark bluish-gray, fine grained, cherty	2
Five Oaks limestone	
2. Limestone, very fine grained	10
Elway limestone	
1. Limestone, very fine grained; contains abundant blocky weathering, fossiliferous chert	35
Blackford formation	

Thinner zones of pinkish limestone in the Rockdell limestone could be quarried near State Highway 71 in the vicinity of Dorton Fort. Possibly some of these beds could be used for decorative marble.

Geologic Section 142.—Rockdell limestone and associated formations at locality 234, along State Highway 71, near Dorton Fort, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone	
12. Limestone, light-gray to pinkish, coarse grained; contains wavy siliceous partings; weathers slabby to platy	62

	Thickness Feet
11. Limestone, dark-gray, coarse grained	10
10. Limestone, light-gray to pinkish, medium bedded	
9. Limestone, pink and chocolate-brown, coarse grained, stylolitic; some beds are crumbly	47
8. Limestone, light-gray, coarse grained	20
Analysis of units 8 to 9; thickness sampled, 67± feet: SiO_2, 0.40; R_2O_3, 1.74; $CaCO_3$, 96.52; $MgCO_3$, 1.13; Total, 99.79.	
7. Limestone, coarse grained, argillaceous; weathers crumbly	18
6. Limestone, dark-gray to medium-gray; contains numerous wavy bituminous streaks	86
Lincolnshire limestone	
5. Limestone, medium to coarse grained, cherty	142
Five Oaks limestone	
4. Probably present in covered interval	10±
Elway limestone	
3. Residual chert, blocky, fossiliferous; contains *Dinorthis holdeni*, *Calliops*, and *Leperditia*	65
Blackford formation	
2. Shale, ash-gray; contains impure argillaceous cherty limestone; very poorly exposed	80
1. Shale, dolomitic, silty, mottled, maroon-drab and pale-green	72
Beekmantown dolomite	

The sector between Dorton Fort and Clinchport is relatively isolated although only a few miles from the railroad. Near Manville School the coarse-grained limestones are locally thick enough to be quarried (Unit 9, Geologic Section 144), but farther southwest, at locality 242 the thickest high-calcium limestone is less than 30 feet thick. The limestone exposed along the Clinchfield Railroad between localities 244 and 245 is thoroughly sheared and all of it appears to be very impure. No quarriable thicknesses of high-calcium limestone occur in the Copper Creek belt southwest of Clinchport and the interval between the Lincolnshire and the Benbolt formations decreases progressively southeastward toward Tennessee. None of the limestones in Rye Cove are considered suitable for industrial development, but agstone and agricultural lime for local use could be obtained from the coarse-grained limestones of the Rockdell and from the slabby limestones in the Witten.

Geologic Section 143.—Rockdell limestone and associated strata between localities 238 and 239, 4 miles northwest of Gate City, Scott County, Virginia

	Thickness Feet
Benbolt formation	
Rockdell limestone (266 feet)	
11. Limestone, coarse grained, light-gray; contains *Cheirocrinus*	15
10. Limestone, dark-gray, medium grained, slightly cherty	21
9. Limestone, light-gray, coarse grained	144
8. Limestone, dark bluish-gray, sparsely cherty	14
7. Limestone, gray, coarse grained, relatively pure	72
Lincolnshire limestone (163 feet)	
6. Limestone, dark bluish-gray, sparsely cherty; contains *Dinorthis atavoides*	155
5. Limestone, medium-gray, granular; contains *Acrolichas*	8
Five Oaks limestone	
4. Limestone, dove-gray, very fine grained, shaly	10
Elway limestone	
3. Limestone, dark-gray, very cherty, shaly	50
Blackford formation	
2. Shale and limestone, ash-gray, cherty	35
1. Shale, maroon-drab and ash-gray, dolomitic, silty; basal layers contain detrital chert	45
"Knox" dolomite	

Geologic Section 144.—Rockdell limestone and associated strata at locality 242, about 2 miles northeast of Speers Ferry Bridge across Clinch River, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (151 feet)	
14. Limestone, light-gray to pinkish, coarse grained; a few intercalated dove-gray fine-grained layers	27
13. Limestone, medium grained; weathers cobbly; sparsely cherty	66
12. Limestone, light-gray, coarse grained	12
11. Limestone, dark bluish-gray, fine grained, cherty	18
10. Limestone, light-gray, coarse grained	13
9. Limestone, mainly fine grained but contains inclusions of coarse-grained limestone	10
8. Limestone, medium grained, dense, wavy bedded	5
Lincolnshire limestone	
7. Limestone, dark bluish-gray, very fine grained, very cherty	8–10
Five Oaks limestone	
6. Limestone, dove-gray, fine grained	2–3
Elway limestone	
5. Limestone, dark bluish-gray, very cherty; weathers with white chalky crust; contains *Dinorthis holdeni*	47
Blackford formation (80 feet)	
4. Shale and argillaceous limestone, ash-gray	29
3. Limestone, light-gray, earthy, cherty	18
2. Dolomite, purplish-gray, argillaceous and silty	22
1. Chert conglomerate; matrix of steel-gray dolomite	11
"Knox" dolomite	

Geologic Section 145.—Rockdell limestone and associated strata between localities 257 and 258, Rye Cove, Scott County, Virginia

	Thickness Feet
Benbolt limestone	
Rockdell limestone (110 feet)	
16. Limestone, medium- to dark-gray, coarse grained; contains *Girvanella* and *Solenopora*	35
15. Limestone, dark bluish-gray, argillaceous, crumbly; contains abundant *Sowerbyella negritus, Calliops, Gonioceras, Nidulites,* and *Strophamena*	60
14. Limestone, gray, coarse grained, crumbly	15
Lincolnshire limestone	
13. Limestone, dark bluish-gray, medium to coarse grained, cherty; contains *Maclurites, Sowerbyella,* and *Dinorthis atavoides*	75
Five Oaks limestone	
12. Limestone, dove-gray, fine grained, sparsely cherty; poorly exposed; a few beds show *Tetradium syringoporoides*	27
Elway limestone	
11. Limestone, dark-gray, fine grained; contains abundant blocky chert	30
10. Covered interval; showings of residual chert	80
Blackford formation	
9. Shale, light-gray to pale reddish	
8. Shale, purplish blotched with green; intercalated ash-gray layers	20
7. Shale, dark-gray, mealy; contains chert nodules	20
6. Covered	20
5. Shale, purplish-drab and greenish-gray, mud cracked	15
4. Mudrock, greenish-gray to dark-gray, dolomitic, silty; conchoidal fracture	20
3. Chert conglomerate	2
2. Shale, drab-gray with intercalated reddish laminae	5
1. Chert conglomerate; contains chert pebbles up to 4 inches in diameter	5
"Knox" dolomite	

TABLE 5.—*Analyses of limestones and dolomites in Scott County, Virginia*

(Froehling and Robertson, Inc., Analysts)

Locality (Shown on Plate 23)	Formation	Geologic Section		Thickness in Feet of Sampled Interval	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3		SiO_2	Total	
							Al_2O_3	Fe_2O_3			
201	Rockdell	129	14–19	134	97.40	0.88	0.54	0.22	0.72	99.76	About 0.3 mile west of Mt. Hagan School
206	Rockdell	130	4–8	85	97.13	1.20	0.90	0.08	0.62	99.93	About 0.3 mile east of Cedar Point School
206	Rockdell	130	10–15	126	97.54	1.00	0.82	0.16	0.28	99.80	
209	Wardell	112	5–10	60.5	91.86	1.83	1.62	0.60	3.16	99.07	Quarry about a mile southeast of Snowflake
211	Rockdell	132	12–13	68	95.88	1.45	0.34	0.08	1.88	99.63	Near Antioch Church
	Martinsburg[a]				32.88	1.51	8.37		55.55	98.31	Gate City
	Martinsburg[a]				70.53	0.18	3.86		23.48	98.05	Gate City
215	Tumbez-Elway	126	2–4	74	94.19	1.92	0.96	0.64	1.92	99.63	North end of quarry of Penn-Dixie Cement Company's quarry, Marcem
215	Rockdell	126	8a	145	96.83	1.59	0.88	0.32	0.36	99.98	East side of Penn-Dixie Cement Company's quarry, Marcem
215	Rockdell	126	8b	113	96.62	1.02	0.56	0.28	0.80	99.28	

215	Rockdell	126	9a	11	98.28	0.89	0.04	0.24	0.44	99.89	West side of quarry of Penn-Dixie Cement Company's quarry, Marcem
215	Rockdell	126	9c	77	96.88	1.56	0.28	0.20	1.04	99.96	
219	Rockdell	134	10–11	84	97.13	1.09	0.84	0.16	0.16	99.38	About a mile northeast of Lane School
219	Rockdell	134	12	110	96.22	0.77	0.42	0.28	1.24	98.93	
221	Rockdell	135	7	193	96.55	1.30	0.46	0.16	0.88	99.35	Near Lane School
224	Rockdell	136	2	202	97.96	0.82	0.62	0.08	0.18	99.66	About 0.7 mile west of Lane School
225	Rockdell	137	4	68	97.44	0.79	0.76	0.04	0.22	99.25	About 1.5 miles northwest of Lane School
225	Rockdell	137	7	103	94.50	1.33	0.28	0.44	2.68	99.23	
229	Rockdell	127	2–7	73	96.63	1.14	1.00	0.16	0.38	99.31	Quarry near Speers Ferry Post Office
	Moccasin[a]				56.92	1.44	4.96		34.28	97.60	Speers Ferry Post Office
	Martinsburg[a]				90.36	0.87	1.88		7.08	100.19	
233	Rockdell	141	7	145	97.54	1.19	0.82	0.16	0.14	99.85	About 2.8 miles east of Nickelsville
234	Rockdell	142	8–9	67±	96.52	1.13	1.22	0.52	0.40	99.79	Along State Highway 71, near Dorton Fort
245–246	"Knox"	100	5–13	444	56.29	34.80	1.02	0.48	8.00	100.59	Along Clinchfield Railroad, about a mile south of Clinchport
247	"Knox"	99	15–63	298.6	52.17	41.32	0.36	0.98	4.40	99.23	Along U. S. Routes 23 and 58, the Clinchfield Railroad, and the Southern Railway, south of Clinch River
247	"Knox"	99	86–111	180	50.14	39.52	0.78	0.48	8.16	99.08	

[a] Analyses from Bassler, R. S., The cement resources of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull. II-A, pp. 232, 234.

TABLE 5.—*Analyses of limestones and dolomites in Scott County, Virginia—Continued*

Locality (Shown on Plate 23)	Formation	Geologic Section		Thickness in Feet of Sampled Interval	Chemical Composition						Location
		No.	Unit		$CaCO_3$	$MgCO_3$	R_2O_3: Al_2O_3	R_2O_3: Fe_2O_3	SiO_2	Total	
247	"Knox"	99	157–162	365	55.63	36.00	0.44	0.90	7.20	100.17	Along U. S. Routes 23 and 58, the Clinchfield Railroad, and the Southern Railway, south of Clinch River
247	"Knox"	99	163–181	377.5	51.55	38.15	1.10	0.44	7.68	98.92	
247	"Knox"	99	182	175	55.60	39.00	0.72	0.24	4.72	100.28	
250	Maryville	102	5–9	256.2	92.26	4.86	0.30	0.12	2.08	99.62	Along Road 630, about 3 miles southwest of Speers Ferry bridge
250	Maryville	102	10–21	407	84.75	12.60	0.34	0.28	1.56	99.53	
253	"Knox"			85	52.36	40.80	0.52	0.16	6.22	100.06	Glenita Quarry
260–261	Maryville	103	3–10	1371	85.79	7.09	1.16	0.28	5.06	99.38	Along U. S. Routes 23 and 58, south of Horton Summit
262	Mississippian	124	2	60	94.40	1.98	0.26	0.84	1.60	99.08	Near Horton Summit
264	Mississippian	125	4	85	91.86	5.06	1.02	0.40	1.32	99.66	Near Dungannon
264	Mississippian	125	6	87	84.97	11.00	0.60	0.24	2.44	99.25	

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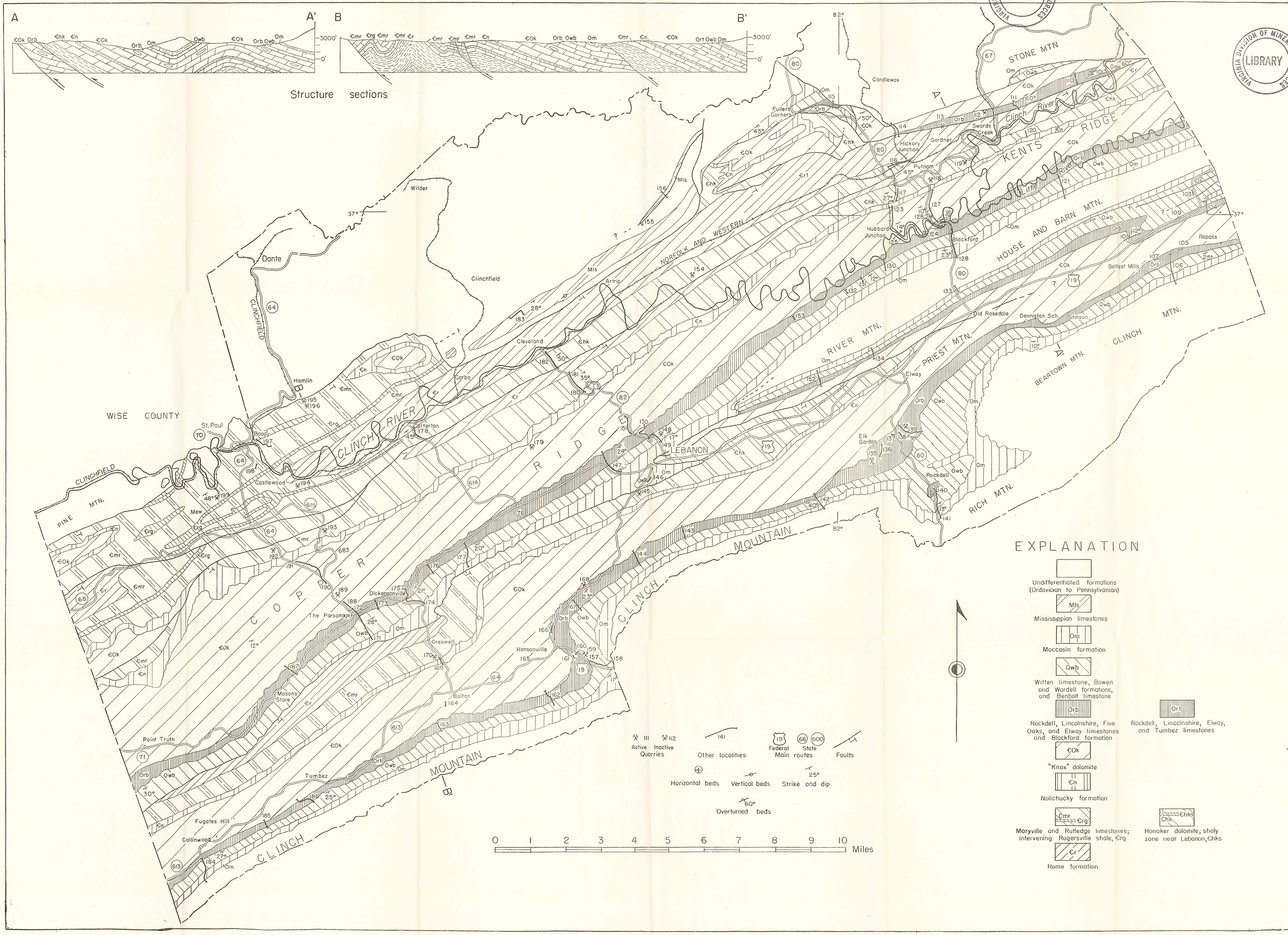
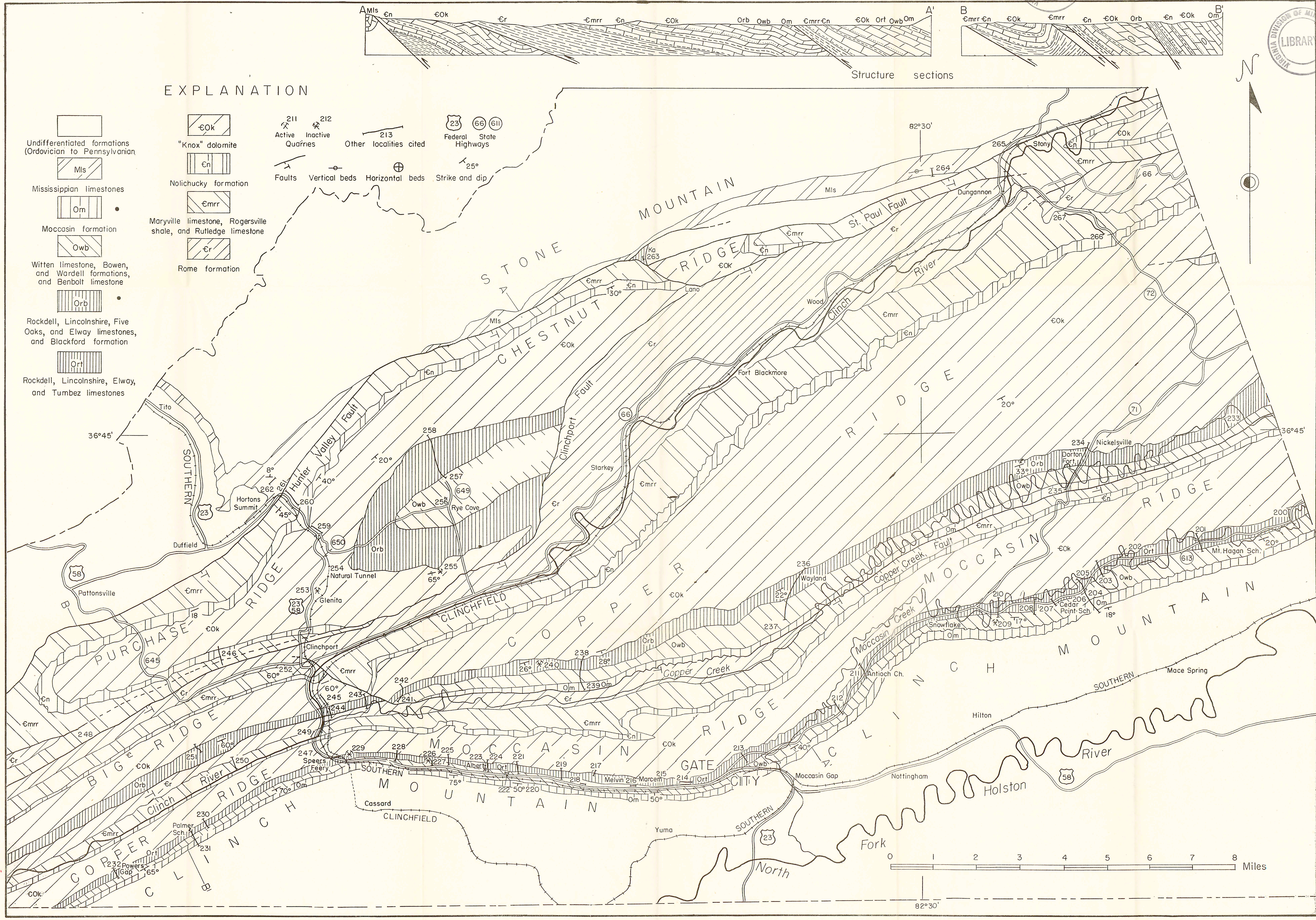
INDEX

Distribution of limestone and dolomite formations in Tazewell County, Virginia.



Distribution of limestone and dolomite formations in Russell County, and near St. Paul, Wise County, Virginia.



Distribution of limestone and dolomite formations in Scott County, Virginia.