Pennsylvanian Formations of Southwest Virginia

GEOLOGICAL SURVEY BULLETIN 1280

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By RALPH L. MILLER

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Descriptions and type sections of the Lee Formation, Norton Formation, Gladeville Sandstone, and Wise Formation, and description of the Harlan Formation

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PENNSYLVANIAN FORMATIONS OF SOUTHWEST VIRGINIA

By Ralph L. Miller

ABSTRACT

In 1893 Marius R. Campbell divided the rocks of Pennsylvanian age in southwest Virginia into five formations as follows: Lee Conglomerate, Norton Formation, Gladeville Sandstone, Wise Formation, and Harlan Sandstone. These names have been in common use ever since, except that Lee Conglomerate has been changed to Lee Formation, and Harlan Sandstone is changed to Harlan Formation in this report. Campbell designated type areas for his formations, but he published a measured section only of the Lee. This paper includes a more detailed section of the Lee Formation, and describes and presents type sections for the Norton Formation, Gladeville Sandstone, and Wise Formation. The Harlan Formation is described, but a type section is not given because a well-exposed section has not been found.

The Gladeville Sandstone, a rather thin formation, separates the thick Norton and Wise Formations in most of southwest Virginia. It is, however, not distinctive. Because of this and because of misinterpretation of structure along the upturned southeast margin of the coal fields, the Gladeville has in the past been misidentified in the western part of the Virginia coal fields. Detailed and reconnaissance mapping has established its presence along an 8-mile stretch, where formerly it was believed to be absent due to faulting. In the westernmost part of the coal fields, the Gladeville seems to thin and change facies so it is no longer a mappable unit.

Both the Norton and Wise Formations consist of intertonguing units of sandstone, siltstone, and shale. In the Wise Formation, resistant sandstone units are numerous; four of the most prominent and areally extensive of these are herein designated formal members—the Robbins Chapel, Keokee, Clover Fork, and Marcum Hollow Sandstone Members. In addition, a thick sandstone in the uppermost part of the Wise Formation in Lee and Wise Counties is tentatively designated the Reynolds Sandstone Member(?), as identified by Wanless (1946) in Black Mountain. Two calcareous zones, the Kendrick Shale of Jillson (1919) and the Magoffin Beds of Morse (1931), are believed to be present everywhere in the Wise Formation.

Campbell defined the Harlan Sandstone as being the beds on Big Black Mountain characterized by a basal cliff-forming quartzose sandstone 40 to 100 feet thick and extending upward to the top of the mountain. In Lee County, extensive strip mines in the High Splint coal just below the Harlan Formation reveal that resistant quartzose sandstone units at the approximate base of the Harlan Formation are lenticular, and in many places they are completely absent. For this reason, the base of the Harlan is redefined as the top of the High Splint coal.

INTRODUCTION

In the Pennsylvanian System, more than in any other system of southeastern United States, each formation name in past and present use tends to be restricted to an individual State, and almost completely different sets of formation names are applied to the system in various States. Nomenclature has grown from early work in important coal-producing regions in the different States; at that time, accurate interstate correlations of the largely continental sediments were almost impossible. Once a system of names for Pennsylvanian formations was established in a State by one of the early workers, most subsequent workers in the same State used the names wherever possible.

Rocks of Pennsylvanian age in Virginia are confined to the southwest corner of the State in the coal-producing regions of Lee, Wise, Scott, Dickenson, Russell, Buchanan, and Tazewell Counties (fig. 1). Early studies of these coal fields were made by Stevenson (1881), Boyd (1887), and McCreath and d'Invilliers (1888). Campbell (1893), however, was the first to divide the rocks of Pennsylvanian age into named

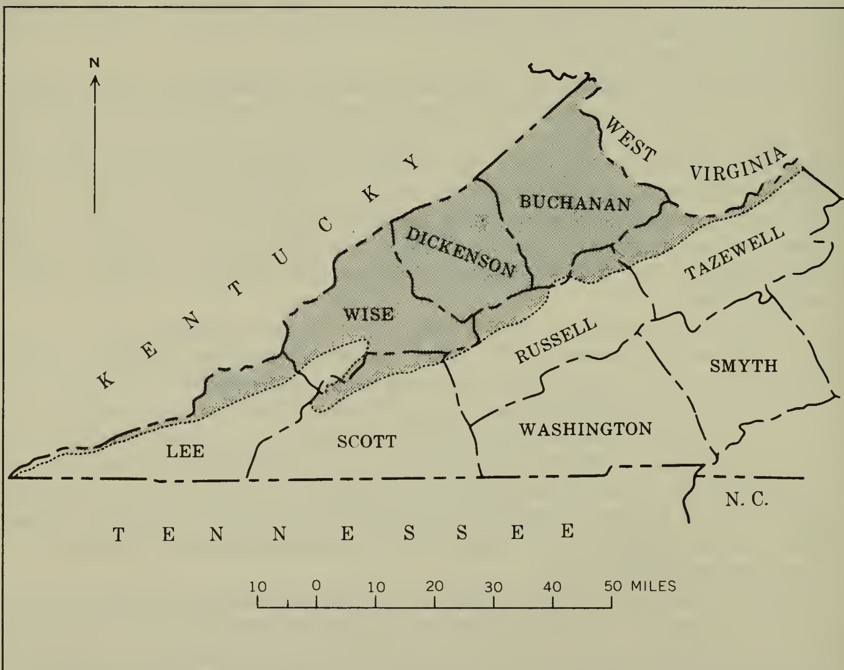

FIGURE 1.—Index map showing area underlain by Pennsylvanian rocks (stippled) in southwest Virginia.

formations and to show these units on a geologic map. His units were:

Harlan Sandstone
Wise Formation
Gladeville Sandstone
Norton Formation
Lee Conglomerate

Campbell's publication and map covered parts of Lee, Wise, Russell, and Scott Counties, Va., and small parts of adjoining Harlan and Letcher Counties, Ky. The location of features from which Campbell's names were derived is shown in figure 2.

These names were adopted by later workers and in particular by writers of a series of county reports on the Virginia coal fields (Harnsberger, 1919; Giles, 1921, 1925; Wentworth, 1922; and Eby, 1923). The only formation name of Campbell that gained acceptance in the adjoining states of Tennessee and Kentucky was the Lee Formation. In the Pocahontas coal fields, Tazewell County, Va., there is a tendency to use the formation names of adjoining West Virginia rather than those of Campbell. Elsewhere in the Virginia coal fields, however, the Campbell names are firmly intrenched, and they have been re-

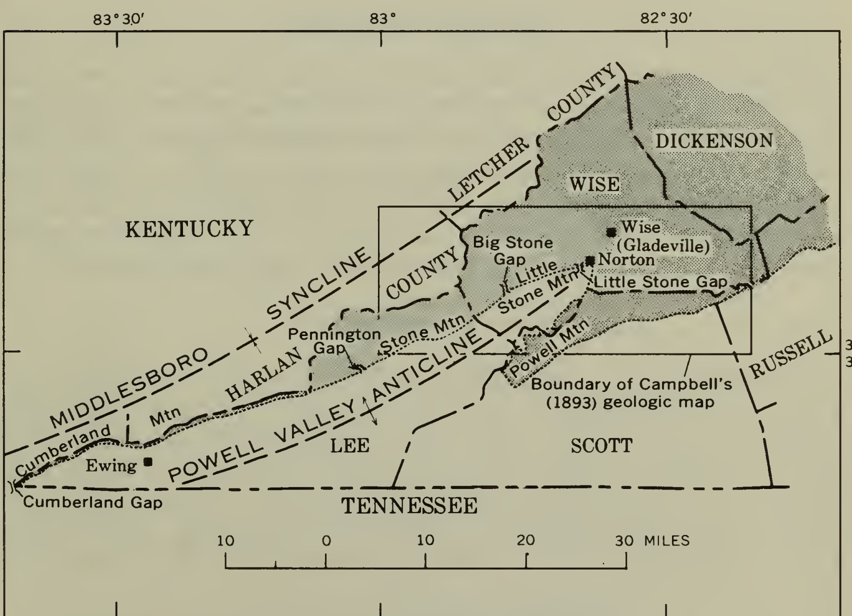

FIGURE 2.—Geographic localities for geologic names used by Campbell (1893) for Pennsylvanian formations of southwest Virginia. Stipple indicates area underlain by rocks of Pennsylvanian age.

iterated as recently as 1963 on a geologic map of Virginia by the Virgina Division of Mineral Resources (1963).

Campbell (1893), following the custom of the day, indicated the general region where each of his five named formations was well represented, but he did not designate specific type localities and he included only one measured section of a Pennsylvanian formation. His general descriptions have, however, been used by subsequent workers in identifying, not always correctly, the formations he named.

In both detailed and reconnaissance mapping in the western part of the Big Stone Gap coal field, including the area from Wise in Wise County to a point 5 miles west of Pennington Gap in Lee County (fig. 2), I have been faced with the problem of exactly what rocks should be included in each of the five named formations of Pennsylvanian age in Virginia. Much time has been spent finding and measuring suitable sections and tracing units from their type regions as designated by Campbell (1893) into the areas of my detailed mapping. As a result, it is now possible to designate exact type and reference localities and to present type and reference sections for the Pennsylvanian formations of Virginia, thus describing these formations as recommended by the Stratigraphic Code.

ACKNOWLEDGMENTS

During part of my mapping and stratigraphic studies in both field and office, I was assisted by John B. Roen, whose help is gratefully acknowledged. I am also indebted to Mr. William Shupe of the Stonega Division of Penn Virginia Corporation, to Mr. Clifford L. Stallard of the Wise Coal and Coke Co., and to Mr. William A. Thompson, Jr., of Thompson and Litton Engineers for providing engineer's logs of deep drill holes, information from which is used in this report.

LEE FORMATION

Campbell (1893) named the lowest formation of the Pennsylvanian System the Lee Conglomerate for Lee County, Va. (fig. 2), "as it constitutes the northwestern line of that county from near Pennington Gap to Cumberland Gap, a distance of 35 miles." It crops out on both flanks of the Middlesboro syncline in Virginia, Kentucky, and Tennessee (fig. 2). The name Lee is still used in Kentucky and Virginia, but the Tennessee Division of Geology (Wilson and others, 1956) has proposed new nomenclature for beds equivalent to the Lee, as well as for younger Pennsylvanian formations. In Lee County, Va., the lower part of the Lee forms the upper slopes and crest of Cumberland Mountain and the middle and upper parts of the formation underlie the back slopes of the mountain in adjoining Bell and Harlan Counties, Ky. Cumberland Mountain (fig. 2) continues northeastward into Wise County, Va., but its name changes successively to Stone Mountain, Little Stone Mountain, and Powell Mountain (fig. 2, pl. 1).

The Lee Formation in its type region is composed of a heterogeneous sequence of quartzose sandstone, conglomerate, siltstone, and shale and contains a few coal beds. Outcrops of the resistant sandstone and conglomerate units are abundant, and these units form high cliffs or prominent flanges in many places on the mountains. The intervening less resistant units are, however, almost completely covered on the mountain slopes but are partly exposed in railroad and highway cuts through gaps in the mountain. For this reason and also because of the rugged topography of the mountains formed by the Lee, there are but four places in Virginia in the type region where good sections of the Lee may be measured. These are Cumberland Gap and Pennington Gap in Lee County and Big Stone Gap and Little Stone Gap in Wise County (fig. 2).

When Campbell (1893) introduced the name Lee Conglomerate, he stated that the Lee "is best exposed at Big Stone Gap," and he included a measured section 1,531 feet thick divided into 12 units. Although the term "type section" was not in vogue at that time, Campbell's intent seems to have been to designate his published section at Big Stone Gap, which he called the "best exposed" one, as the section typical of the formation. Eby (1923, p. 65), in the Wise County report to which Campbell contributed, states: "The formation is named for Lee County, Va., although the type section as described by Campbell is in Big Stone Gap." The section still is well exposed; Campbell correctly interpreted and diagrammed the folded structure in the gap, and his generalized section is in proper order of units. The name has been changed from Lee Conglomerate to Lee Formation by later workers, however, because of the heterogeneous lithology of the formation.

I have remeasured the section at Big Stone Gap in more detail than did Campbell (geologic section 1). Most exposures of the Lee are in cuts along the two railroads that follow opposite sides of the Powell River through the gap and that reverse sides in the middle of the gap. Some parts of the Lee are better exposed on one side of the river and other parts are better exposed on the opposite side, so the section was measured partly along the west side and partly along the east. Figure 3 shows the location of prominent resistant sandstone units in the Lee.

BEE ROCK SANDSTONE MEMBER

Campbell (1893) designated the topmost sandstone of his Lee section at Big Stone Gap as the Bee Rock Sandstone. He derived the name from an earlier publication of Stevenson (1881), who stated that the

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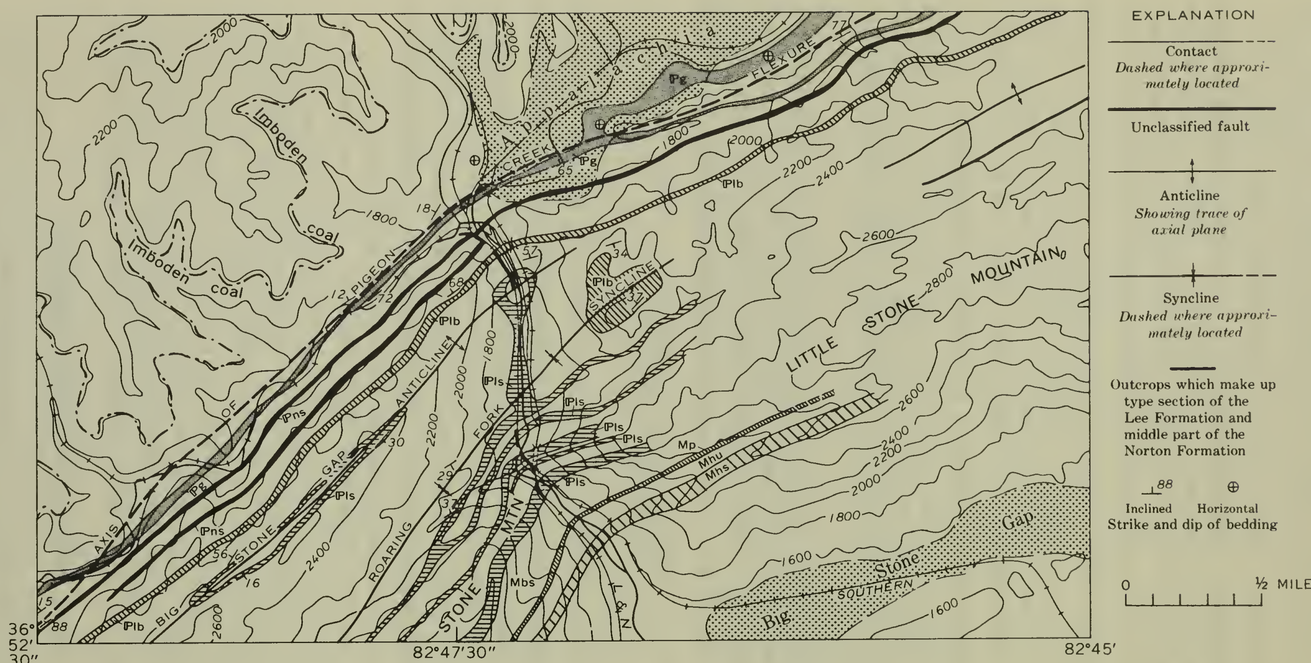

FIGURE 3.—Partial geologic map of the area around Big Stone Gap, Wise County, Va., showing major structural features, outcrop belts, and resistant sandstone units within the following formations of Mississippian and Pennsylvanian age: Stony Gap Sandstone Member of Hinton Formation, resistant (Mhs); upper member of Hinton Formation, nonresistant (Mhu); Princeton Sandstone, resistant (Mp); Bluestone Formation, nonresistant (Mbs); unnamed sandstone units in Lee Formation, resistant (ℙls); Bee Rock Sandstone Member of Lee Formation, resistant (ℙlb); unnamed sandstone units in Norton Formation, resistant (ℙns); Gladeville Sandstone, resistant (ℙg). Contour interval is 200 feet.

highest bed of the Seral (Pottsville) Conglomerate at Big Stone Gap "is a moderately fine-grained rock and is well shown at the head of the gap, where it dips at 80°. This is known as the 'Bee Rock,' as the laurel blossoms covering it are the resort of immense numbers of bees during the early summer." The Bee Rock forms a prominent unit on the lower northwest slopes of Stone Mountain and Little Stone Mountain, which is readily traceable on aerial photographs and in the field. Where the beds dip steeply to vertical, the Bee Rock forms a flange as at Big Stone Gap, where the Louisville and Nashville Railroad passes through it in a tunnel. Where beds dip more gently, southwest of Big Stone Gap, the Bee Rock forms sheer south-facing cliffs as much as 80 feet high. I have mapped the Bee Rock in the field from Norton, 10 miles northeast of Big Stone Gap, to the south edge of the Pennington Gap quadrangle, 19 miles southwest of Big Stone Gap. Englund (1964, p. B37) has traced the Bee Rock an additional 34 miles southwest to Cumberland Gap. In most places the Bee Rock is a quartzose, massive-bedded, crossbedded, medium- to coarse-grained sandstone, but locally it contains lenses or thick zones of pebbly conglomerate. Nowhere within the Bee Rock have I seen abundant conglomeratic pebbles larger than a half an inch in diameter, though a few pebbles may exceed this size.

At the Louisville and Nashville Railroad tunnel in Big Stone Gap, the Bee Rock Sandstone Member is about 95 feet thick, of which the lower 90 feet of beds are well exposed, and the upper part, estimated to be about 5 feet thick, is concealed. A thickness of about 80 to 100 feet is persistent northeastward to Norton and also for several miles southwestward. At Pennington Gap, however, the Bee Rock is 213 feet thick along the highway, and it seems to be about 250 feet thick at the Louisville and Nashville Railroad tunnel three-quarters of a mile east of the highway. The explanation for this large westward increase in thickness became clear when the member was mapped continuously between the two gaps. About 5½ miles northeast of Pennington Gap and 1 mile southwest of the small town of Delvale, a siltstone and shale unit appears within the thick Bee Rock Sandstone Member. This unit thickens northeastward and separates a lower cliff-forming quartzose sandstone about 100 feet thick from a higher cliff-forming quartzose sandstone as much as 60 feet thick. This upper sandstone continues to be more than 30 feet thick for about 5 miles northeast of Delvale. Beyond this point, however, it thins, and near the Wise County-Lee County line it disappears (pl. 1). Thus, the Bee Rock at Pennington Gap and farther southwest includes not only the main sandstone unit of the type Bee Rock at Big Stone Gap but also a higher quartzose sandstone tongue of typical Lee (and Bee Rock) lithology that has merged with it about 5 miles northeast of Pennington Gap.

Englund and DeLaney (1966, fig. 2) have also noted this pronounced thinning of the Bee Rock Sandstone Member of the Lee between Pennington Gap and Big Stone Gap and have attributed it to the dying out eastward of a sandstone tongue of the Bee Rock. They have interpreted the tongue as being the lower part of the Bee Rock at Pennington Gap, which thus would be intertongued with the underlying nonresistant unit of the Lee. My detailed mapping in this region indicates, however, that between the two gaps the upper part of the Bee Rock is intertongued with nonresistant beds of the lower part of the overlying Norton Formation. (See pl. 1.)

BALD ROCK CONGLOMERATE MEMBER

Eby (1923, p. 65) named another member of the Lee the Bald Rock Conglomerate Member, which he described as the middle resistant conglomerate of the Lee. He took the name from a prominent mountain near Miller Yards (railroad yards), 4 miles northeast of Dungannon in Scott County, and 6 miles south-southeast of Coeburn, Wise County (pl. 1). This feature is labeled Bald Rock on Eby's geologic map but is unnamed on the 1957 edition of the 7½-minute topographic map of the Dungannon quadrangle; it is the prominent mountain lying 0.4 mile northwest of the switchback at Miller Yards. A resistant conglomerate unit, overturned and dipping 50° southeast, forms a bare rock dip slope on the south flank of Bald Rock Mountain. This is apparently the conglomeratic unit to which Eby attached the name Bald Rock Conglomerate Member. In air photos, this unit is very prominent, and it may readily be traced to the water gap of the Clinch River 0.6 mile east-northeast. In this gap the unit crops out along the railroad track of the Clinchfield Railroad on the west side of the river, and it forms a very prominent flange from water level to a mountain top on the east side of the river. It is a massive-bedded pebbly conglomerate and is at least 30 feet thick. It lies, however, at the base of the Lee, rather than higher in the formation. This same unit was likewise picked as the base of the Lee by Wilpolt and Marden (1949, 1959), who measured an Upper Mississippian section at Miller Yards. They also commented that the conglomerate unit is "very resistant and very striking on the aerial photographs." Eby did not map his Bald Rock Conglomerate Member separately nor did he trace it continuously; he seems to have mistakenly assumed that the resistant unit at Bald Rock was the same as the second resistant unit in the water gap. This second unit, which is coarse grained to pebbly, is almost 600 feet higher stratigraphically and is partly exposed in the core of a syncline along the railroad. If the name Bald Rock Conglomerate Member of the Lee is used in the future, it should be applied to the resistant conglomeratic sandstone at the base of the Lee in the vicinity of Bald Rock and Miller Yards. Eby (1923) did not measure a section of his Bald Rock Conglomerate Member at Miller Yards, so no type section has been established. A better section than the very poor Miller Yards section should be found, if possible, for the type section. At the Clinch River water gap sizable covered intervals are present, both above and below the exposed beds of the basal resistant conglomerate unit, and the unit may be considerably thicker than the apparent 30 feet.

MEMBERS OF THE LEE FORMATION NEAR CUMBERLAND GAP

Englund (1964) has divided the Lee in the Cumberland Gap region into seven mappable members. These are:

- Hance Formation
- Lee Formation
  - Bee Rock Sandstone Member
  - Hensley Member
  - Middlesboro Member
  - Dark Ridge Member
  - White Rocks Sandstone Member
  - Chadwell Member
  - Pinnacle Overlook Member
- Pennington Formation

He demonstrates intertonguing of resistant and nonresistant units in this region, not only within the Lee, but also at its base; the lowest resistant member of the Lee at Cumberland Gap, his Pinnacle Overlook Member, intertongues with the uppermost part of the underlying Pennington Formation of Mississippian age and dies out 16 miles east-northeast of Cumberland Gap.

Englund and DeLaney (1966) traced the named members of the Lee in the Cumberland Gap area northeastward to determine the relation of the Lee Formation of Lee and Wise Counties to the Pocahontas and New River Formations of Tazewell County, Va., and adjoining areas of West Virginia. They believe that the basal resistant sandstone unit of the Lee, about 275 feet thick at Pennington Gap, is the same as the White Rocks Sandstone Member of the Lee in the Cumberland Gap-Ewing region (fig. 2), but they incorrectly show this basal resistant unit tonguing out eastward between Pennington Gap and Big Stone Gap. My mapping between the two gaps, based on dozens of traverses up Stone Mountain, indicates that the basal resistant sandstone and conglomerate unit at Pennington Gap is continuous through and northeast of Big Stone Gap. Study of aerial photographs and of a considerably thinner section of the Lee at Little Stone Gap, 7 miles northeast, suggests strongly that this basal unit does lens out between

Big Stone and Little Stone Gaps. Hence, it intertongues with the underlying Bluestone Formation at the top of the Pennington Group as Englund and DeLaney interpret, but this basal tongue seems to die out northeast of Big Stone Gap rather than southwest of it.

In mapping the Lee in western Wise and eastern Lee Counties, I have mapped individually all resistant sandstone and conglomerate units more than 30 feet thick, and I have also mapped thinner resistant units where they made prominent outcrops or topographic features. These resistant sandstone and conglomerate units are moderately to very quartzose and normally have very few impurities. They are commonly nearly white when fresh and light colored when weathered. They are predominantly medium grained, but coarse-grained and pebbly sandstone beds are common and lenses and thick beds of pebble conglomerate are also common. Conglomerate and pebbly sandstone are more abundant in the basal and near-basal resistant units of the Lee but may be present in higher units. West of Big Stone Gap the Bee Rock is notably pebbly, but at its type locality in the gap it is entirely sandstone.

Resistant sandstone and conglomerate units are almost the only rock types visible on the mountains formed by the Lee, and even in the water gaps few of the intervening nonresistant beds are exposed. Nevertheless, these nonresistant beds form a large part of the formation, which in the type section at Big Stone Gap amounts to 49 percent of the total thickness. Most of these poorly exposed beds seem to be composed of medium-dark-gray siltstone and shale, although thin sandstone beds or units are undoubtedly present.

Coal beds and associated underclays are included in the Lee but most are thin. In Wise County, chips of coal are found at various horizons in the Lee in cuttings from deep wells that have penetrated the formation, and several coal beds crop out in cuts in Big Stone and Pennington Gaps. The thickest coal bed (geologic section 1, unit 19), about 500 feet above the base of the formation, is 4.7 feet thick, but the coal is so badly sheared that the original thickness before folding and shearing cannot be determined here. Another coal bed, 2.7 feet thick (geologic section 1, unit 15) but also badly sheared, lies about 85 feet lower in the section. Probably other coal beds are present, particularly in the middle and upper parts of the formation. Steep dips along Stone Mountain and its east and west extensions, as well as the sheared condition of visible coal beds, have discouraged mining and prospecting. Where the Lee Formation again comes to the surface on the northwest flank of the Middlesboro syncline, a coal bed in the upper part of the Lee Formation has been mined near Elkhorn City, Ky. Englund and DeLaney (1966) correlate the rich coal-bearing Pocahontas Formation and the lower part of the New River Formation in Tazewell

County, Va., and adjoining West Virginia with much of the Lee Formation.

The Lee Formation is 1,596 feet thick at its type locality at Big Stone Gap. Englund and DeLaney (1966) showed it to be about 1,675 feet thick at Pennington Gap to the west. In a series of wells of the Clinchfield Coal Co., starting at a point 3 miles north of Appalachia and continuing 30 miles northeastward, the Lee decreases from 1,349 feet to 1,148 feet. Thus, the Lee seems to maintain a rather constant thickness westward from its type section at least as far as Pennington Gap, but it thins markedly both northward and northeastward. A great part of this northeastward thinning is probably due to loss of beds at the base through intertonguing with the Bluestone Formation at the top of the Pennington Group, but Englund and DeLaney (1966, fig. 2) indicated that the Bee Rock Sandstone Member at the top of the Lee lenses out in an eastward direction by intertonguing with the lower part of the Norton Formation about 20 miles from Big Stone Gap.

NORTON FORMATION (Preliminary Discussion)

The Norton Formation is characterized by impure sandstone, siltstone, shale, and coal beds, which in places are commercial. Campbell (1893) named the formation for the town of Norton in Wise County, Va. (fig. 2), and defined it as including all beds between the Lee Conglomerate (Formation) below and the Gladeville Sandstone above. He estimated the Norton to be about 1,300 feet thick. As previously noted, the top of the Lee, and hence the base of the Norton, in Virginia is the top of the Bee Rock Sandstone Member, which seems to be a persistent unit from the Tennessee State line for at least 60 miles to the northeast. The thick Wise Formation overlying the Gladeville Sandstone also consists of impure sandstone, siltstone, shale, and coal beds, very similar in overall aspect to the Norton. Thus, delineation of the Norton and Wise Formations depends on recognition and tracing of the rather thin Gladeville Sandstone that separates them. This seemingly simple stratigraphic problem has instead proved extremely difficult. Inasmuch as the upper limits of the Norton cannot be discussed until the identity of the Gladeville is established, the Gladeville Sandstone is described below out of stratigraphic sequence before returning to discuss the Norton Formation more completely.

GLADEVILLE SANDSTONE

The Gladeville Sandstone has been a problem formation ever since Campbell named it in 1893. Though Campbell believed that the "massive sandstone or conglomerate," which he named for the town of Gladeville (since renamed Wise), Wise County, Va., and which he said ranged in thickness from 75 to 120 feet, was distinctive and could be readily recognized over a wide area of the Virginia coal fields, the reverse has proved true. Campbell, himself, misidentified as being Gladeville a sandstone, which is about 300 feet higher in the section, near the town of Norton and only 4 miles from Wise (Eby, 1923, p. 67); from here on westward in Virginia and in adjoining Harlan County, Ky., Campbell's mapped Gladeville Sandstone in his original publication (1893) and in the Estillville folio (Campbell, 1894), which includes the type region, is not the true Gladeville Sandstone on which downtown Wise is situated.

Eby (1923) corrected Campbell's misidentification of the Gladeville Sandstone around Norton and traced the Gladeville another 4 miles westward along the base of Stone Mountain, where the steep dips on the northwest flank of the Powell Valley anticline flatten abruptly. At Blackwood (pl. 1) this flexure is nearly a right angle; because of the crowding of competent and incompetent beds, including thick coal beds, at the hinge of this sharp inflection, a few feet of fault displacement has resulted. This very minor fault is observable in a railroad cut of the Interstate (now Southern) Railroad just east of Blackwood, where it was noted by both Eby and Campbell, but it is even better exposed in a recent highway cut close above the railroad. Eby could not find the Gladeville Sandstone west of Blackwood. He concluded that its apparent absence was due to westward increase in the displacement of the "incipient fault" in the Blackwood railroad cut, which eliminated the Gladeville at the surface. He and Campbell, who wrote a section on the history of geologic work and the correlation of coal beds in Eby's Wise County report (1923, p. 73–114), both believed that this fault increased with corresponding elimination of stratigraphic section to a maximum of 1,500 feet at the head (north side) of Big Stone Gap. West of the gap the displacement on this fault was said to decrease gradually to Laurel Fork of Pigeon Creek where the fault terminated and the Gladeville Sandstone reappeared at the surface. Eby named this fault the Pigeon Creek fault, because the trace of the fault as drawn lay near that creek west of Big Stone Gap.

In 1962 I began mapping the Pennsylvanian rocks of the Big Stone Gap quadrangle, which includes the town of that name and which lies just south of the gap itself. In mapping the part of the section where the Gladeville Sandstone should be, two things quickly became apparent. First, there were several, very similar, massive-bedded, resistant sandstone units, somewhat arkosic but otherwise quite clean, ranging in thickness from 30 to 50 feet; any one of these might be the Gladeville. There was no sandstone 75 to 125 feet thick in this part of the section, nor was there one of distinctive lithology. Second, no evidence for faulting was noted anywhere along the course of the presumed Pigeon Creek fault, except for the very minor movement visible in the railroad and highway cuts at Blackwood. Instead, in a cut of the Louisville and Nashville Railroad just south of the trestle across the Powell River at the head of Big Stone Gap, an outcropping sandstone follows continuously around the sharp flexure, without any rupturing, at the place where the Pigeon Creek fault with 1,500 feet of displacement and elimination of beds is supposed to occur. Subsequently, a similar relation was found along strike 1,000 feet to the west at the junction of Pigeon Creek and Looney Creek. These two findings cast doubt not only on the identification of the Gladeville Sandstone by Eby in his mapping west of Laurel Fork of Pigeon Creek but also on the existence of the Pigeon Creek fault. Furthermore, if there is no Pigeon Creek fault, where is the Gladeville Sandstone in the 8-mile stretch between Blackwood and Laurel Fork?

To resolve this problem, John B. Roen and I have mapped a belt of rocks that includes the Gladeville Sandstone at a scale of 1:10,000; the belt extends from the type locality of the Gladeville at the town of Wise, southwestward to Norton, thence west-southwestward through Blackwood, Appalachia, and the head of Big Stone Gap, to the north edge of the Big Stone Gap quadrangle. West of Blackwood the line of outcrop is largely south of the Powell River on the steep timbered lower slopes of Little Stone Mountain. The Gladeville and other sandstones above and below the Gladeville were mapped without finding any evidence for faulting and elimination of beds. This unpublished mapping has been summarized at much smaller scale on plate 1. In places along the lower slopes of the mountain, debris from the steep mountain slopes above and heavy vegetation cover the bedrock for considerable distances, so it cannot be said that the Gladeville has been traced continuously from Wise to the Big Stone Gap quadrangle. There were only two places where there was doubt that the mapped sandstones were correctly matched on opposite sides of covered intervals. One of these places is near the east edge of the Appalachia quadrangle, where a prominent spur protrudes northward from the main ridge of Little Stone Mountain. Several very similar sandstone units are present on the crest of this spur, but I have considerable confidence that the one we believed to be the Gladeville is the same resistant sandstone as the one that Roen and I followed and mapped from Wise to this point. From here to the town of Appalachia, a distance of 1 mile, almost continuous cover of this part of the section makes it less than certain that I have correctly connected mapped sandstones across the interval. Nevertheless, similarity of section, spacing of sands, and

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stratigraphic distance above the top of the Bee Rock Sandstone member support the mapping, and it is probably right.

As a further check on the geologic mapping, a series of 12 structure sections was drawn from Norton to the mouth of Laurel Fork (pl. 1, section lines *A–A′* to *L–L′*). The top of the Lee and the Gladeville Sandstone were plotted to scale in each section. In addition, the Imboden coal, which lies about 450 feet above the Gladeville and is exposed almost continuously in strip mines, was included in those sections (*F–F′* to *L–L′*) where it lies close to the Gladeville belt of outcrop. One section, *J–J′* (pl. 1), is at the head of Big Stone Gap. A summary of all the measurements from these 12 sections is shown in table 1. The consistent thickness from the top of the Lee Formation to the Gladeville Sandstone and from the base of the Gladeville to the Imboden coal further substantiates that the Gladeville has been correctly mapped from Norton to and beyond the head of Big Stone Gap; it also offers additional proof that no sizable fault such as the presumed Pigeon Creek fault exists along the flexure at the foot of Little Stone Mountain and Stone Mountain from Blackwood to the mouth of Laurel Fork. Because of these findings, the Pigeon Creek fault was not shown on the 1963 geologic map of Virginia (Virginia Division of Mineral

TABLE 1.—*Thickness of intervals, in feet, from the top of the Lee Formation to the base of the Gladeville Sandstone and to the Imboden coal in the Wise Formation*

[Measurements are from 12 structure sections between Norton and the mouth of Laurel Fork, Wise County, Va. See plate 1 for location of sections]

Structure section	Top of Lee formation to—		Base of Gladeville Sandstone to Imboden coal
	Base of Gladeville Sandstone	Imboden coal	
A–A′	850		
B–B′	885		
C–C′	865		
D–D′	[1] 1, 110		
E–E′	930		
F–F′	840	1, 560	720
G–G′	970	1, 600	630
H–H′	880	1, 525	635
I–I′	([2])	1, 500	
J–J′	925	1, 505	580
K–K′	920	1, 480	560
L–L′	895	1, 440	505
Range	[3] 840–1, 110	1, 440–1, 600	505–720

[1] Interval in doubt because of observed small-scale folding in the Norton Formation which could not be compensated for.
[2] Gladeville not identified with certainty in this section.
[3] Probable range is from 840 to 970 feet. See footnote 1.

Resources, 1963). The very sharp flexure along the base of the mountain from Norton to the mouth of Laurel Fork is here named the Pigeon Creek flexure. Mapping by Roen and myself also seems to disprove the existence of a similarly located fault at the head of Pennington Gap, named the North Fork fault (Giles, 1925).

Stratigraphic sections were also measured across the Gladeville interval at favorable localities from Norton to Big Stone Gap to supplement and control the geologic mapping. These sections contain many resistant sandstone units; the thicker units have been traced for miles. Correlation of these very similar resistant sandstone units without mapping key units between sections is very difficult and emphasizes the problems Campbell, Eby, and other earlier workers faced in trying to identify the Gladeville Sandstone throughout the Big Stone Gap coal field.

No measured section of the Gladeville Sandstone was given by Campbell when he named the formation. It is clear, however, from Campbell's collaboration in the Wise County report (Eby, 1923) that he intended the name to apply to the massive sandstone that is visible in roadcuts of U.S. Highway 23 on the south edge of the town of Wise and on top of which the courthouse and other downtown buildings are situated (fig. 4). This sandstone, which crops out conspicuously at many places in and near town, is massive bedded, strongly crossbedded, white, quartzose, and medium grained. It is extremely difficult to get accurate measurements of the thickness of the Gladeville Sandstone from surface sections at the town of Wise, because the base and top of the formation are not exposed anywhere in close proximity and the persistent crossbedding makes it almost impossible to measure meaningful dips and strikes to correct for dip. The best thickness measurement I could obtain was from the base of Gladeville ledges in the woods west of the hill on which the water tank and Wise County Memorial Hospital are located to the hillcrest, which is believed to be capped by beds very near the top of the formation. This measurement gave a thickness of 51 feet.

Thompson and Litton Engineers of Wise, Va., have kindly made available to me the logs of cores from three diamond-drill holes near Wise, each of which penetrated all of the Gladeville. In hole 1 (table 2), a mile north of the center of town, an upper sandstone 32 feet thick and a lower sandstone 17 feet thick are separated by 11 feet of black shale. In hole 2 (table 2), a mile and a half north-northwest of town, two sandstone units 32 feet and 27 feet thick, respectively, are separated by 13 feet of shale and a ½-inch-thick coal bed. In hole 3 (table 2), 2 miles north-northwest of the center of town, an upper sandtone 47 feet thick and a lower sandstone 21 feet thick are separated by

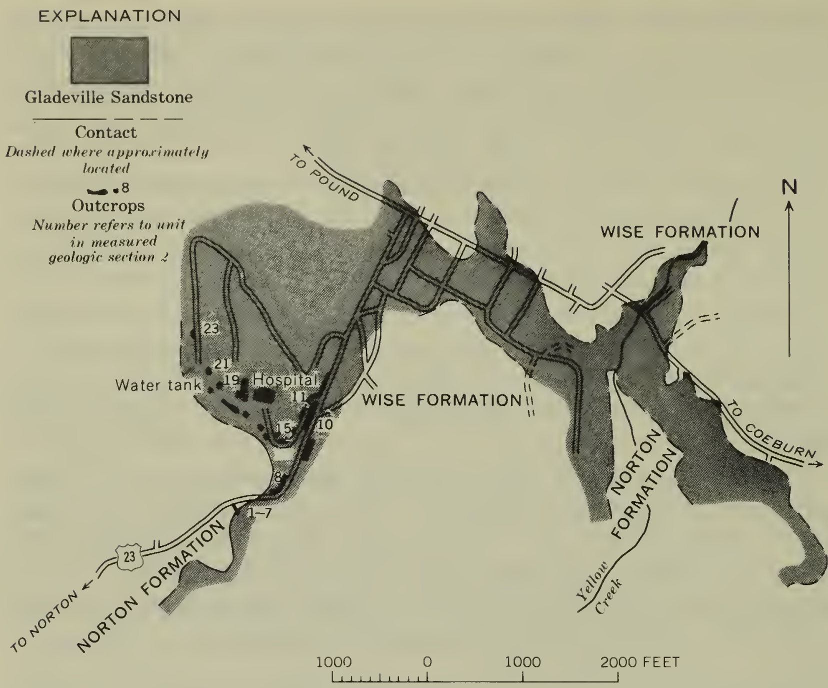

FIGURE 4.—Location of outcrops and distribution of part of the Gladeville Sandstone (shaded) and adjacent formations at Wise, Va.

18½ feet of dark shale. In the three holes the Norton coal lies 2 to 8 feet below the lower sandstone, and the Dorchester coal lies 14 to 35 feet above the upper sandstone. In the type section of the Gladeville Sandstone in the town of Wise (geologic section 2), a lower sandstone more than 12 feet thick lies 2½ feet above the Norton coal. It is very fine grained and micaceous, and this description does not fit the lithologic concept of the Gladeville Sandstone. By position this should be the lower sandstone of the three drill holes; in the driller's logs, lithologic details of this unit are omitted. Hence, the upper sandstone in the three drill holes is the sandstone in the town of Wise to which Campbell (1893) gave the name Gladeville. Thus, the thickness of the formation in these holes is 32 feet, 32 feet, and 47 feet (table 2), which is considerably less than Campbell's 75 to 120 feet (1893, p. 33) and Eby's (1923) 90 to 110 feet. The coal operators in the vicinity of Wise also cite about 100 feet as the thickness of the Gladeville Sandstone. The explanation for the discrepancy in the case of the coal operators is that they include within the Gladeville all beds that are between the Norton and Dorchester coals for the sake of convenience and because they have abundant data on the position of these coals and the interval between them in northern and eastern Wise County. Campbell's (1893) greater thickness for the Gladeville at Wise may have been due to the difficulty of getting accurate measurements at the surface of a "spread out" crossbedded sandstone. My first attempt at such a measurement in the town of Wise resulted in a calculated thickness of 83 feet, which later proved to be about 32 feet too great. Eby (1923) may have encountered the same problem or he may have accepted Campbell's approximate thicknesses. Nowhere does Eby indicate that he includes all beds between the two coals within the Gladeville Sandstone, though his geologic map of Wise County does show the Norton and Dorchester coals directly in contact with the mapped Gladeville, probably because of lack of space at the inch-to-the-mile scale of the map.

TABLE 2.—*Thickness of sandstone and shale units, in feet, between the Norton and Dorchester coals in three diamond-drill cores and in geologic section 2 in the vicinity of Wise, Va.*

Unit	Drill hole			Section 2 (see fig. 4)
	1	2	3	
Base of Dorchester coal to top of upper sandstone	35	14	22	--------
Upper sandstone	32	32	47	[1] 55±
Shale and associated nonresistant rocks	11	13	18½	32±
Lower sandstone	17	27	21	12+
Base of lower sandstone to top of Norton coal	3	2	8	2½
Total thickness	98	88	116½	97½+

[1] Includes estimated 4 feet of covered beds at top of formation.

I believe that the Gladeville Sandstone should be restricted to the massive resistant sandstone unit because this sandstone makes a mappable unit, whereas the whole interval between the two coals includes units of nonresistant and normally covered beds almost greater or even greater in thickness than the resistant sandstone. Moreover, the Dorchester and Norton coals are accurately located only in areas of intensive mining or prospecting, and the fact that both coals seem to disappear west of Big Stone Gap and to thin markedly eastward from Wise leaves no good criterion for mapping the Gladeville beyond these limits. Finally, restricting the Gladeville to the massive resistant sandstone unit fits Campbell's original definition of the formation at Wise, though in his discussion he does include some sandy shale units in the Gladeville elsewhere.

The same difficulty that exists in trying to measure an accurate thickness of the Gladeville in the vicinity of Wise also exists in trying to find a good type section for the formation. The Gladeville disappears beneath the surface north of Wise. East, west, and south of the town I could find many outcrops, including prominent ledges and small cliffs of the Gladeville Sandstone, but none of these provided a good section of the entire formation that could be measured with accuracy. The most suitable section seems to be the one that starts along U.S. Highway 23 just south of the bend in the highway at the south edge of town and ends at the top of the high hill behind the county hospital and the town water tank. Exposures along this section are abundant and lithologies are well represented; however, thicknesses of individual units within the crossbedded sandstones cannot be measured accurately, and the attempted measurements had to be adjusted to fit an overall thickness of 51 feet at this locality (p. 15). Because this section seems to be the best one near Wise (Gladeville), it is here designated the type section (geologic section 2); figure 4 shows the location of measured units.

The Gladeville Sandstone has been traced southwestward to the north edge of the Big Stone Gap quadrangle as previously explained. In the Big Stone Gap quadrangle (Miller, 1965) it is a resistant sandstone 35 to 40 feet thick, quartzose to slightly feldspathic, predominantly medium grained, massive bedded, and crossbedded. It has also been mapped across the Keokee quadrangle (Miller and Roen, 1969) adjoining the Big Stone Gap quadrangle on the west. The Gladeville becomes thinner near the west edge of the Keokee quadrangle and probably does not persist as a mappable unit across westernmost Lee County to the Kentucky State line. It is not the sandstone mapped as Gladeville by Campbell (1893) southwest of Norton and in Kentucky, nor is it the sandstone mapped as Gladeville by Giles (1925) in Lee County. I do not know if the mapped Gladeville in county reports that deal with the coal fields east of Wise is everywhere the same sandstone unit as the type Gladeville, but major errors in recognition and mapping of the Gladeville in this region seem less likely because of less complicated structure and availability of more mining and exploration data.

In spite of problems in identifying the Gladeville Sandstone, the formation is stratigraphically very useful in Virginia because it divides a very thick sequence of clastic continental coal-bearing sedimentary rocks between the Lee and Harlan Formations into three more manageable parts. Its retention as a mapped formation in Virginia is warranted, but experience has proved that misidentification of the Gladeville is all too easy. Unusual care must be exercised to assure that Gladeville is applied to the correct resistant sandstone unit. Detailed mapping in this part of the section seems to be the only sure criterion for its identification, except where abundant mining and drilling data are available.

NORTON FORMATION

The Norton Formation by definition includes all beds between the top of the Lee Formation and the base of the Gladeville Standstone. Campbell (1893, p. 34) named it for the town of Norton where, because he misidentified the Gladeville Sandstone, he thought the nearly flat-lying beds beneath the business district and in the hills north of town were beneath the Gladeville, and hence were part of the Norton Formation (Eby, 1923, p. 67). Instead, the Gladeville crops out in the steeply dipping sequence of beds south of the business district and railroad tracks, and the Norton, also steeply dipping and very poorly exposed, lies in the lower slopes of Little Stone Mountain (pl. 1).

In Wise and Lee Counties the Norton crops out along the lowest slopes of Stone and Little Stone Mountains and in places underlies parts of the lowlands north of the mountains. Because it is composed predominantly of nonresistant rocks, one or another of the larger streams of the region have subsequent courses along its belt of outcrop. From east to west these are the Guest River, Powell River, and Pigeon Creek in Wise County and North Fork of the Powell River and Stone Creek in Lee County.

The Norton is a heterogeneous sequence of clastic sedimentary rocks composed predominantly of dark siltstone and shale with lesser amounts of thin-bedded fine-grained sandstone, more resistant medium-grained sandstone, and coal beds. The overall aspect of the Norton differs markedly from the underlying Lee Formation and somewhat from the Wise Formation, from which it is separated only by the rather thin Gladeville Sandstone. The proportion of shale and siltstone to sandstone is much greater in the Norton than in the Lee, and somewhat greater than in the Wise Formation. Norton sandstone units are characteristically medium to dark colored, fine or medium grained, impure, and micaceous, and some are feldspathic. Lee sandstone units are light colored, quartzose, and may be conglomeratic. Wise sandstone units are typically light colored, white speckled, and feldspathic with few dark minerals; mica (muscovite), if present, is in widely scattered flakes, which may be large and very conspicuous. The siltstone and shale units of the Lee, Norton, and Wise Formations, on the other hand, are very similar, though in western Wise and in Lee Counties the shale and siltstone units in the Wise Formation seem to contain more abundant ironstone beds and bands of nodules than do those in the Norton Formation.

Gray siltstone and shale and a few thin interbeds of fine-grained impure sandstone form the lowest 250 to 400 feet of the Norton Formation. These nonresistant beds crop out only in a few places. Above this nonresistant sequence, resistant sandstone units form a significant part of the formation, though drab shale and siltstone still predominate. Fine-grained impure micaceous sandstone is more common, but some units are medium-grained crossbedded feldspathic sandstone similar to that in the Wise Formation. No two sections of the middle and upper parts of the Norton are alike in order and spacing of units. Some resistant thick sandstone units may be traced for several miles, but none seem extensive enough to warrant member status.

Coalbeds in the Norton Formation have been mined extensively, east of Norton (Harnsberger, 1919; Giles, 1921; Wentworth, 1922; Eby, 1923). West of Norton there has been little mining of Norton coalbeds, because most of the Norton Formation is steeply dipping to nearly vertical and is largely covered by colluvium and talus on the steep lower slopes of Little Stone Mountain for the first 10 miles west of Norton; farther west most Norton coalbeds are too thin and discontinous to have attracted much interest. In westernmost Lee County in the Pennington Gap quadrangle, the Norton and Wise Formations were not mapped separately because the intervening Gladeville Sandstone has pinched out. In the mining district known as The Pocket (pl. 1), in the Pennington Gap quadrangle three named coalbeds have been mined in the part of the section equivalent to the Norton. These are (from oldest to youngest) the Bentley, North Fork, and Penn Lee coals. The Penn Lee coal, which averages about 3 feet thick, has been most extensively mined; the Bentley, least.

Northeast and east of the town of Norton, in eastern Wise, Dickenson, and Buchanan Counties, the Norton is gently dipping to nearly flat, and it is the most important coal-bearing formation. County reports (Eby, 1923; Giles, 1921; Hinds, 1918) list the named coalbeds in the Norton (from oldest to youngest) as Tiller, Jawbone, Raven, Aily, Kennedy, Lower Banner, Upper Banner, Splash Dam, Hagy, and Norton (Glamorgan). Whereas the Gladeville west of Norton has either been consistently misidentified or has been erroneously believed to be faulted out at the surface, northeast and east of Norton it probably is correctly mapped; hence, all the coalbeds listed above are indeed within the Norton Formation. In most parts of this region, post-Norton beds have been removed by erosion.

Complete and well-exposed sections of the Norton Formation near Norton are unknown. At Little Stone Gap, a prominent wind gap through Little Stone Mountain 2 miles west of the center of Norton, the lowest part of the Norton, about 400 feet thick, is will exposed in a roadcut along State Highway 610 (geologic section 3). This section represents no more than half the total Norton. Through the courtesy of the Wise Coal and Coke Co., John B. Roen and I were able to study the cuttings of the Graham 1, a cable-tool well drilled for gas 2½ miles northwest of Norton. This well spudded in at about 40 feet below the Norton coal bed and about 90 feet below the base of the Gladeville Sandstone. Inasmuch as the top of the Bee Rock Sandstone Member is clearly recognizable in the well at a depth of 701 feet, we conclude that the Norton Formation near Norton is about 790 feet thick. The well also gives a continuous record of the sequence of lithologies for almost 700 feet of the Norton Formation. The lithologic log of this well is cited as a reference section for the Norton Formation (geologic section 4).

The most complete surface section of the Norton Formation that is moderately close to the town for which it is named is along State Highway 646, just northwest of the town of Coeburn and 8 miles east of Norton (fig. 5). This road climbs westward from the valley floor, a little below 2,000 feet elevation, to the upland level, more than 800 feet higher (Toms Creek and Wise 7½-minute quadrangles). A section of the Norton, 928 feet thick, here designated the type section of the Norton Formation (geologic section 5), was measured along this road. This section represents the upper part of the formation; the lower part is concealed beneath the town of Coeburn and the valley of Guest River. Reconnaissance mapping in the vicinity of Coeburn has made it possible to calculate very roughly the thickness of covered beds to the top of the Lee Formation. Assuming no changes of dip and no faulting in the covered interval, the concealed lower part of the formation is about 250 feet thick. The full thickness of the Norton Formation at this locality is therefore about 1,175 feet. Eby (1923, p. 106) has also published a section 752+ feet thick, less detailed than geologic section 5, from this same locality. In the measured part of the type section at Coeburn, 39 percent of the section is sandstone; the remainder is principally siltstone and shale. Assuming there is little or no sandstone in the 250± feet of concealed beds in the lowest part of the formation, as is the case at Little Stone Gap, and assuming that the top sandstone unit of the Lee at Norton is the Bee Rock Sandstone Member, sandstone content of the Norton Formation drops to 31 percent, which is much lower than the percentage of sandstone in any other Pennsylvanian formation in this region.

At the head of Big Stone Gap, old cuts along the two railroads that pass through the gap and along the road to Keokee expose a sandy, coal-bearing, nearly vertical sequence about in the middle of the Norton Formation; new cuts dug for the Southern Railroad in 1965–66, on the west side of the gap, have increased and improved the exposures of this part of the Norton so that it is now one of the best sections of the middle part of the formation (geologic section 6). In this section the lowest 290 feet of the Norton is covered and presumed to be largely

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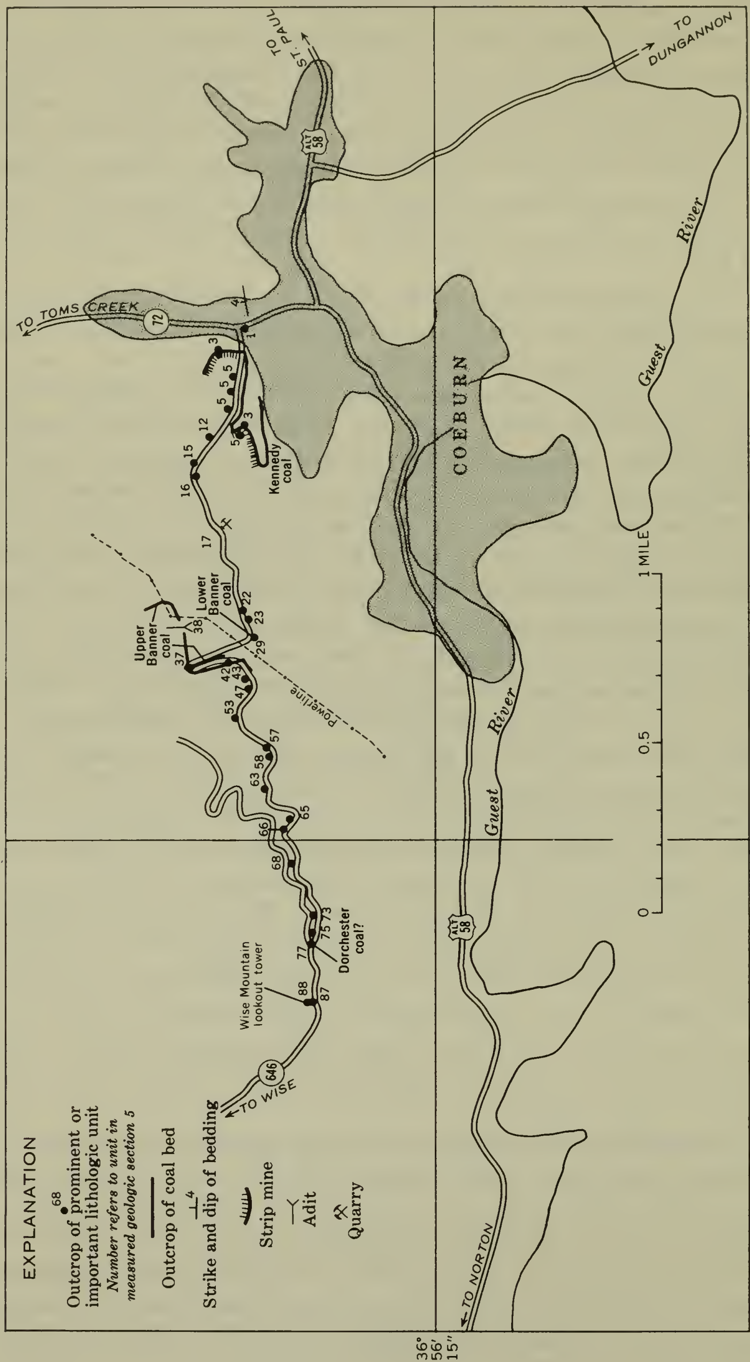

FIGURE 5.—Location of prominent units within the type section of the Norton Formation at Coeburn, Wise County, Va.

shale and siltstone. Of the exposed beds, 347 feet thick, 62 percent is sandstone, approximately the same as the percentage of sandstone in the Wise Formation.

The thickness of the Norton is difficult to determine accurately in most places. Some of the thicknesses cited in the earlier literature are in error because of misidentification of the Gladeville Sandstone, which overlies the Norton. Others seem to have been considerably in error because they were estimates rather than measurements. In Wise and Lee Counties the most reliable measurement is at the Graham 1 well where the formation is about 790 feet thick. At the type section of the Norton at Coeburn, 11 miles east of the Graham well, the measured thickness plus calculated thickness of concealed beds totaled 1,175 feet. In the series of 12 structure sections across the Norton Formation from Norton to west of Big Stone Gap (table 1) all but one thickness measurement lay in the range 840 to 970 feet. The one anomalous figure of 1,110 feet in section *D–D′* (pl. 1) is probably too high because of small-scale folding that was observed but could not be allowed for. Eby (1923) states that the Norton in Wise County is 1,300 to 1,500 feet thick, and Giles (1925) gives a figure of about 1,400 feet for eastern Lee County. My observations and calculations indicate that these thicknesses are too great for both areas, but my figures also suggest a rather rapid thickening of the formation east of Norton. Detailed mapping between Norton and Coeburn will probably be required to explain how this thickening takes place and what parts of the formation are involved in the thickening.

WISE FORMATION

Campbell (1893) named the Wise Formation for Wise County, Va., and defined it as that part of the coal measures lying between the "key rock" (Gladeville Sandstone) below and the Harlan Sandstone above. The Harlan caps the highest parts of Little and Big Black Mountains along the State line between Lee and Wise Counties, Va., and Harlan County, Ky. Problems in identifying the Gladeville Sandstone in the western part of the Virginia coal fields have been discussed above. Somewhat similar problems in recognizing the base of the Harlan as defined by Campbell (1893) will be discussed in the section on the Harlan Formation.

The base of the Wise Formation is herein placed at the top of the Gladeville Sandstone. The exact contact is almost everywhere covered, but it is readily mappable because of the contrast in resistance of the Gladeville and the overlying shale and siltstone of the basal part of the Wise. The top of the Wise Formation is placed at the top of the High Splint (No. 12) coal.

The total thickness of the Wise at any one locality cannot be determined accurately because at the surface the base of the formation is several miles distant from the top. A combination of thickness measurements at the surface and those from core-hole logs in eastern Lee and western Wise Counties gave an overall thickness of 2,440 feet. In central Lee County near the west edge of the Lee County coal fields, the Gladeville Sandstone has pinched out, but projection of the Gladeville horizon from exposures farther east gives an approximate base for use in estimating thickness. The sequence of beds from this horizon to the High Splint coal, as determined from deep core holes, is about 1,950 feet thick, so the Wise Formation seems to thin appreciably in a westward direction.

The Wise Formation consists of a thick sequence of sandstone, siltstone, and shale units and includes many coal beds; it is the most important coal-bearing formation in Lee and western Wise Counties. This formation contains dozens of coal beds, most of which are of limited areal extent and are too thin to be of economic importance. All the thick beds have been mined and have been named or numbered, but correlation of coal beds from one part of the coal fields to another is difficult and many miscorrelations exist in the literature. Only by detailed mapping and tracing of the coal beds and intervening mappable units can one be assured of correct correlation of coal beds in parts of the coal field where mining is not extensive. Robert Kosanke, John Roen, and I collected samples from several important coal beds of the Wise and Norton Formations for spore analysis to assist in regional correlations. R. M. Kosanke (written commun., September 8, 1964) reported, however, that the coals proved so metamorphosed that spores could not be separated by conventional maceration methods. Work on the samples was temporarily suspended.

More than one name has been applied to several of the important coal beds, and in the western part of the coal field in central Lee County a numbering system has dominated local usage. Discussion of regional correlations of Wise coal beds is beyond the scope of this report. The most acceptable names for important mined beds in the Wise Formation of western Wise and eastern Lee Counties is given in table 3, and the equivalent number in use in central Lee County is also shown. The occurrence and distribution of coal in the Wise Formation and in other formations in Virginia is discussed from the economic and resource point of view by Brown, Berryhill, Taylor, and Trumbull (1952).

TABLE 3.—*Equivalence of named and numbered coal beds of the Wise Formation in Lee and western Wise Counties, Va.*

Name (eastern Lee and western Wise Counties)	No. (central Lee County)	Name (eastern Lee and western Wise Counties)	No. (central Lee County)
High Splint	12	Marker	----------
Morris	11	Wilson (Harlan of Kentucky?).	4
Pardee	10		
Wax	9	Imboden	----------
Gin Creek	8	----------------------	3 (jackrock coal)
Phillips (Fireclay of Kentucky).	7	----------------------	2
Low Splint	6	Dorchester	----------
Taggart (Darby)	5		

Resistant sandstone units, most of which are less than 45 feet thick, are by far the most conspicuous rock units within the Wise Formation. These sandstone units consist predominantly of medium-grained, feldspathic, friable, massive-bedded and(or) crossbedded sandstone. Fine-grained sandstone may be present in considerable quantity, normally in the upper part of a sandstone unit, but coarse-bedded sandstone is rare and pebble conglomerate is practically absent. Silvery mica flakes are abundant and conspicuous in some sandstone units and are totally absent in others. Dark mineral grains are either rare or absent in most sandstone units, although some units may be locally argillaceous and less resistant to weathering. The thicker sandstone units form low linear ridges where the beds are moderately inclined or ledges and small cliffs capping spurs and irregular ridge crests where the beds are gently inclined or nearly flat. In the type section of the Wise Formation (fig. 6 and geologic section 7), 58 percent of the section is sandstone; most of the remainder is shale and siltstone.

Approximately a dozen sandstone units that are more than 25 feet thick apiece are present in a typical section of the Wise Formation in western Wise and Lee Counties. Traced laterally, some of these persist for miles, and others lens out or grade into nonresistant sandstone or siltstone. Four of the most persistent and conspicuous sandstone units are herein given formal member names. These are, in ascending order, the Robbins Chapel, Keokee, Clover Fork, and Marcum Hollow Sandstone Members.

ROBBINS CHAPEL SANDSTONE MEMBER

The Robbins Chapel Sandstone Member is named for Robbins Chapel, a small community in the northwestern part of the Keokee 7½′ quadrangle, Lee County, Va. (pl. 1). The massive sandstone beds of the member crop out in the church yard and in fields on both sides

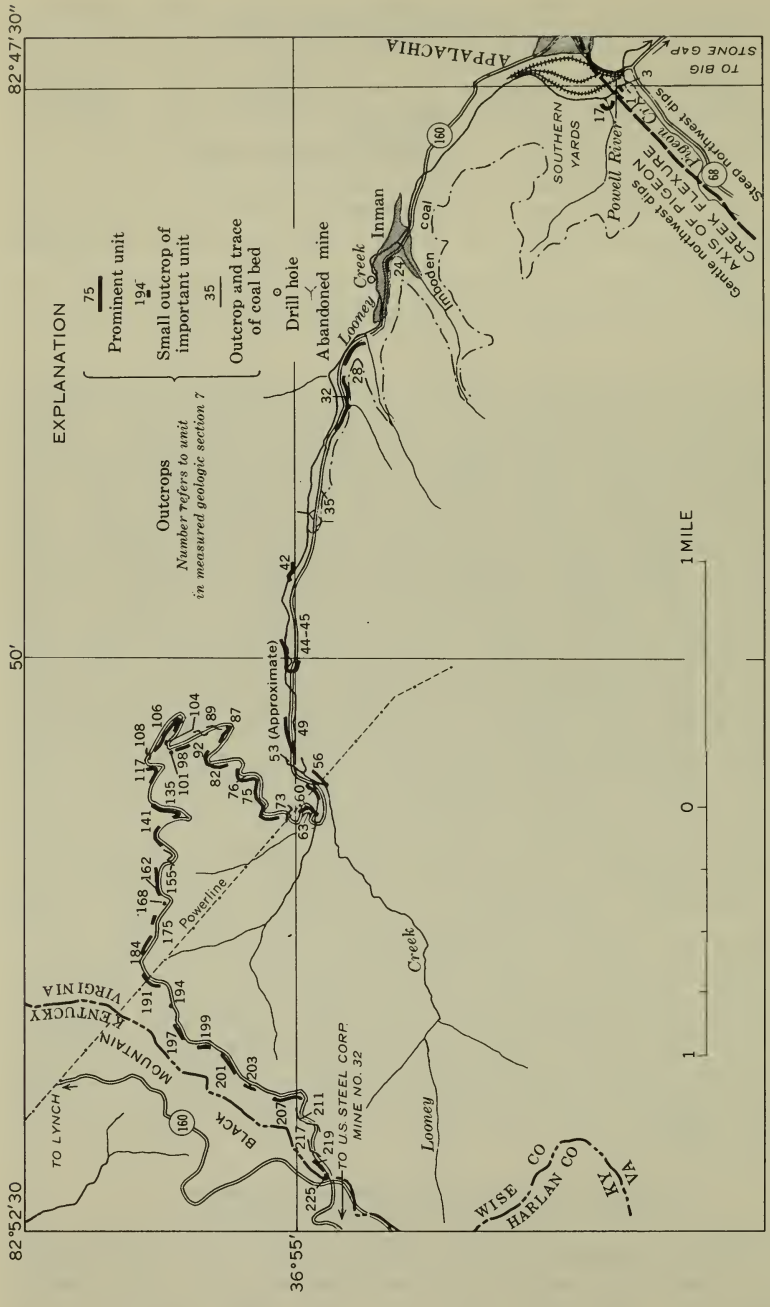

FIGURE 6.—Location of prominent and important rock units within the type section of the Wise Formation.

of the highway. The measured section at this locality (geologic section 8) is the type section for the member. The member consists of medium- and fine-grained, massive-bedded moderately quartzose sandstone. Some units are markedly crossbedded, and some are micaceous. In spite of the fact that this is a resistant unit, much of the sandstone is very friable when weathered.

The Robbins Chapel Sandstone Member does not have economically important coal beds associated with it at its type locality or to the east. Westward, however, in the westernmost part of the Keokee quadrangle and in the adjoining Pennington Gap quadrangle two mined coal beds, known locally as No. 2 and No. 3, lie close below and close above, respectively. At the west edge of the Keokee quadrangle, the No. 2 coal bed lies 0 to 16 feet below the base of the Robbins Chapel, and the No. 3 coal bed lies 10 to 14 feet above the top of the member.

The Robbins Chapel Sandstone Member has been traced continously 4 miles east-northeast of its type locality to the vicinity of Darnell Town, and in the opposite direction for about 6 miles to the vicinity of St. Charles. Beyond these points it thins and becomes less resistant due to facies changes so that it no longer constitutes a distinct mappable unit.

The Robbins Chapel Sandstone Member is about 120 to 150 feet above the base of the Wise Formation. Although it is about 80 feet thick at its type locality, throughout most of its extent it ranges from 30 to 50 feet in thickness.

KEOKEE SANDSTONE MEMBER

From 150 to 200 feet above the Robbins Chapel Sandstone Member is another prominent resistant sandstone unit, which is here designated the Keokee Sandstone Member for the town of that name in northeastern Lee County in the northeastern part of the Keokee 7½-minute quadrangle (pl. 1). The Keokee is composed predominantly of medium-grained, thick-bedded, feldspathic, slightly micaceous sandstone but contains some fine-grained sandstone. It is a resistant unit that forms ledges and low cliffs in many places. The southern part of the town of Keokee is built on the Keokee Sandstone Member, but the most complete well-exposed section of the member is along State Highway 68 almost exactly 1 air mile east of Keokee School. The measured section along the highway (geologic section 9) is here designated the type section of the member.

The Keokee Sandstone Member has been traced by mapping for 1 mile east of its type section and for 6 miles to the west. Beyond these limits it thins and changes facies so that it no longer forms a distinctive and significant mappable unit. At its type locality the Keokee is

59 feet thick. Throughout its mapped extent it is consistently more than 30 feet thick and is prominent.

CLOVER FORK SANDSTONE MEMBER

The Clover Fork Sandstone Member takes its name from Clover Fork of the Cumberland River in the northeast corner of the Keokee 7½-minute quadrangle in Harlan County, Ky. The member crops out for several miles along the floor of the valley at the foot of Little Black Mountain, but the base of the member is not exposed in this stretch of the valley. On the Virginia side of Little Black Mountain the member is conspicuous in the lower slopes of the mountain, and it is well exposed along Virginia State Highway 624 from Keokee northward to the State line at Morris Gap (pl. 1). Geologic section 10, a measured section of the middle part of the Wise Formation exposed along this road, is also the type section of the Clover Fork Sandstone Member.

The Clover Fork Sandstone Member is a massive, resistant small cliff- and ledge-forming unit consisting predominantly of medium-grained, moderately quartzose, massive-bedded sandstone. Locally, it contains mica flakes sparingly or abundantly and in places includes shale-pebble inclusions and thin shale lenses. At Keokee it lies about 40 feet above a mined coalbed, locally called the Wilson coal. Giles (1925) calls this the Harlan coal, but whether or not he is correct is uncertain. About 20 feet above the top of the Clover Fork is a rather thin but persistent coalbed known as the Marker (or Taggart Marker). The Clover Fork has been mapped northeastward from its type locality for 2 miles to the north edge of the Keokee quadrangle and 6 miles to the southwest to the west edge of the quadrangle. In its type section it is 78 feet thick but probably averages no more than 50 feet in thickness. It lies about 120 feet above the top of the Keokee Sandstone Member.

MARCUM HOLLOW SANDSTONE MEMBER

This member is the most prominent sandstone unit in the middle part of the Wise Formation, because in places it exceeds 100 feet in thickness. It lies close above the Taggart (also called Darby, No. 5, and Keokee) coal, the most extensively mined bed in the western part of the Virginia coal fields. The Marcum Hollow consists almost entirely of medium-grained, massive-bedded, locally crossbedded, moderately quartzose sandstone. In places the base of the sandstone lies directly on the Taggart coal, but elsewhere a few feet to as much as 15 feet of shale and siltstone beds intervene between the two. In no place have I seen the coal bed cut out by downward extension across the coal of sand-filled channels at the base of the Marcum Hollow Sandstone Member.

The member is named for Marcum Hollow just north of the town of Keokee (pl. 1). The type section (geologic section 10) is along State Highway 624, which follows Marcum Hollow from Keokee to Morris Gap and crosses the Marcum Hollow Sandstone Member and the hollow at the first sharp switchback turn as the road climbs the mountain. Here, the member is 44 feet thick, but to the west it thickens irregularly and reaches a maximum of about 120 feet. The Marcum Hollow has been mapped for 1½ miles northeastward from its type locality to the north edge of the Keokee quadrangle and for 13 miles southwestward to the west edge of the Pennington Gap quadrangle. It extends farther in both directions. It lies 60 feet above the top of the Clover Fork Sandstone Member at the type locality of the two members.

REYNOLDS SANDSTONE MEMBER(?)

There are many sandstone units within the Wise Formation above the Marcum Hollow Sandstone Member, but only one has the thickness, outcrop prominence, and lateral continuity sufficient to justify applying a formal member name to it. During mapping of Little Black Mountain by John Roen and myself, this member was informally called the "interstrip sandstone," because of its location between two extensively stripped coal beds (Wax and High Splint coals) high on the slopes of the mountain, on both sides of the Virginia-Kentucky State line.

This is probably the same sandstone as the one named Reynolds Sandstone Member of the Hignite Formation by Ashley and Glenn (1906, p. 43) farther west, in Harlan County; it was also identified by Wanless (1946, p. 117; see geologic section 7, units 207 and 208 of this paper) on Big Black Mountain, west of Appalachia. Although the resistant beds of this sandstone unit have abundant prominent outcrops on Little Black Mountain, no suitable section of the whole sequence was found. The Reynolds Sandstone Member(?) also underlies Big Black Mountain a few miles to the north. When this mountain is mapped in detail, a suitable section may be discovered that is better exposed and more accessible than any on Little Black Mountain.

The Reynolds Sandstone Member(?) on Little Black Mountain is consistently more than 100 feet thick. At the head of Stretchneck Branch of Yocum Creek, just south of the town of Dizney (pl. 1), it is 141 feet thick; 133 feet of the unit consists of massive-bedded, very fine to fine-grained, moderately quartzose, resistant sandstone. An 8-foot-thick siltstone sequence occurs about 95 feet above the base of the member. At the head of Days Branch of Clover Fork on the Kentucky side or Little Black Mountain (Pennington Gap 7½′ quadrangle) the sandstone sequence is 177 feet thick, and at the head of Rockhouse

Valley near the east edge of the Pennington Gap quadrangle it is 165 feet thick. The lower one-fourth to one-third of the sequence is rather thinly bedded and has few natural exposures, but the middle and upper parts are massive bedded, though fine grained, and form many ledges and imposing cliffs.

The base of the Reynolds Sandstone Member(?) is about 70 feet above the Magoffin Beds of Morse (1931), the best horizon marker in the Little and Big Black Mountains area. The top of the Reynolds(?) lies 80 to 120 feet below the High Splint (No. 12) coal at the top of the Wise Formation.

In addition to the many resistant sandstone units, including both the formally named members and other unnamed but mappable sandstone units, most of the remainder of the Wise Formation is composed of thinner units of sandstone, thin to thick units of siltstone, and shale. The thin standstone units are commonly also thin bedded, and they contain more impurities than do the thicker sandstones. Siltstone is medium to dark gray, drab, and commonly micaceous. Shale is dark gray to grayish black, and many shale units contain ironstone nodules and thin beds. In many places, shale and siltstone are interbedded, but elsewhere sequences completely of siltstone or shale may be several tens of feet thick. No two sections are alike, and it is often difficult to correlate between sections only fractions of a mile apart because of thickness or facies changes in equivalent units.

KENDRICK SHALE OF JILLSON (1919)

Two marker zones in the Wise Formation are especially valuable for correlation. These are the Kendrick Shale of Jillson (1919) and the Magoffin Beds of Morse (1931). The Kendrick Shale at Morris Gap (geologic section 10) lies 55 feet above the Low Splint coal, and at Darty Gap, 1½ miles west-southwest, it is 46 feet above the Low Splint. Although it crops out near the crest of the mountain at Morris Gap, the Kendrick Shale is very close to the middle of the Wise Formation, rather than in its upper part. The Kendrick Shale on Little Black Mountain normally consists of 5 to 10 feet of dark-gray to nearly black shale which is in some places silty. It is distinguished by being calcareous and fossiliferous; most fossils are small brachiopods. At Morris Gap and also in the high wall of a strip mine on the Low Splint coal at Darty Gap, the Kendrick Shale contains large oval limestone concretions that have well-formed cone-in-cone structure. The concretionary zone is presumed to be continuous in the Kendrick between Morris and Darty Gaps but was not seen elsewhere in the region.

The Kendrick Shale and enclosing beds are nonresistant, so that natural outcrops of these beds are rare and are confined to steep gullies and sharp ridges. Wherever this part of the Wise is exposed, the Kendrick has always been found, and it is believed to be present throughout the western part of the Virginia coal fields.

MAGOFFIN BEDS OF MORSE (1931)

The Magoffin Beds of Morse (1931) are the most distinctive and reliable horizon marker in the Wise Formation. In Virginia, the Magoffin lies on the upper slopes of Little Black Mountain and Black Mountain in Lee and Wise Counties. Natural outcrops of the Magoffin Beds are rare and confined to steep gullies and sharp ridges. In diamond-drill holes that penetrate this part of the Wise Formation, the Magoffin is invariably present. The most distinctive unit of the Magoffin Beds, and in many places apparently the only unit, is a 1- to 2-foot-thick bed of nearly black, very dense, hard limestone, which contains abundant brachiopods. The brachiopod shells are white, and the white fossils in a black matrix form a striking rock type and a nearly unique one for this area. In some localities this ubiquitous limestone bed is overlain and underlain by calcareous shale, siltstone, and even sandstone, which may also be moderately to sparingly fossiliferous. The total thickness of the calcareous zone in places seems to be as much as 20 feet, though poor exposures make accurate measurements difficult.

The Magoffin Beds lie about 70 feet below the base of the Reynolds Sandstone Member(?) and about 60 feet above the Wax (No. 9) coal, which is extensively stripped on Little Black Mountain.

Additional zones of calcareous shale and sandstone, some of which contain marine fossils, occur within the Wise Formation. In the area of detailed mapping by R. L. Miller and J. B. Roen (Big Stone Gap, Keokee, and Pennington Gap 7½-minute quadrangles) all zones seem to be local and to lack the lateral persistence of the Magoffin and Kendrick zones. If all the Wise Formation were exposed or cored at any one locality, probably at least half a dozen calcareous zones would be found. All those I have seen lie between the Marcum Hollow Sandstone Member and the Reynolds Sandstone Member(?), that is, in the middle and upper parts of the formation.

HARLAN FORMATION

Campbell (1893) defined the Harlan Sandstone, which he named for Harlan County, Ky., as being the beds on Big Black Mountain characterized by a basal cliff-forming quartzose sandstone 40 to 100 feet thick and by less resistant beds extending upward to the top of the mountain some 400 to 600 feet higher. His type locality was Isom Rock Spur, a prominent eastward-extending spur of Big Black Mountain, west-northwest of Appalachia, Wise County, Va. (See pl. 1.) He gives no type section, but his general description indicates that the Harlan is composed predominantly of quartzose sandstone but also contains shale and coal beds.

At Isom Rock Spur and elsewhere, the Harlan contains a massive cliff-forming quartzose sandstone that channels into underlying beds, causing a minor unconformity. The base of this sandstone is a few inches to 15 to 20 feet above the High Splint (No. 12) coal. A diamond-drill hole nearby on the crest of Big Black Mountain has penetrated 563 feet of the beds overlying this basal sandstone. The engineer's written log has been reproduced graphically as figure 7. In this core hole the basal sandstone is 30 feet thick. Where State Highway 160 crosses Big Black Mountain near Isom Rock Spur, this basal sandstone is 17 feet thick, is quartzose, and grades upward from pebbly or coarse-grained to fine-grained particles. Above this unit the log shows 200 feet of shale and a few sandstone units; all are less than 10 feet thick. From here to the top of the mountain, the log shows predominantly gray sandstone and lesser amounts of shale. Overall, 48 percent of the Harlan sequence in this core hole is sandstone, whereas 58 percent of the underlying Wise Formation in its type section nearby is sandstone. About 22 coal beds are scattered throughout the 563-foot sequence overlying the basal sandstone, but most beds are only a few inches thick. The thickest coal bed, 2 feet thick, lies 150 feet above the base of the formation. Because of the heterogeneous lithology of the Harlan in its type region, the name Harlan Sandstone is herein changed to the Harlan Formation.

Wanless (1946, p. 115–116) has published a measured section of the Harlan near Isom Rock Spur. Only the more resistant beds are exposed along the line of his section which extends from the highway crossing southwestward to the high point on the mountain known as The Doubles that is now marked by a prominent radar tower (pl. 1). When I examined this section about 20 years after Wanless published it, many of the exposures Wanless found seemed to have become covered, and exposures in this area are now too poor to designate this as the typical section for the Harlan. Nonetheless, I have been unable to find any better exposed section of the Harlan. Perhaps when someone maps Big Black Mountain in the Appalachia and Benham 7½-minute quadrangles (Virginia-Kentucky), a suitable section will be discovered which can then be designated as a standard reference section of the Harlan Formation.

In the Pennington Gap 7½-minute quadrangle the Harlan Formation caps the high parts of Little Black Mountain. Here, the High Splint coal has been extensively stripped, and the lowest beds of the Harlan are excellently exposed in the high wall for long distances. In some places a coarse-grained, quartzose, resistant sandstone lies a few

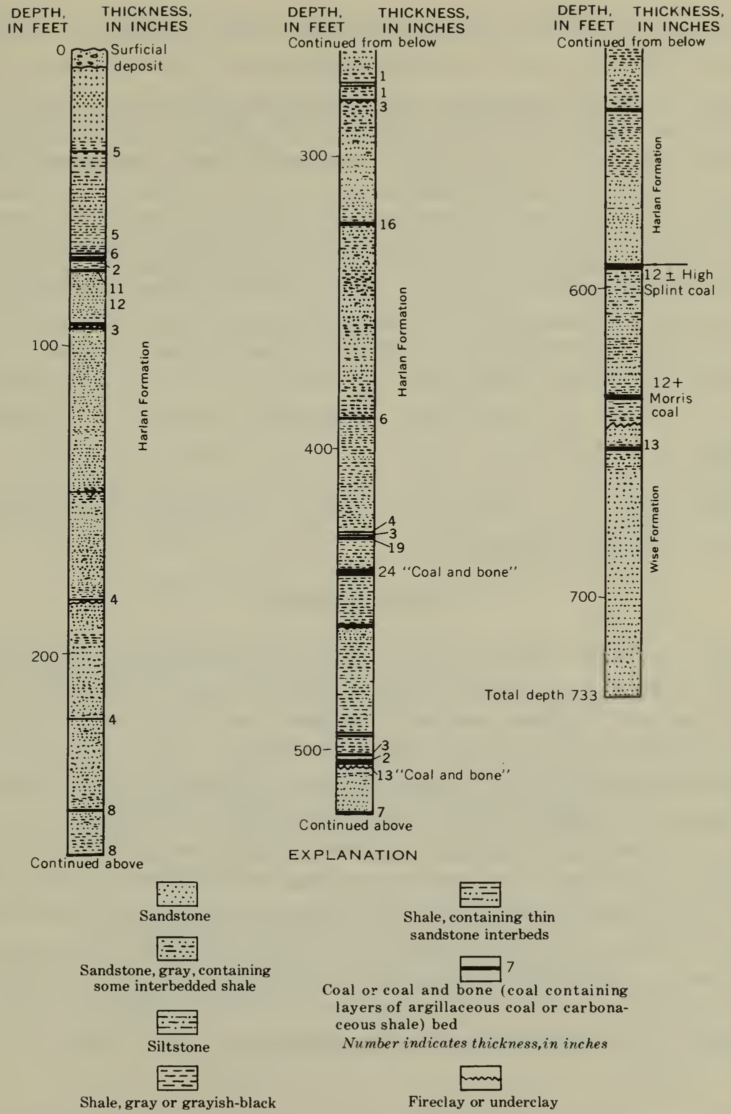

FIGURE 7.—Columnar section of the Harlan and upper part of the Wise Formations. From engineer's log of deep core hole at Grassy Gap on Big Black Mountain, Harlan County, Ky.

feet to a few tens of feet above the coal, as at Isom Rock Spur, but this basal sandstone is extremely lenticular and is totally absent for long distances. At other places there is no resistant sandstone, such as Campbell (1893) designated for his basal unit of the Harlan, for many scores of feet above the High Splint coal. Furthermore, where a coarse-grained and massive quartzose basal sandstone is lacking, higher sandstone units are finer grained, less quartzose, and hardly differ from sandstone units in the underlying Wise Formation. At one locality on the State line at the head of Rockhouse Valley (Pennington Gap 7½-minute quadrangle) two lenticular quartzose sandstones in the lowest part of the Harlan overlap (fig. 8) so that strict adherence to Campbell's (1893) definition of the base of the Harlan would result in jumping the contact from the base of the lower sandstone to the base of the higher one where the lower one lenses out. For all the above reasons it is best to pick a less erratic marker for the base of Harlan Formation. I therefore propose that the base of the Harlan Formation be redefined as the top of the High Splint coal, which is thick and continuous throughout the area of the Harlan Formation in Virginia. In spite of the fact that this formation was named for Harlan County, Ky., the formation name has not been used in recent years by geologists working in Kentucky, so it remains strictly a Virginia formation.

CONCLUSION

Type localities and type sections have been presented for the formation names in current use for rocks of Pennsylvanian age in the southwestern Virginia coal fields except for the Harlan Formation. When a good section of the Harlan Formation is found, probably on Big Black Mountain, it too should be similarly designated. Experience has shown that detailed tracing of key horizons by walking out beds or by large-scale mapping is the most reliable means of carrying accurate correlations from one part of the coal fields to another. Published identifications of key horizons such as the Gladeville Sandstone beyond their type regions must be considered suspect unless the units have been continuously traced from the known region to the unknown because distinctive lithologic characteristics are lacking for almost all the rock units within the Pennsylvanian System of this area.

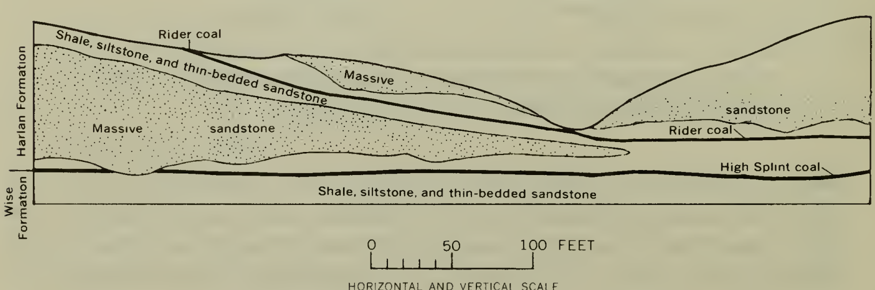

FIGURE 8.—Sandstone units near the base of the Harlan Formation at the head of Rockhouse Valley, Harlan County, Ky.

MEASURED GEOLOGIC SECTIONS

Geologic section 1

Type section of the Lee Formation and its Bee Rock Sandstone Member. Section extends across Big Stone Gap, Wise County, Va. For location of units, see figure 3. Units 30 to 41 are on west side of gap in a new railroad cut (1966) of the Southern Railroad, starting at core of Big Stone Gap anticline and continuing north. Units 25 to 29 are on west side of gap in a cut of the Southern Railroad, between trestle across river and axis of Roaring Fork syncline. Units 16 to 24 are on east side of gap in a cut of the Southern Railroad, just south of trestle across river. Units 13 to 15 are on east side of gap in a cut of the L & N (Louisville and Nashville) Railroad, at south portal of tunnel. Units 1 to 11 are on west side of gap in a cut of the L & N Railroad, near west end of trestle across river. Section measured by R. L. Miller, assisted by Abraham Jutoran.

	Thickness (feet)	*Top of unit to base of formation (feet)*
Norton Formation (290+ feet):		
41. Covered on both sides of gap	290	
Incomplete thickness of Norton Formation	290	
Lee Formation (type section; 1,596 feet):		
Bee Rock Sandstone Member (type section; 95± feet):		
40. Sandstone, yellowish-gray; fine grained in lower few feet, but changes to medium grained; quartzose; contains widely scattered coarse to very coarse grains and a few small flakes of muscovite; beds are as much as 4 feet thick, but average 1½ feet in thickness; strongly cross-bedded; very resistant; forms prominent flange on mountain and on east side of gap at river level where it is traversed by a tunnel of the L & N Railroad; 82 feet exposed along Southern Railroad on west side of gap, 90 feet exposed along L & N Railroad on east side	95±	1, 596
Total thickness of Bee Rock Sandstone Member	95±	1, 596
39. Shale; medium-dark-gray in upper two-thirds of unit, and medium-dark-gray siltstone in lower one-third; much jointed; contact with overlying Bee Rock Sandstone Member is smooth	50	1, 501
38. Sandstone, medium-light-gray, speckled, and medium-dark-gray, laminated, very fine grained; mostly thin bedded, but some beds are as much as 2 feet thick; moderately resistant	41	1, 451

Geologic section 1—Continued

Lee Formation—Continued	*Thickness (feet)*	*Top of unit to base of formation (feet)*
37. Covered; probably predominantly siltstone and shale, but float in upper part is very fine grained sandstone and siltstone. On east side of gap a 20-foot-thick sandstone, medium grained, quartzose, crops out 130 feet below top of this covered interval	302	1,410
36. Sandstone ("anticline sandstone"), very light gray, medium-grained, quartzose; contains widely scattered dark grains and faint dark bedding laminae; beds are 1 to 3 feet thick; strongly crossbedded; very resistant unit. This sandstone crops out in the anticline along the Southern Railroad track and in the riverbed for 0.4 mile southward, where it is nearly flatlying	138	1,108
35. Shale, dark-gray, folded; 3-foot zone of chevron folds at base	30±	970
34. Siltstone, medium-dark-gray, slightly micaceous, even-bedded; contains scattered ironstone concretions as much as 3 inches in longest dimension; well-preserved fossil plants	7.5	940
33. Sandstone, very pale orange, medium-grained, quartzose	7.5	932
32. Siltstone, medium-dark-gray, slightly micaceous	13	925
31. Sandstone, medium-light-gray, very fine grained, micaceous, thin-bedded and laminated	19	912
30. Sandstone, very pale orange, medium-grained, quartzoze; grades upward into overlying sandstone; lowest bed exposed at track level in core of anticline	6	893
29. Sandstone, grayish-green to pale-reddish-brown, medium-grained, speckled; some beds micaceous; some beds slightly feldspathic; crossbedded; beds are 1 inch to 2 feet thick. This unit is overlain by 17 feet of shale, 54 feet of unexposed beds, and a resistant sandstone, 44+ feet thick. This resistant sandstone is the same sandstone as unit 36	35	887
28. Shale, medium-dark-gray, contains ironstone concretions	7	852
27. Sandstone, grayish-orange and pale-yellowish-orange; very coarse grained with scattered pebbles at base; grades upward into coarse- and medium-grained sandstone; beds are 1 to 3 feet thick; crossbedded; exposed in abandoned quarry above highway and railroad tracks	76	845
26. Covered	121	769
25. Sandstone, reddish-orange to moderate-orange-pink (weathered); coarse-grained with scattered pebbles and a 5-foot zone of pebbly sandstone near middle; quartzose; beds are ½ to 3 feet thick; crossbedded; resistant	46	648

Geologic section 1—Continued

Lee Formation—Continued	Thickness (feet)	Top of unit to base of formation (feet)
24. Largely covered at Southern Railroad track level, but farther up mountain appears to be predominantly resistant sandstone and pebble conglomerate	51	602
23. Sandstone, light-olive-gray and light-brown, fine-grained; beds are as much as 3 feet thick, but most are a few inches thick	23	551
22. Sandstone, shaly, light-olive-gray, very fine grained	3	528
21. Sandstone, reddish-orange (weathered), medium-grained, quartzose, massive-bedded. A 2-foot zone of very coarse sandstone contains many oval flattened cavities as much as 6 inches in largest dimension. Shale pebbles have weathered out to form cavities	8	552
20. Shale, dark-gray; platy and laminated fine-grained sandstone at base	19	517
19. Coal, badly sheared	4. 7	498
18. Underclay, shaly, dark-yellowish-brown and olive-gray; contains *Stigmaria* in top 2 feet	5. 4	493
17. Shale, light-olive-gray to dark-gray; contains interbeds of fine-grained sandstone; ironstone concretions and beds; sandstone units at base and top contain many plant impressions; small fault at base of unit has estimated 5 to 10 feet of stratigraphic displacement	13	488
16. Sandstone, pale-olive, medium-grained, quartzose; in massive beds as much as 5 feet thick; basal 3-foot zone has many cavities and plant impressions. Minor slippage over underlying coal bed. This sandstone on west side of gap is covered by steel mesh above highway	66	475
15. Coal, sheared; thickens and thins due to shearing and slippage	2. 7	409
14. Sandstone, greenish-gray and light-greenish-gray, fine-grained, micaceous, laminated, thin-bedded; contains plant impressions; two small faults have displacement of 5 and 10 feet in this unit at south portal of L & N Railroad tunnel	10	407
13. Sandstone, greenish-gray, very fine to fine-grained, micaceous; weathers dusky-yellow; contains cross-bedded laminae; beds are as much as 6 inches thick	19	397
12. Covered on both sides of gap	194	378
11. Sandstone, pale-olive, platy; about 80 percent exposed; medium-grained beds become coarse-grained with scattered pebbles upward; top 3 feet conglomeratic with pebbles as much as ½ inch diameter	23	184
10. Sandstone, light-brown to white; coarse-grained with scattered pebbles; quartzose; crops out at south end of L & N Railroad trestle across river	36	161
9. Sandstone, medium-grained; grains cemented by quartz; crossbedded, channeled at top; contains squeezed coal lenses as much as 6 inches thick	6±	125

Geologic section 1—Continued

	Thickness (feet)	Top of unit to base of formation (feet)
Lee Formation—Continued		
8. Covered; probably contains a coal bed	14	119
7. Sandstone, nearly white, medium-grained; beds are as much as 3 feet thick; resistant	69	105
6. Sandstone, nearly white, very coarse and coarse-grained; contains abundant milky white quartz pebbles as much as 1 inch in diameter at base, becoming scarce upward	36	36
Total thickness of Lee Formation	1, 596	
Bluestone Formation (78+ feet):		
5. Covered	5	
4. Shale, siltstone, and very fine grained grayish-olive and olive-gray sandstone	22	
3. Siltstone, grayish-olive, and olive-gray shale	20	
2. Covered; probably like unit 1	11	
1. Sandstone, moderate-brown, dark-yellowish-brown, and light-olive-gray; fine grained in lower part, very fine grained in upper; moderately resistant	20	
Incomplete thickness of Bluestone Formation	78	

Geologic section 2

Type section of the Gladeville Sandstone in the south part of the town of Wise, Wise County, Va. See figure 4 for location of units. Measured by R. L. Miller.

	Thickness (feet)
Gladeville Sandstone (type section; 55± feet):	
23. Sandstone, white, fine-grained, very friable; 4 feet of beds partly exposed in bank at fire hydrant and beneath houses on crest of hill; no gain in section	0?
22. Covered; probably no gain in section	0?
21. Sandstone, much weathered and disaggregated; probably represents several feet of beds containing numerous layers 1 to 3 inches thick of rudely bedded mammilary limonite; limonite is secondary and is a phenomenon of recent weathering. This unit may represent the very top of the Gladeville, and units 22 and 23 are probably slightly lower rather than overlying. Beds are presumed to be about the same as found in unit 17	
20. Covered; probably no gain in section	0?
19. Sandstone, white, medium-grained, very friable, massive-bedded; 5 feet of beds exposed in low cut above flat-topped cement reservoir 100 feet northeast of water tank; probably same as upper part of unit 17	0?
18. Covered; probably no gain in section	0?
17. Sandstone, white, medium-grained, massive; contains widely scattered muscovite flakes; weathers grayish orange; 13 feet of beds exposed in gully along first steep pitch of road from hospital to water tank; probably only about top 4 feet represent beds higher than in units 15 and 16	4±

Geologic section 2—Continued

	Thickness (feet)
Gladeville Sandstone—Continued	
16. Mostly covered; a few small outcrops in steep bank at southwest edge of hospital grounds; probably represent beds equal to units 15 and (or) 17	0?
15. Sandstone, white, medium-grained, friable, massive-bedded; weathers grayish orange; exposed at base of low retaining wall 40 feet south of lower hospital parking lot	4±
14. Covered; probably no gain in section	0?
13. Sandstone, white, medium-grained, strongly crossbedded; exposed in bank of sharp turn to right of road approaching hospital	4±
12. Covered; probably little or no gain in section	0?
11. Sandstone, white, medium-grained, friable; massive-bedded in lower part; beds are 2 to 4 inches thick in upper part; near middle contains a 5-inch-thick lens of thin-bedded sandstone with abundant carbonized plant remains and a few coal fragments	11
10. Sandstone, white, medium-grained, friable, massive-bedded; contains scattered dark grains in basal and top beds; 3-foot interval near middle contains thin wavy beds and abundant carbonized plant fragments; exposed in highway cut just south of entrance to hospital grounds	14
9. Mostly covered; scattered outcrops on east side of road probably are the same as beds of unit 8	0?
8. Sandstone, white, medium-grained, friable; contains a few widely scattered dark grains; massive bedded in upper part; lower part weathers from slabby to shaly and is crossbedded; contains a few flattened pellets and angular pebbles of weathered medium-gray shale as much as 2 inches in largest dimension; upper 14 feet completely exposed in highway cut at bend	18
Total thickness of Gladeville Sandstone	55±
Norton Formation (56+ feet):	
7. Covered	10
6. Siltstone and sandstone, pale-yellowish-brown and light-gray, very fine grained, weathered; more shaly than underlying units	9
5. Covered	13
4. Sandstone, very fine grained, micaceous; weathers grayish orange	12
3. Siltstone, micaceous, even-bedded; weathers dark yellowish orange and pale yellowish brown	2. 5
2. Coal (Norton coal); 21 inches thick; deeply weathered; includes a 1-inch-thick clay seam 2 inches above base	1. 8
1. Clay, medium-light-gray; grades upward into deeply weathered medium-gray siltstone that contains carbonized plant remains throughout	8
Incomplete thickness of Norton Formation	56. 3

Geologic section 3

Section of the lower part of the Norton Formation at Little Stone Gap, Wise County, Va. (Norton 7½-minute quadrangle). See plate 1 for location of section. Section begins on State Highway 610 at gentle curve to right, heads north, and ends 500 feet farther north at sharp curve to right at north edge of gap. Beds in upper part of section also well exposed on old U.S. Highway 58 Alternate, below highway 610. Bedding is nearly vertical. Measured by R. L. Miller.

	Thickness (feet)
Norton Formation (394+ feet):	
17. Covered for hundreds of feet	?
16. Sandstone, white, medium-grained and fine-grained, friable; weathers moderate pink and pink speckled; partly slumped. Highest beds of Norton exposed anywhere in vicinity are at sharp bend of road	9
15. Siltstone, shaly; weathers gray and pale yellowish brown; contains three zones of very fine grained, poorly exposed sandstone, each seemingly less than 2 feet thick	85. 5
14. Sandstone, micaceous, earthy; weathers yellowish gray and pale yellowish brown; moderately resistant	6. 5
13. Sandstone, very fine grained, earthy; weathers pale yellowish brown; nonresistant	38
12. Sandstone, light-olive-gray, very fine grained, earthy	7
11. Siltstone, light-olive-gray; middle part contains two zones of earthy sandstone like unit 7	30
10. Siltstone, light-olive-gray; contains two zones of sandstone like unit 7, one at top and one 3 feet from top	11
9. Sandstone, light-olive-gray, very fine grained, earthy	0. 5
8. Siltstone, light-olive-gray	8
7. Sandstone, light-olive-gray, very fine grained, earthy	0. 5
6. Shale, weathers yellowish orange, and siltstone, weathers light olive gray; in outcrops and as float	51. 5
5. Covered; float suggests largely siltstone with some interbedded shale; partly equivalent beds on old U.S. Highway 58 Alternate below are interbedded siltstone and shale	83
4. Siltstone, light-olive-gray	27
3. Sandstone, fine-grained; weathers pale yellowish brown; micaceous in zones that are 5, 12, and 8 inches thick separated by siltstone and shale like that in unit 2	5. 5
2. Siltstone, weathers light olive gray, and shale, weathers light olive gray	30. 5
Incomplete thickness of Norton Formation	393. 5
Lee Formation (part):	
Bee Rock Sandstone Member (82 feet):	
1. Sandstone, very pale orange, quartzose; coarse grained in lower part, medium grained in upper; massive bedded and crossbedded; forms prominent flange at gentle bend in road	81. 5
Total thickness of Bee Rock Sandstone Member	81. 5
Incomplete thickness of Lee Formation	81. 5

Geologic section 4

Reference section for the Norton Formation. Log of Graham 1, a cable-tool well drilled by Wise Coal and Coke Co. Well is located about 2½ miles northwest of Norton, Wise County, Va. (See pl. 1.) Well spudded in at 90 feet below base of Gladeville Sandstone and 40 feet below Norton coal. Cuttings are now in the repository of the Virginia Division of Mineral Resources at Charlottesville, Va., where they are available for study. Measurements based on sample studies by John B. Roen.

	Thickness (feet)	*Depth (feet)*
Norton Formation (reference section; 792 feet):		
No cuttings	25	0–25
Shale, silty, and fine-grained and medium-grained, moderately quartzose to dirty sandstone	40	25–65
Shale, medium-gray, silty; contains interbedded, very fine grained sandstone in upper part	50	65–115
Sandstone, medium-grained, moderately quartzose; contains some coarse-grained and some fine-grained sandstone	60	115–175
Coal	?	175–176
Sandstone, medium-grained, moderately quartzose	16	176–192
Sandstone, fine- to medium-grained, dirty	10	192–202
No cuttings	37	202–239
Shale, silty; contains ironstone concretions and a little fine-grained sandstone	19	239–258
Coal	?	258–259
Shale, medium-dark-gray, slightly silty	17	259–276
Sandstone, medium-grained; becomes fine-grained upward; dirty; contains mica flakes	37	276–313
Shale, silty	25	313–338
Sandstone, medium-grained and fine-grained, dirty; contains some siltstone and shale in upper part	32	338–370
Shale, medium-dark-gray; contains a little very fine grained, dirty sandstone	96	370–466
Coal	?	466–467
Shale, medium-dark-gray; contains some silty shale	176	467–643
Coal	?	643–644
Shale, medium-dark-gray, and silty shale; contains a little very fine grained, dirty sandstone	11	644–655
Sandstone, very fine grained, dirty; grades upward into siltstone and silty shale	27	655–682
Shale, dark-gray; contains ironstone concretions	20	682–702
Total thickness of Norton Formation, including 90 feet above well collar	792	
Lee Formation (81+ feet):		
Bee Rock Sandstone Member (81 feet):		
Sandstone, mostly medium grained, quartzose; contains some coarse-grained and a few fine-grained beds	81	702–783
Total thickness of Bee Rock Sandstone Member	81	
Incomplete thickness of Lee Formation	81	

Geologic section 5

Type section of the Norton Formation along State Highway 646 between Coeburn and Wise, Wise County, Va., starts in town of Coeburn at junction of State Highways 646 and 72 (Toms Creek 7½-minute quadrangle) and ends at Wise Mountain lookout tower (Wise 7½-minute quadrangle) 2 miles to the west. See figure 5 for location of units. Section includes Gladeville Sandstone and lowest part of the Wise Formation. Measured by R. L. Miller.

	Thickness (feet)	*Top of unit to base of section (feet)*
Wise Formation (111+ feet):		
88. Sandstone, medium-grained, quartzose, massive-bedded; weathers nearly white; forms prominent ledges beneath Wise Mountain fire lookout tower	12+	111
87. Partly covered; siltstone, shale, and fine-grained sandstone; includes coal bed 3 inches thick in upper part of unit	38±	99
86. Sandstone, fine-grained, very micaceous; weathers shaly in places	11	61
85. Shale, weathered	4	50
84. Coal, slumped, 16 inches; brownish-gray clay, 9 inches; weathered coal, 3 inches; light-gray clay, 21 inches	4	46
83. Siltstone and weathered shale	10	42
82. Largely covered; weathered shale at base and several other places in road bank	15±	32
81. Sandstone, medium-grained, deeply weathered, micaceous, massive-bedded; crops out in bank just below low-angle road junction	4	17
80. Shale, carbonaceous; weathers brownish black; 3 inches; underlain by 15 inches of light-gray plastic clay containing *Stigmaria*	1. 5	13
79. Sandstone, fine-grained, moderately quartzose, and weathered shale	4. 5	12
78. Shale, weathered; contains sandstone lens	5±	7
77. Coal (Dorchester?)	1±	2
76. Shale, weathered (units 76 to 78 exposed at top of cliff; covered at road level)	1±	1
Incomplete thickness of Wise Formation	111+	
Gladeville Sandstone (45 feet):		
75. Sandstone, medium-grained, quartzose; contains shale pebbles and coal chips at base; becomes coarse grained, micaceous, and feldspathic at top; in massive beds 1 to 10 feet thick	45	45
Total thickness of Gladeville Sandstone	45	

Geologic section 5—Continued

Norton Formation (type section; 928+ feet):	Thickness (feet)	Top of unit to base of section (feet)
74. Shale, grayish-brown, slightly carbonaceous	1	928
73. Coal, weathered, rashy; on slumped slope; 11± inches (not Norton coal)	1	927
72. Siltstone, clayey; contains plant impressions	2	926
71. Siltstone, medium-light-gray; laminated with ironstone bands; more sandy at top	58	924
70. Covered (at bend to left in highway going uphill)	3	866
69. Sandstone, very fine grained, micaceous; weathers yellowish brown; moderately resistant	4	863
68. Siltstone, medium-gray; contains prominent thin ironstone bands	21	859
67. Shale, medium-dark-gray; becomes silty upward; contains prominent ironstone bands; grades upward into next unit	19	838
66. Siltstone, medium-gray, laminated	34	819
65. Coal, 6 to 7 inches	0.5	785
64. Sandstone, medium-light-gray, medium-grained; similar to underlying unit, but thinner bedded and less resistant; 9 to 15 feet	12	784
63. Sandstone, medium-light-gray, medium-grained; grades upward to fine-grained arkosic resistant sandstone; forms sheer rock wall in cut above highway	64	772
62. Shale, medium-dark-gray; contains ironstone bands	5	708
61. Sandstone, fine-grained, impure, micaceous; lower part forms minor ledge	8	703
60. Siltstone, weathers grayish orange, and shale, weathers moderate yellowish brown	25	695
59. Covered; probably same as overlying unit	12	670
58. Clay, yellow, 4 inches; overlain by brown carbonaceous clay, 14 inches	1.5	658
57. Sandstone, medium-grained, impure, micaceous; weathers pale yellowish brown; in massive beds that weather to laminated beds; resistant	23	657
Unconformity.		
56. Sandstone, medium-gray, fine-grained, impure; changes upward to siltstone	9	634
55. Covered at bend to left going uphill	9±	625
54. Sandstone, fine- and medium-grained, impure, micaceous; weathers pale yellowish brown; crossbedded in units as much as 5 feet thick	44±	616
53. Sandstone, very fine grained, impure, micaceous, thin-bedded; weathers pale yellowish brown	9	572
52. Siltstone, laminated, and medium-dark-gray shale containing ironstone beds; includes ironstone lens 5 feet long and 5 inches thick	16	563
51. Covered at bend to left going uphill	17	547
50. Shale, silty; weathers pale yellowish brown	23	530

Geologic section 5—Continued

Norton Formation—Continued	*Thickness (feet)*	*Top of unit to base of section (feet)*
49. Coal, 9 inches; medium-dark-gray underclay, 6 inches; coal, 1½ inches; carbonaceous shale containing plant remains, 2 inches; light-gray siltstone, 3 inches	1. 8	507
48. Claystone, light-gray, shaly; bottom 3 inches replaced by limonite	1. 5	505
47. Sandstone, light-gray, fine-grained, micaceous; where weathered, shows very even parallel bedding within more massive units	25	503
46. Clay, grayish-orange, shaly; contains plant remains; 0 to 3 inches	0. 2	478
45. Coal; 11 inches to 17 inches	1. 2	478
44. Underclay, pale-yellowish-brown; contains *Stigmaria*	0. 8	477
43. Sandstone, very pale orange, fine-grained, moderately quartzose, slightly micaceous; contains thin limonite-stained bands along some bedding planes and cross joints	23	476
42. Coal, 17 inches; exposed at spring on highway	1. 4	453
41. Clay, medium-dark-gray, shaly; grades into underclay at top	3. 5	452
40. Siltstone	14	448
39. Shale, light-gray; contains thin ironstone bands and concretions	7	434
38. Coal, 1 inch; olive-gray clay, 2 inches; coal, 29 inches; brownish-black carbonaceous sandstone containing scattered large mica flakes, 1½ inches; coal, 14½ inches; (Upper Banner coal); siltstone, 1+ inch; coal not exposed at hairpin turn on highway but well exposed at abandoned mine 200 yards to east	4. 1	427
37. Underclay, pale-yellowish-brown, hard; contains *Stigmaria;* in bank at middle of hairpin turn	4. 5	423
36. Covered	16	418
35. Sandstone, white speckled, medium-grained, impure, micaceous	3	403
34. Covered	6	400
33. Siltstone, medium-gray	24	394
32. Covered	13	370
31. Sandstone, fine-grained, micaceous; weathers grayish orange; thin bedded in lower part; massive with spheroidal weathering in upper part	9	357
30. Siltstone, light-olive-gray, laminated	17	348
29. Coal, upper 10 inches rashy (Lower Banner coal)	3. 4	331
28. Underclay, grayish-black, carbonaceous; contains carbonized plant remains	0. 8	327
27. Clay, dark-yellowish-brown, silty; grades upward into siltstone; contains carbonized plant fragments	9	326
26. Sandstone, light-gray, fine-grained, micaceous; thin bedded in lower part; massive with spheroidal weathering in upper part	10	317

Geologic section 5—Continued

Norton Formation—Continued	*Thickness (feet)*	*Top of unit to base of section (feet)*
25. Sandstone, very fine grained, and siltstone; most is evenly bedded, but some is irregularly bedded	7.5	307
24. Sandstone, medium-gray, very fine grained, micaceous; contains carbonaceous patches; conspicuous spheroidal weathering	2	300
23. Siltstone, medium-gray, even-bedded	17	298
22. Siltstone, even-bedded, laminated	6	281
21. Shale, medium-gray; 8½ inches	0.7	275
20. Coal, 1 inch	0.1	274
19. Siltstone, poorly exposed	3	274
18. Sandstone, pale-yellowish-brown, micaceous, very even bedded; contains abundant dark grains	11	271
17. Siltstone, medium-gray, well-bedded; small long-abandoned quarry at top of unit	67	260
16. Siltstone, pale-yellowish-brown, and very fine grained sandstone	11	193
15. Siltstone, pale-yellowish-brown; contains 1-foot bed of very fine grained sandstone in middle	25	182
14. Sandstone, pale-yellowish-brown, very fine grained; grades into siltstone upward and laterally	5	157
13. Siltstone, pale-yellowish-brown, thin- and even-bedded	13.5	152
12. Siltstone; weathers grayish orange	8	139
11. Coal, 4 inches; gray and brown shaly clay, 6 inches; carbonaceous shale, 1½ inches; medium-light-gray shaly clay, 5 inches	1.4	131
10. Clay, medium-gray, hard	3.5	129
9. Sandstone, very pale orange, fine-grained, moderately quartzose; massive bedded in lower part; becomes thinner bedded upward	20	126
8. Covered	6	106
7. Sandstone, fine- and medium-grained, earthy; weathers grayish orange	7	100
6. Shale, medium-dark-gray; in bank just below ravine on northeast side of highway	6.5	93
5. Sandstone, medium-grained, feldspathic, friable; weathers grayish orange; contains scattered mica flakes; partly exposed in high wall of strip pit north of highway and completely exposed at old strip mine in nose of spur south of highway	41	86
4. Siltstone, medium-gray; contains platy interbeds of very fine grained sandstone in upper part	15	45
3. Coal; not exposed in old strip pits; reported by Eby (1923) to be 51 inches thick; includes one 2-inch and one 3-inch shale parting (Kennedy coal)	4.2	30
2. Covered	3	26
1. Sandstone, yellowish-gray, white speckled, medium-grained, feldspathic, massive-bedded (McClure Sandstone Member of Eby, 1923)	23	23

Geologic section 5—Continued

	Thickness (feet)
Base of section.	
Concealed beds of lower part of Norton Formation beneath town of Coeburn calculated to be about	250
Approximate total thickness of the Norton Formation	1, 175

Geologic section 6

Section is along Southern Railroad cut at head of Big Stone Gap, Wise County, Va. See plate 1 and figure 3 for location of section. Section begins with the Bee Rock Sandstone Member of the Lee Formation (exposed in new railroad cut) and ends in middle part of the Norton Formation (exposed along State Highway 68 just west of railroad crossing). Measured by R. L. Miller.

	Thickness (feet)	Top of unit to base of formation (feet)
Norton Formation (636+ feet):		
32. Shale, carbonaceous; grades upward into olive-gray shale and very fine grained platy sandstone	2	636
31. Coal, sheared and slickensided; 7 inches	0. 6	634
30. Claystone, light-olive-gray	0. 8	634
29. Sandstone, light-olive-gray, very fine grained, quartzose	1	633
28. Shale, weathered	2	632
27. Sandstone, light-olive-gray and olive-gray, fine-grained, moderately quartzose; weathers pale yellowish brown; beds average 1 foot in thickness; ripple marked; interbedded shale near top	21	630
26. Sandstone, very light gray, medium-grained, quartzose; massive bedded in lower part. Top of this unit is at corner between railroad right-of-way and State Highway 68	49	609
25. Coal, sheared, 16½ inches; carbonaceous siltstone 1 to 3 inches; pulverized coal, 0 to 1½ inches	1. 7	560
24. Underclay, carbonaceous	4. 2	558
23. Siltstone, gray	2	554
22. Sandstone, medium-light-gray, fine-grained, moderately quartzose, micaceous; prominently cross-bedded and massive bedded in lower and middle parts	12	552
21. Shale, dark-gray, even-bedded; contains thin ironstone bands; ¼-inch-thick coal at base	6. 5	540
20. Sandstone, fine-grained, laminated	1. 5	533
19. Sandstone, light-gray, medium-grained, massive, moderately quartzose, slightly micaceous	3. 5	532
18. Shale, dark-gray, even-bedded	47	528
17. Shale, medium-dark-gray, weathered; contains *Stigmaria*	1	481
16. Shale, medium-dark-gray; grades upward into laminated siltstone	22	480

Geologic section 6—Continued

	Thickness (feet)	Top of unit to base of formation (feet)
Norton Formation—Continued		
15. Coal, ½ inch; carbonaceous wavy-bedded shale, 9 inches; coal, 2 inches	1	458
14. Shale, gnarled, weathered; contains abundant *Stigmaria* at top	2. 2	457
13. Sandstone, medium-light-gray, fine-grained, moderately quartzose, micaceous	30	455
12. Shale, medium-light-gray; grades upward into siltstone that contains thin ironstone bands	4	425
11. Coal, 23 inches	1. 9	421
10. Siltstone, medium-gray; weathers blackish red and light olive gray; contains abundant *Stigmaria*	2	419
9. Siltstone, medium-light-gray, micaceous; contains sparse *Stigmaria*	1. 5	417
8. Sandstone, light-gray, very fine grained, laminated, wavy-bedded	1. 2	416
7. Sandstone, very light gray, white speckled, medium-grained, crossbedded, massive; becomes fine grained at top; abundant muscovite flakes on bedding planes	50	415
6. Shale, dark-gray	13. 5	365
5. Sandstone, medium-dark-gray, very fine grained, laminated; contains lighter and darker bands	47	351
4. Covered	10	304
3. Siltstone, micaceous; weathers pale yellowish brown	4	294
2. Covered to top of Bee Rock Sandstone Member of Lee Formation	290	290
Incomplete thickness of Norton Formation	636. 1	
Lee Formation (82+ feet):		
Bee Rock Sandstone Member (82+ feet):		
1. Sandstone, fine-grained, quartzose, slightly feldspathic; changes upward to medium grained; crossbedded in beds as much as 4 feet thick; same as unit 40 of geologic section 1	82+	
Incomplete thickness of Bee Rock Sandstone Member	82+	
Incomplete thickness of Lee Formation	82+	

Geologic section 7

Type section of the Wise Formation. Section extends along Virginia State Highway 160, from mouth of Looney Creek at Appalachia, Wise County, Va., westward to crest of Big Black Mountain on Virginia-Kentucky State line (Appalachia 7½-minute quadrangle). Location of section and key units shown in figure 6. Section also includes Gladeville Sandstone and parts of the Harlan and Norton Formations. Units 35 to 191 condensed and slightly revised from Wanless (1946, p. 85–87, 100–102). Identification of coal beds and named sandstone members in units 35 to 191 are from Wanless (1946), unless otherwise noted. Units 18 to 22 from engineer's log of diamond-drill hole 450 feet northwest of base of bluff on highway in Inman, Va. Units 1 to 17 (at mouth of Looney Creek on west side of Southern Railroad yards at Appalachia, 1 mile southeast of Inman), units 23 to 34, and units 192 to 225 measured by R. L. Miller.

	Thickness (feet)	*Top of unit to base of formation (feet)*
Harlan Formation (67+ feet):		
225. Sandstone, moderately quartzose, crossbedded, massive-bedded, resistant; coarse grained at base; grades upward into medium grained; crops out at high point of State Highway 160 at crest of Big Black Mountain; channels into underlying beds	11+	67
Unconformity.		
224. Clay and coal, interbedded: clay, 12 inches; weathered coal, 6 inches; shaly clay, 4 feet 7 inches; coal, 7½ inches; underclay, 10 inches; coal, 12 inches	7.8	56
223. Siltstone, light-gray; contains *Stigmaria* at top	7	48
222. Covered	4	42
221. Sandstone, fine-grained, micaceous, impure; forms ledge exposed in bank 100 yards east of ridge crest	3	38
220. Partly covered; a few beds of medium-gray siltstone and shale exposed in ditch	17	34
219. Sandstone, light-gray, white-speckled, coarse-grained; becomes medium grained to fine grained upward	17	18
Unconformity.		
218. Shale, medium-light-gray; weathers yellow	0.5	1
Incomplete thickness of Harlan Formation	67+	
Wise Formation (type section; 2,268 feet):		
217. Coal (High Splint, No. 12 coal); top 10 inches is bony	6.8	2,268
216. Underclay	2.6	2,261
215. Siltstone, medium-light-gray, dense; *Stigmaria* at top	3	2,258
214. Siltstone, medium-light-gray; shaly with a more resistant 6-inch bed at top	10	2,255
213. Sandstone; medium grained at base with ironstone conglomeratic nodules; grades upward into fine-grained and very fine grained sandstone	10–18.	2,245

Geologic section 7—Continued

	Thickness (feet)	Top of unit to base of formation (feet)
Wise Formation—Continued		
Unconformity.		
212. Shale entirely removed by erosion in places	0–2.5	2,231
211. Coal (Morris), 30 inches; carbonaceous shale and clay, 2 inches; coal, 4 inches	3	2,230
210. Underclay, medium-light-gray, shaly; contains plant impressions	3.2	2,227
209. Shale, medium-gray; siltstone bed at top	2.7	2,224
Probable equivalent of Reynolds Sandstone Member(?) of this paper:		
208. Sandstone, medium-light-gray, very fine grained; contains interbedded siltstone; top bed 6–12 inches thick weathers to form prominent flange	38	2,221
207. Sandstone, light-gray, medium-grained, white speckled, feldspathic. Reynolds Sandstone Member of Wanless (1946)	42	2,183
Total thickness of probable equivalent of Reynolds Sandstone Member(?) of this paper	80	
206. Coal, 22 inches, and underclay containing *Stigmaria*, 10 inches	2.7	2,141
205. Siltstone, light-gray	5	2,138
204. Covered	6	2,134
203. Sandstone, medium-gray, fine-grained, feldspathic, massive; forms one ledge	22	2,128
202. Mostly covered; contorted coal bed in ditch near base and a few beds of siltstone near top	17	2,106
201. Sandstone, medium-gray, feldspathic; has "salt-and-pepper" speckled appearance	41	2,088
Unconformity.		
200. Siltstone, medium-dark-gray; grades upward into shale; this unit completely cut out by overlying sandstone along outcrop	0–10	2,048
199. Sandstone, medium-light-gray, medium-grained, white speckled, feldspathic; sparingly micaceous	29	2,042
198. Covered	5±	2,013
197. Sandstone, light-gray, medium- and fine-grained; bedding, which is strongly deformed in lowest 4 feet, changes upward to very even thin beds and then massive beds	42	2,008
196. Siltstone and shale, medium-dark-gray, very even bedded; contains ironstone nodules and thin bands	20	1,966
195. Shale, medium-dark-gray; contains ironstone bands and nodules	20	1,946

Geologic section 7—Continued

Wise Formation—Continued	Thickness (feet)	Top of unit to base of formation (feet)
Equivalent of Magoffin Beds of Morse (1931):		
194. Limestone, black, very fossiliferous; exposed in ditch	0. 7	1, 926
193. Siltstone, light-olive-gray, even-bedded, calcareous	19	1, 926
192. Shale, medium-dark-gray, calcareous; contains ironstone concretions. Wanless (1946) reports 17-inch coal at base of this unit on Kentucky side of mountain	10. 5	1, 907
Total thickness of equivalent of Magoffin Beds of Morse (1931)	30. 2	
191. Sandstone, light-brown, massive, cliff-forming; calcareous at top. Equivalent to "Jesse" and Pilot Knob sandstone units of Wanless (1946). High tension line crosses lower part of this unit	47	1, 896
Unconformity.		
190. Shale, light-gray, silty	3. 2	1, 849
189. Coal, 3 feet 8 inches; light-gray clay, 6 inches; coal (Pardee coal), 8 inches	4. 8	1, 846
188. Shale, light-brownish-gray	3	1, 841
187. Coal	0. 3	1, 838
186. Underclay, silty	2. 2	1, 838
185. Siltstone, brownish-gray, fairly massive	3	1, 836
184. Sandstone, fine- to medium-grained, massive, cliff-forming	49	1, 833
Unconformity.		
183. Coal	0. 5	1, 784
182. Underclay, silty	3	1, 783
181. Shale, light-olive-gray, silty, hard; contains fossil plants	8. 2	1, 780
180. Coal	0. 2	1, 772
179. Underclay, silty	2	1, 772
178. Shale, light-brownish-gray, silty; spheroidal weathering	9. 5	1, 770
177. Coal	0. 2	1, 760
176. Siltstone; not laminated	2	1, 760
175. Sandstone, light-yellow-gray, medium-grained, massive	7. 5	1, 758
Unconformity.		
174. Shale, light- to medium-gray; silty near top; contains 1-foot underclay and ½-inch coal in upper part	11. 7	1, 751
173. Coal, 10 inches; medium-gray clay, 5½ inches; coal, 7½ inches; medium-gray clay, 6 inches; coal, 9 inches	3. 2	1, 739
172. Underclay, light-gray	1. 5	1, 736
171. Siltstone; not laminated	8	1, 734

Geologic section 7—Continued

Wise Formation—Continued	Thickness (feet)	Top of unit to base of formation (feet)
170. Coal	0. 5	1, 726
169. Underclay	4	1, 726
168. Sandstone, fine-grained, even-bedded, massive	8	1, 722
Unconformity.		
167. Shale, silty, light-gray	3. 2	1, 714
166. Coal, 1½ inches	0. 1	1, 711
165. Underclay	2	1, 710
164. Sandstone, light-gray; contains root traces	0. 3	1, 708
163. Underclay, 2 inches	0. 2	1 708
162. Sandstone, olive-gray; interbedded with shaly partings; more massive in upper part	44	1, 708
161. Siltstone, medium-gray, fairly massive; spheroidal weathering	14	1, 664
160. Shale, dark-gray, hard; contains ironstone concretions; 1 foot of clay at base	4	1, 650
159. Coal, blocky, 4 inches; underlain by 4 inches of clay	0. 7	1, 646
158. Shale, medium-gray; contains partings of siltstone and sandstone	4. 5	1, 645
157. Sandstone, light-brownish-gray, fine-grained	4. 2	1, 641
156. Shale, light-olive-gray, silty	5. 9	1, 637
155. Coal; badly split with clay interbeds; total coal, 14½ inches	3. 5	1, 631
154. Underclay, light-yellow-gray	0. 8	1, 627
153. Sandstone, light-gray, poorly bedded	5. 5	1, 626
152. Shale, silty, light-gray; contains plant traces	7. 3	1, 621
151. Coal, 20 inches	1. 7	1, 614
150. Underclay, sandy	3	1, 612
149. Siltstone; contains *Stigmaria*	2	1, 609
148. Underclay, sandy	6. 2	1, 607
147. Coal, shaly	0. 2	1, 601
146. Underclay	0. 6	1, 600
145. Shale, light-olive-gray; coaly at base; changes to platy sandstone at top	4	1, 600
144. Underclay	0. 2	1, 596
143. Underclay, silty, 2 feet thick at base; changes to shale, then fine-grained sandstone upward	3. 3	1, 596
142. Siltstone, olive-gray, massive- to thin-bedded	13	1, 592
141. Sandstone, olive-gray, medium-grained, very massive, micaceous	40	1, 579
Unconformity.		
140. Shale, black, hard; contains pelecypod shells (*Naiadites*)	1. 9	1, 539
139. Shale, silty, olive- to blue-gray; spheroidal weathering	16	1, 538
138. Coal, 1 foot 6 inches; clay, 2 inches; coal, 5 inches; flaky medium-gray clay, 5½ inches; coal, 1 foot 8½ inches; light-gray flaky shale, 1 inch; coal, 2¼ inches; Phillips or Fireclay coal of this report, not of Wanless (1946)	4. 6	1, 522

Geologic section 7—Continued

Wise Formation—Continued	*Thickness (feet)*	*Top of unit to base of formation (feet)*
137. Underclay, light-blue-gray, silty	2	1, 517
136. Sandstone, light-gray, very fine grained; very micaceous in lower part; weathers thin bedded	7	1, 515
135. Sandstone, light-gray, medium-grained, massive- and crossbedded; contains a conglomerate of ironstone pebbles at base; basal contact has relief of 18 feet	60–80.	1, 508
Unconformity.		
134. Clay, blue-gray; contains root traces; 1½-inch coal bed at top	3. 1	1, 438
133. Shale, medium-gray	15	1, 435
132. Siltstone, blue-gray; contains ironstone concretions	4	1, 420
131. Shale, poorly bedded; underlain by 2-inch coal bed and overlain by 3-inch coal bed	1. 2	1, 416
130. Underclay, 4½ inches	0. 3	1, 414
129. Siltstone, light-gray	3. 5	1, 414
128. Covered	2	1, 411
127. Shale, light-gray, silty; changes upward to siltstone and to massive sandstone at top	10	1, 409
126. Coal, 10 inches	0. 8	1, 399
125. Underclay, light-gray, sandy	1. 3	1, 398
124. Sandstone, light-gray, fine-grained, massive	2. 8	1, 397
123. Shale, coaly, 1 inch; underclay, 11 inches; coaly shale, 1 inch	1. 1	1, 394
122. Underclay	1. 3	1, 393
121. Shale, light-gray; contains small ironstone concretions	1. 8	1, 391
120. Coal, containing shaly partings, 6 inches; underclay, 1 foot 2 inches; shaly coal, 1 inch	1. 7	1, 390
119. Underclay	1. 5	1, 388
118. Siltstone, light-gray; contains ironstone bands	5. 5	1, 386
117. Sandstone, light-gray, very massive and crossbedded, cliff-forming. Equivalent to Puckett Sandstone Member of Mingo Formation of Kentucky	58	1, 381
116. Coal, 1 inch; shale, 1¼ inches; coal, 2¼ inches; underclay, 6 inches	0. 9	1, 323
115. Shale, blue-gray; 14-inch sandstone bed at top	5. 2	1, 322
114. Covered	3	1, 317
113. Coal, 4 inches; underclay, 7 inches	0. 9	1, 314
112. Siltstone; contains root traces; very fine grained sandstone at base and top	4. 9	1, 313
111. Underclay; 1 inch of shale at top that contains plant impressions	1	1, 308
110. Siltstone, medium-gray; contains root traces	3. 8	1, 307
109. Sandstone, light-brownish-gray, fine-grained, massive	14	1, 303

Geologic section 7—Continued

Wise Formation—Continued	*Thickness (feet)*	*Top of unit to base of formation (feet)*
Unconformity.		
108. Coal; Phillips coal of Wanless (1946), not of this report	2. 3	1, 289
107. Underclay, light-gray, sandy; changes at top to sandstone that contains *Stigmaria*	2. 8	1, 287
106. Sandstone, olive-gray, fine-grained; massive in lower part; boardlike structure in middle and upper parts; includes shale lens one-third of way above base	101	1, 284
Unconformity.		
105. Siltstone, olive-gray, thin-bedded	10	1, 183
Kendrick Shale of Jillson (1919):		
104. Shale, blue-gray; contain marine fossils, including *Chonetes*, *Marginifera*, *Glabrocingulum*, and *Amphiscapha*	3. 7	1, 173
Total thickness of Kendrick Shale of Jillson (1919)	3. 7	
103. Covered	12	1, 169
102. Shale, medium-gray, silty	10	1, 157
101. Shale, medium-gray; contains oval ironstone concretions and *Aviculopecten;* changes to siltstone at top	10. 2	1, 147
100. Coal, blocky, 7 inches; underclay, 2 inches; sandstone containing *Stigmaria*, 9 inches; light-gray cross-bedded siltstone, 2 feet; light-gray silty shale, 10 inches; blocky coal, 8 inches; bone, 2 inches; coal, 3 inches	5. 4	1, 137
99. Underclay, light-gray, sandy	2. 2	1, 132
98. Sandstone, light-brownish-gray, coarse-grained, massive; contains shaly lenses	36	1, 130
Unconformity.		
97. Coal, 2¼ inches; coaly shale, 1½ inches; coal, 5 inches; sandstone, 0–3 inches; coal, ¼ inch	1. 0	1, 094
96. Underclay, brownish-gray	0. 7	1, 093
95. Siltstone, not laminated	4	1, 092
94. Sandstone, light-brownish-gray, fine-grained, platy	12	1, 088
93. Shale, yellow-gray, sandy, micaceous	7	1, 076
92. Coal, weathered, 2 feet 2 inches; rash (impure coal), 11 inches; clay, ½ inch; coal, 1½ inches; Low Splint coal. Unit is exposed in ditch, bloom in bank	3. 2	1, 069
91. Underclay, light-gray	4	1, 066
90. Shale; contains fossil plant impressions	5	1, 062
89. Coal, 1¼ inches; clay, ½ inch; coal, 11½ inches	1. 1	1, 057
88. Underclay, sandy	1. 2	1, 056
87. Sandstone, light-greenish-gray, massive, micaceous; weathers brownish. Equivalent to Pioneer Sandstone Member of Mingo Formation of Tennessee	53	1, 054
86. Coal, 1 foot 8½ inches	1. 7	1, 001

Geologic section 7—Continued

Wise Formation—Continued	*Thickness (feet)*	*Top of unit to base of formation (feet)*
85. Underclay	1.4	1,000
84. Shale, light-gray, and siltstone with 1½-inch coal near base and ½-inch coal in upper part	1.8	998
83. Sandstone, and sandy underclay	2.4	996
82. Sandstone, brownish-gray, medium-grained, micaceous, massive	50	994
Unconformity.		
81. Shale, silty, medium- to olive-gray	4	944
80. Shale, medium- to dark-gray, pyritic; fossiliferous with *Derbya*	5.3	940
79. Coal, 4 inches; medium-gray shale, 1¼ inches; coal, 4 inches; light-gray underclay, 7½ inches	1.4	935
78. Siltstone, brownish-gray; contains root impressions	3.4	933
77. Sandstone; contains plant stems; changes upward to medium- to dark-gray flaky shale	3.5	930
76. Siltstone, medium-gray, massive to shaly; contains 8 inches of medium-blue-gray shale at top	12.6	926
Marcum Hollow Sandstone Member (this report):		
75. Sandstone, medium- to coarse-grained micaceous, massive and cliff-forming; contains shaly partings	75	914
Total thickness of Marcum Hollow Sandstone Member	75	
Unconformity.		
74. Shale, medium-gray; contains fossil plants	17	839
73. Coal, 1 foot 5 inches; clay, 2 inches; coal, 10 inches; brownish-gray clay, 3½ inches; coal (Taggart, No. 5 coal), 1 foot 7 inches. Unit is exposed in ditch on north side of road, 120 feet uphill from power line crossing	4.3	822
72. Underclay, brownish-gray	3.5	818
71. Shale, brownish-gray, silty	2.5	814
70. Siltstone, medium-gray; contains lenticular masses of sandstone	7	812
69. Sandstone, brownish-gray, micaceous, massive	6	805
68. Shale, light-brownish-gray; contains plant traces	5	799
67. Coal, 4½ inches	0.4	794
66. Siltstone; contains root and stem traces	2.5	793
65. Shale, silty, light-gray	4	791
64. Covered	2	787
63. Coal (Taggart Marker or Marker coal)	3.3	785
62. Underclay; sandy at top; contains *Stigmaria*	3.9	781
61. Siltstone, shaly	1.7	778

Geologic section 7—Continued

	Thickness (feet)	Top of unit to base of formation (feet)
Wise Formation—Continued		
Clover Fork Sandstone Member (this paper):		
60. Sandstone, brownish-gray, massive and cliff-forming	40	776
Total thickness of Clover Fork Sandstone Member	40	
59. Covered	12	736
58. Sandstone, brownish-gray, medium-grained, micaceous, massive to platy	8	724
57. Covered	16	716
56. Sandstone, brownish-gray, coarse-grained, massive and cliff-forming	60	700
Unconformity.		
55. Siltstone, medium-gray, shaly	6	640
54. Sandstone, medium-grained, micaceous, massive	11	634
Unconformity.		
53. Coal (Standiford coal of Butts (1914, p. 175) and Wanless (1946); Wilson coal of this report)	1. 6	623
52. Underclay	3. 8	621
51. Shale, medium-gray; contains fossil plants	3	617
50. Covered	10	614
49. Sandstone, medium-gray, coarse-grained, massive and cliff-forming	44	604
48. Siltstone, brownish-gray, massive	12	560
47. Sandstone, shaly	4. 5	548
46. Sandstone; has boardlike structure	10	544
45. Siltstone, medium-gray, shaly to massive	18	534
44. Shale, medium- to brownish-gray, silty; contains ironstone concretions	23	516
43. Covered	18	493
42. Sandstone, light-gray, micaceous, massive	11	475
41. Covered	20	464
40. Coal (Kelly coal)	1	444
39. Underclay, olive-gray	1. 5	443
38. Shale, medium-gray	5	441
37. Siltstone, brownish-gray	2. 5	436
36. Shale; contains fossil plants	4. 7	434
35. Coal, 6¾ inches; dark-gray shale, 4 inches; coal (Imboden coal), 4 feet 9 inches	5. 6	429
34. Underclay	0. 5	424
33. Covered	42	423
32. Sandstone, impure, moderately quartzose, micaceous; fine grained at base; changes upward to medium grained	55	381
31. Covered	4±	326
30. Sandstone, medium-grained, impure, micaceous	11	322
29. Covered	5±	311

Geologic section 7—Continued

Wise Formation—Continued	*Thickness (feet)*	*Top of unit to base of formation (feet)*
28. Sandstone, light-gray, medium-grained, even-bedded and crossbedded; thinner bedded in middle; beds are as much as 2 feet thick at top	64	306
27. Siltstone, brownish-gray, micaceous, shaly	2	242
26. Covered	13	240
25. Siltstone, medium-gray; interbedded with dark-gray shale; occurs on very steep slope above bluff at Inman	32	227
24. Sandstone, light-olive-gray, very fine grained; beds average 1 foot in thickness; changes to siltstone upward	9	195
23. Covered	5	186
22. Covered (gravel and alluvium cased off in drill hole)	23. 5	181
21. Shale, gray	26. 2	158
20. Coal, bony	0. 3	131
19. Fireclay	0. 8	131
18. Shale, blue, silty	20±	130
17. Sandstone, fine-grained, quartzose, resistant; forms cascades in western tributary of Looney Creek. This sandstone also forms knob in Southern Railroad yard and ledges on east side of yard	49	110
16. Coal, 10 inches; contains 2-inch layers of weathered sandstone at base and shale at top	1. 2	61
15. Covered	7	60
14. Sandstone, very fine grained, moderately quartzose; contains ironstone concretions; makes small waterfall	2. 5	53
13. Siltstone, thin-bedded to shaly, weak	8. 2	51
12. Sandstone, fine-grained, impure; has carbonaceous films on bedding surfaces; forms 1-foot ledge at base and 3-foot ledge at top; lowest beds are exposed at base of cascades of tributary to Looney Creek	5. 7	42
11. Covered; in rhododendron jungle; seems to include thin coal at or near top	4. 5	37
10. Sandstone, medium-grained, massive-bedded and crossbedded, moderately quartzose; involved in sharp flexure which carries beds from steep northwest dips up creek bank to gentle northwest dips just above creek level	8. 5	32
9. Coal (Dorchester coal), prospected, poorly exposed	3±	24
8. Covered	20. 7	21
Total thickness of Wise Formation	2, 268±	

Geologic section 7—Continued

	Thickness (feet)	Top of unit to base of formation (feet)
Gladeville Sandstone (85 feet):		
7. Sandstone, fine-grained, massive-bedded, moderately quartzose, resistant; forms steeply dipping flange jutting into Looney Creek	22.4	85
6. Sandstone, fine-grained, laminated, impure, weak; interbedded with shale	9	62
5. Sandstone, fine-grained, massive, moderately quartzose, micaceous; contains carbonaceous films	20	53
4. Shale, medium-gray	0.7	33
3. Sandstone, white speckled, medium-grained, massive-bedded, resistant; becomes fine grained upward	32.5	32
Total thickness of Gladeville Sandstone	84.6	
Norton Formation (34+ feet):		
2. Covered	30±	
1. Coal (Norton coal); formerly mined but no longer exposed; reported to be 4 feet thick	4±	
Incomplete thickness of Norton Formation	34±	

Geologic section 8

Type section of the Robbins Chapel Sandstone Member of the Wise Formation at Robbins Chapel, Lee County, Va. (Keokee 7½-minute quadrangle). See plate 1 for location of section. Section begins on secondary State Road 606 at top of long hill, 1,900 feet S. 27° W. of brick church at Robbins Chapel and 20 feet north of where two powerlines cross directly above road. Measured by R. L. Miller.

	Thickness (feet)
Wise Formation (91+ feet):	
Robbins Chapel Sandstone Member (type section; 81 feet):	
9. Concealed in fields above old road but believed to be similar to unit 8	28±
8. Sandstone, fine-grained, crossbedded, slightly micaceous; weathers yellowish gray and grayish orange; exposed in cut of abandoned road above main highway	15
7. Sandstone, medium-grained; grades upward to finegrained; micaceous, friable; contains interstitial clay derived from weathered feldspar grains; beds are 6 inches to 3 feet thick; weathers light brown and moderate reddish brown; plant trash along some bedding planes; uppermost beds exposed in tiny gully above main highway cut	34
6. Sandstone, medium-grained, crossbedded, friable; weathers grayish orange and very light gray; contains muscovite flakes and stringers and patches of coal along crossbeds	4
Total thickness of Robbins Chapel Sandstone Member	81
5. Coal, weathered, eroded; ½-inch	0.04

Geologic section 8—Continued

Wise Formation—Continued	*Thickness (feet)*
4. Clay, dark-yellowish-orange; 9 inches	0.75
3. Shale, olive-gray, weathered	3
2. Sandstone, pale-yellowish-brown, fine-grained, impure, friable; 5 inches	0.4
1. Siltstone, dark-yellowish-brown, weathered, shaly	6
Incomplete thickness of Wise Formation	91.2

Geologic section 9

Type section of the Keokee Sandstone Member of the Wise Formation along State Highway 68, 1 mile east of Keokee, Lee County, Va. (See pl. 1.) Section begins 5,200 feet (airline) east of Keokee School and 200 feet east-northeast of junction of side road with highway at curve at bottom of long hill. Measured by R. L. Miller.

Wise Formation (part):	*Thickness (feet)*
7. Siltstone, micaceous, weathered	3+
Keokee Sandstone Member (type section 59± feet):	
6. Sandstone, medium-light-gray, white-speckled, medium- and fine-grained, slightly micaceous; beds are 3 inches to 2½ feet thick; contains carbonized plant fossils. Beds exposed in ditch and roadcut on south side of road. Top of unit in middle of S-turn near top of hill	14
5. Sandstone, pale-yellowish-brown, feldspathic, slightly micaceous, massive; contains abundant white specks and scattered dark grains; occurs in beds as much as 3 feet thick. Top of unit at curve at junction with woods lane on north side of highway	25
4. Covered	4±
3. Sandstone, medium-gray, crossbedded, feldspathic; weathers pale yellowish brown and light brown; contains scattered dark grains; beds are 2 inches to 3 feet thick; fine grained at base and becomes medium grained upward; contains carbonaceous films, stringers, and carbonized plant remains	16±
Total thickness of Keokee Sandstone Member	59±
Erosional unconformity.	
2. Siltstone, medium-light-gray to medium-dark-gray, micaceous, shaly	4
1. Sandstone, very fine grained, massive-bedded, rounded-weathering, carbonaceous, micaceous	2.5+
Incomplete thickness of Wise Formation	68.5±

Geologic section 10

Middle part of the Wise Formation; includes type sections of the Clover Fork and Marcum Hollow Sandstone Members. Section extends along State Highway 624, between Keokee, Lee County, Va., and Morris Gap at crest of Little Black Mountain on Virginia-Kentucky State line. (See pl. 1.) Section begins at Harlan coal exposed in ditch at gentle curve, 1,000 feet north-northwest of junction of State Highways 606 and 624 in north part of town of Keokee. Section ends at top of Little Black Mountain on dirt road, 200 feet west of Morris Gap. Measured by R. L. Miller.

	Thickness (feet)	*Top of unit to base of section (feet)*
Wise Formation (464+ feet):		
57. Shale, silty, and very fine grained impure sandstone	5+	464
Kendrick Shale of Jillson (1919):		
56. Shale, dark-gray, fossiliferous, slightly calcareous; contains large oval calcareous concretions with well-developed cone-in-cone structure; concretions average 3½ feet in longest dimension and 1½ feet in thickness	2.3	459
Total thickness of Kendrick Shale of Jillson (1919)	2.3	
55. Sandstone, medium-dark-gray, very fine grained, impure, micaceous; contains ironstone concretions in upper part	7.5	456
54. Siltstone; contains lenses and beds of ironstone	8.6	449
53. Shale, medium-dark-gray; contains ironstone nodules and lenses	1.8	440
52. Sandstone, very fine grained, impure; occurs in thin wavy beds that contain rootlets	8.7	438
51. Sandstone, medium-light-gray, fine-grained, moderately quartzose; forms prominent outcrops and roadcut at high point of highway at Morris Gap	26.5	430
50. Coal (Low Splint coal); contains two clay partings, 0.1 foot thick	3.5	403
49. Underclay, silty and sandy; contains abundant rootlets	3	400
48. Sandstone, fine- to medium-grained, thin-bedded, impure; rootlets at top	6	397
47. Sandstone, medium-grained, thick-bedded, moderately quartzose, micaceous	14.9	391
46. Shale, silty	5.5	376
45. Covered	23	370
44. Coal, impure, and clay	0.3	347
43. Covered, probably shale	19.6	347
42. Coal, weathered	1.0	328
41. Underclay, silty; contains rootlets	3.8	327
40. Sandstone, fine-grained, impure, irregularly bedded	8.0	323
39. Covered; probably sandstone	10.9	315

Geologic section 10—Continued

	Thickness (feet)	Top of unit to base of section (feet)
Wise Formation—Continued		
38. Sandstone, fine-grained; fills channel in underlying beds	10. 7–17. 7	304
37. Shale, chunky; bedding indistinct	12. 1–19. 1	290
36. Covered; probably shale	11. 0	274
35. Coal, slumped; contains 2-inch clay parting	0. 5	263
34. Underclay	0. 5	262
33. Shale, chunky, weathered; contains rootlets	5. 5	262
32. Sandstone, very fine grained; occurs in thin wavy beds	7. 0	257
31. Covered; probably shale	8. 9	250
30. Coal	0. 5	241
29. Shale, poorly exposed	2+	240
28. Sandstone, fine-grained, and shale	2. 3	238
27. Coal and carbonaceous shale, thinly laminated	0. 6	236
26. Shale and covered beds	3. 4	235
Marcum Hollow Sandstone Member (type section; 44 feet):		
25. Sandstone, medium-grained, massive- and thin-bedded, crossbedded, moderately quartzose; contains shale clasts near middle. Crops out on hairpin turn of highway between 2,367 and 2,415 feet elevation. Forms prominent ledges along Little Black Mountain above Taggart (No. 5) coal and in high wall of Taggart strip mines	44. 0	232
Total thickness of Marcum Hollow Sandstone Member	44	
24. Shale, weathered	4. 3	188
23. Coal (Taggart coal—also called No. 5, Darby, and Keokee); contains 4-inch clay parting in upper part	5. 7	184
22. Underclay, silty; contains rootlets	1. 1	178
21. Sandstone, very fine grained, poorly bedded; contains rootlets	2. 5	177
20. Sandstone, fine-grained, impure to moderately quartzose, micaceous, thin- and thick-bedded	9. 5	174
19. Covered	5+	165
18. Sandstone, fine-grained, wavy-bedded, impure, micaceous; carbonaceous material on bedding planes	7. 4	160
17. Claystone, weathered; contains rootlets	3. 3	152
16. Coal (Marker or Taggart Marker Coal), upper 6 inches impure with clay	1. 5	149
15. Underclay; contains rootlets	0. 7	148
14. Shale, silty, poorly bedded	16. 5	147
13. Coal; contains 6-inch clay parting in upper part	1. 6	130

Geologic section 10—Continued

	Thickness (feet)	Top of unit to base of section (feet)
Wise Formation—Continued		
Clover Fork Sandstone Member (type section; 78 feet):		
12. Sandstone, medium- and coarse-grained, moderately quartzose; contains abundant muscovite flakes; massive, with a few beds of fine-grained shaly sandstone	31. 5	129
11. Sandstone, coarse-grained, moderately quartzose; contains coal laminae and fragments; shale pebbles in upper part	14. 4	97
10. Sandstone; coarse grained in lower part, medium grained above; in thin to thick beds; contains shale lens near top	20. 9	83
9. Shale, silty; contains 8-inch coal lens	5. 0	61
8. Sandstone, very coarse and coarse-grained, moderately quartzose, crossbedded; fills channel in underlying unit	6. 0	57
Total thickness of Clover Fork Sandstone Member	77. 8	
7. Shale, poorly bedded; locally eroded with channels filled by overlying unit	4. 5	51
6. Sandstone, fine- and medium-grained, thin- and thick-bedded, moderately quartzose; muscovite on bedding planes	4. 6	46
5. Shale, dark-gray; contains ironstone nodules and beds	11. 0	42
4. Covered; probably mostly shale	27. 5	31
3. Coal; locally called Wilson coal. It is the Harlan coal of Giles (1925) at Keokee, but not elsewhere	1. 5	3
2. Underclay	0. 8	2
1. Sandstone, fine-grained, thin-bedded, impure; base not exposed	1+	1
Incomplete thickness of Wise Formation	464	

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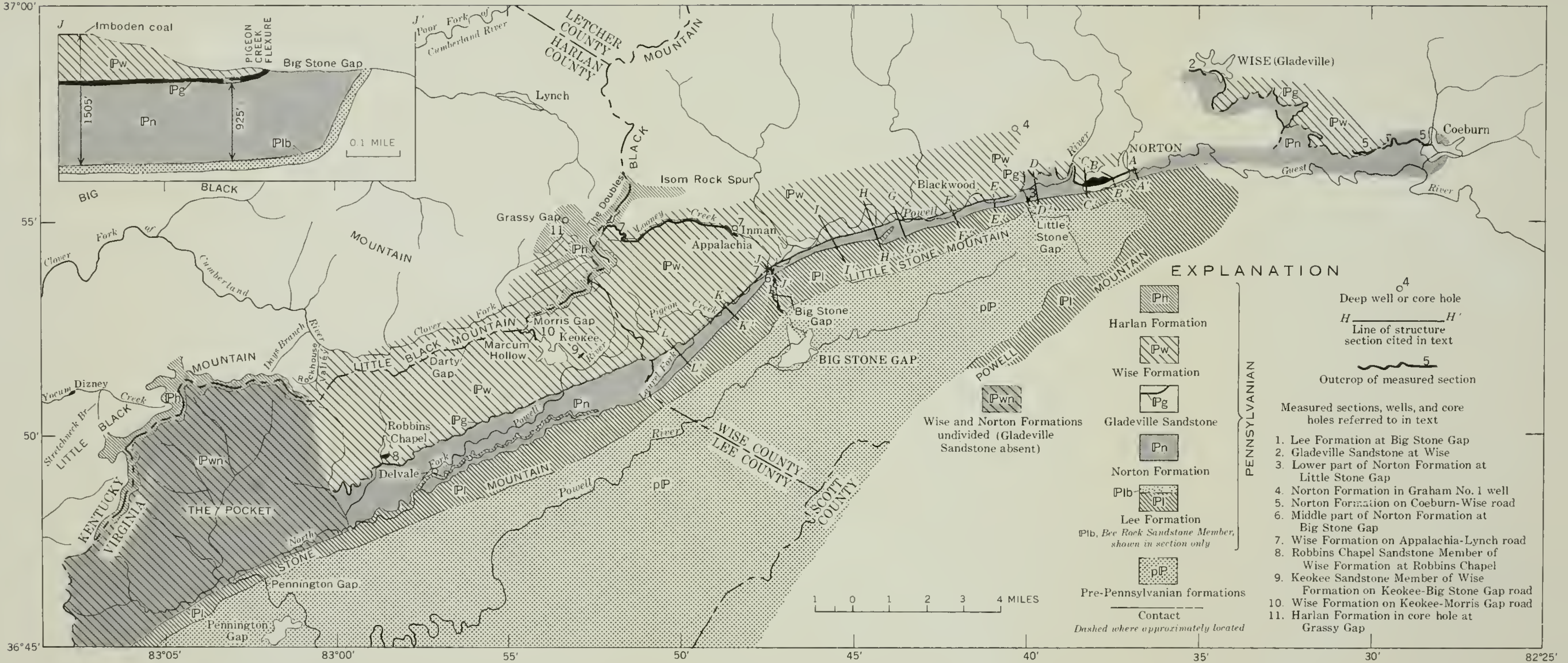

Geology by Ralph L. Miller

GENERALIZED GEOLOGIC MAP AND SECTION OF THE WESTERN PART OF THE VIRGINIA COAL FIELDS SHOWING THE LOCATION OF MEASURED AND STRUCTURE SECTIONS, CORE HOLES, AND DEEP WELLS

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