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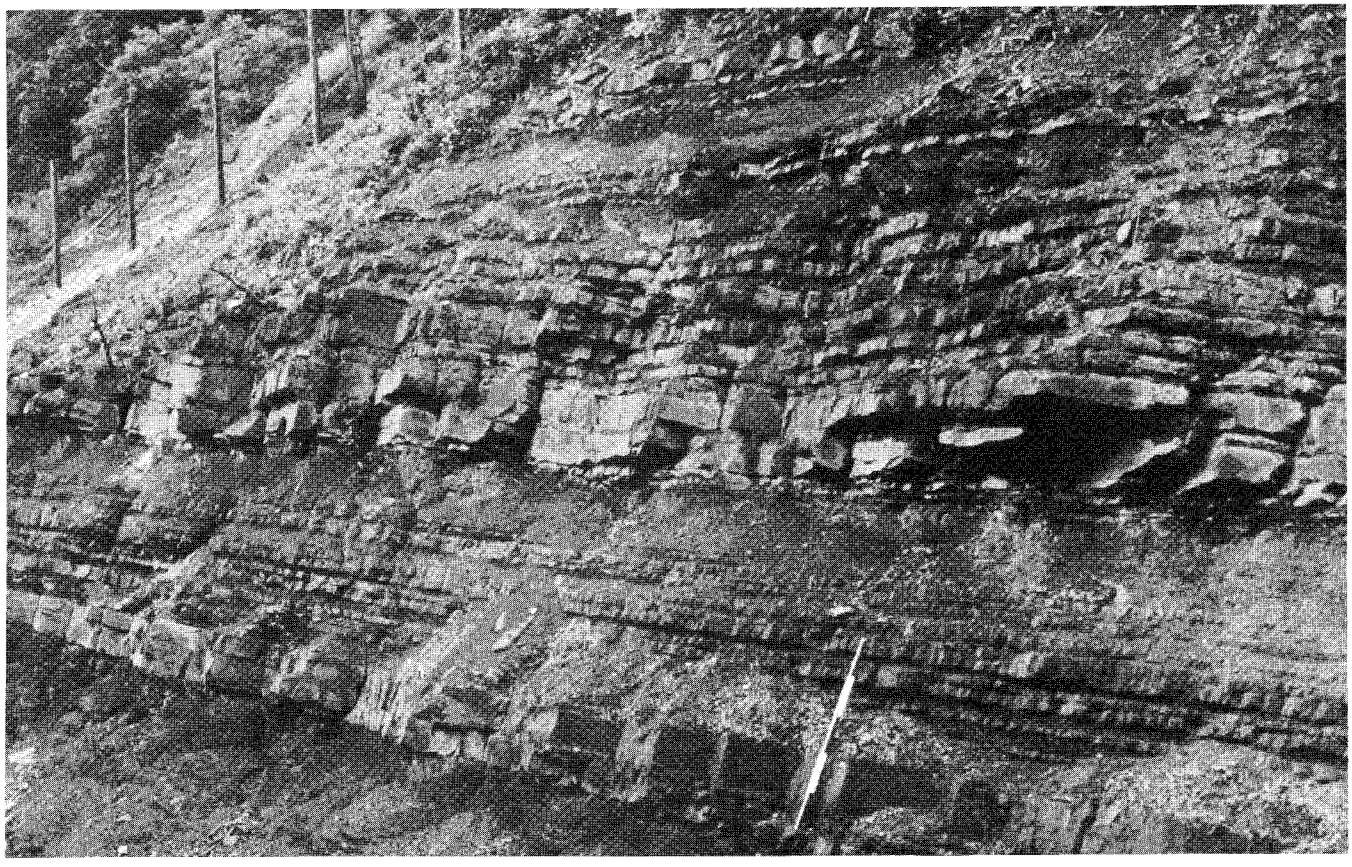
POST-MARTINSBURG ORDOVICIAN STRATIGRAPHY OF VIRGINIA AND WEST VIRGINIA

Richard J. Diecchio



COMMONWEALTH OF VIRGINIA

DEPARTMENT OF MINES, MINERALS AND ENERGY

DIVISION OF MINERAL RESOURCES

Robert C. Milici, Commissioner of Mineral Resources and State Geologist

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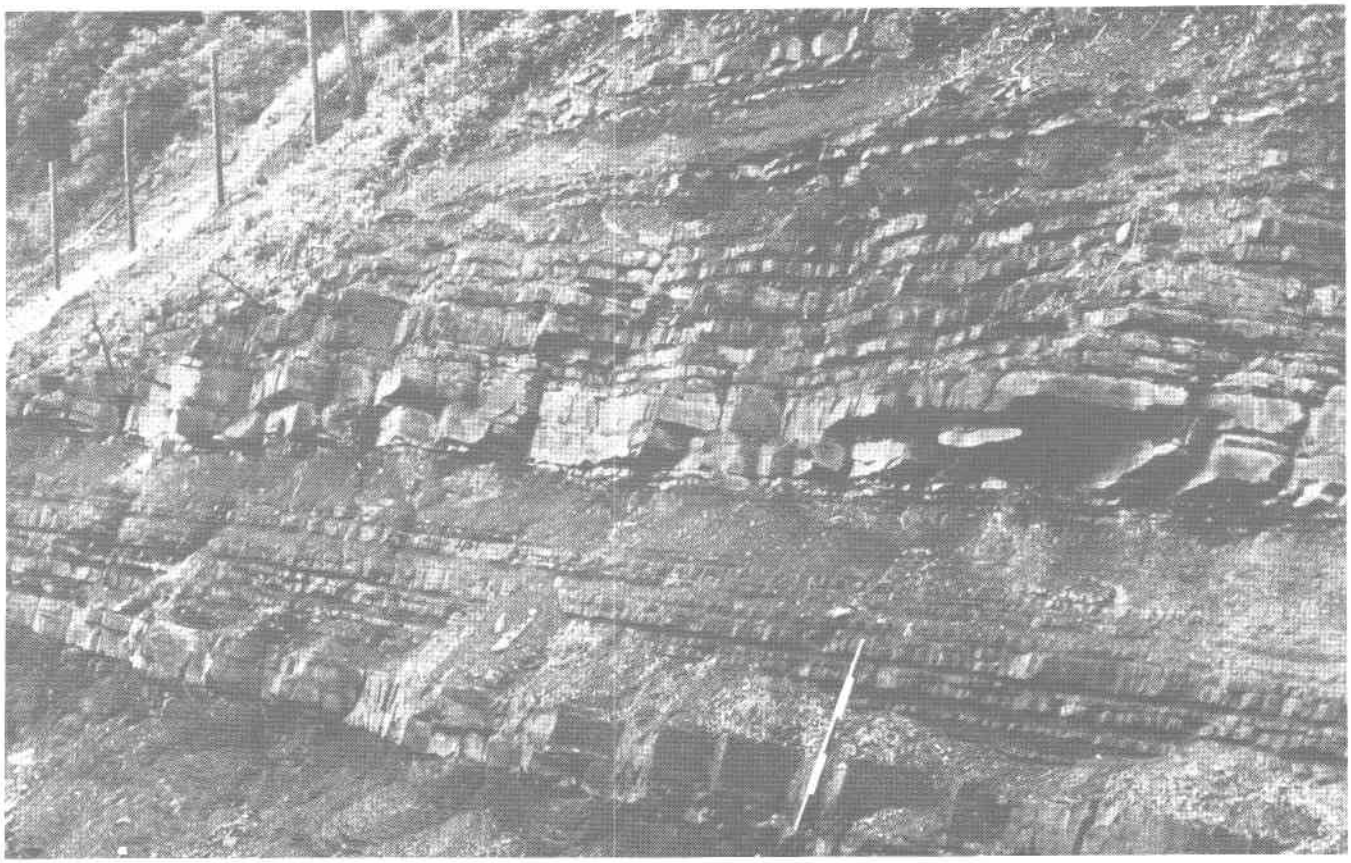

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FRONT COVER: Two cycles within the Juniata Formation, Cumberland, Maryland. Jacob's staff is 5 feet long, graduated in feet. Bottom of staff marks base of lowermost sandstone bed (base of cycle). Basal sandstone is here channeled into the underlying mudstone. Top of Jacob's staff marks the middle *Skolithos*-bearing portion of cycle. Mudstone overlies the *Skolithos* facies and continues up to base of overlying sandstone bed, marking the base of the next cycle.

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POST-MARTINSBURG ORDOVICIAN STRATIGRAPHY OF VIRGINIA AND WEST VIRGINIA

Richard J. Diecchio[1]

ABSTRACT

The Ashgillian (uppermost Ordovician) clastic strata of the Central Appalachian basin were studied in order to interpret their paleoenvironmental history and sedimentary tectonics. Forty-three outcrop and thirteen subsurface data localities were investigated in the Valley and Ridge and Appalachian Plateau provinces of central and northern Virginia, eastern West Virginia, and western Maryland.

The upper portion of the Martinsburg and Reedsville formations is characterized by sandstones to mudstones containing shallow water fauna of the *Orthorhynchula* brachiopod biozone. This interval marks a eustatic lowering of sea level at the beginning of the Ashgill epoch.

The Oswego Sandstone and the Juniata Formation, each of which overlies the Martinsburg, are facies-equivalent to each other. West of 80° W longitude the Oswego is absent, and the Juniata conformably overlies the Martinsburg and Reedsville formations, except in the Salem (Catawba) syncline where the Juniata is for the most part also disconformably absent. To the east, and throughout most of the Valley and Ridge, the Oswego conformably lies above the Martinsburg and Reedsville and below the Juniata. In easternmost outcrop belts, the Juniata lithology is absent, having changed facies into the Oswego. The Oswego conformably overlies the Martinsburg, except in the Massanutten synclinorium where it is disconformably absent.

The Oswego Sandstone, green to gray litharenite to lithic wacke, was derived from an eastern (orogenic) source area. The Oswego was probably deposited in shallow marine conditions. The Juniata Formation is a cyclically bedded sequence of red to green sandstone, mudstone, and shale derived from a source area in Pennsylvania. The Juniata Formation is nonmarine to shallow marine, and was deposited during a low stand of sea level. The widespread transition from the Juniata Formation to the Tuscarora Sandstone probably represents a eustatic rise in sea level at the end of the Ordovician. The Ordovician/Silurian boundary exposed in the Valley and Ridge is disconformable in the eastern synclinoria, conformable in the central Valley and Ridge, and paraconformable in the western anticlines.

INTRODUCTION

The Ordovician and Silurian strata of the Central Appalachian basin may be subdivided into three gross lithologic units. The lowermost unit is the upper portion of the Cambro-Ordovician carbonate sequence, which terminates within the Upper Ordovician, and is represented, throughout much of the Valley and Ridge, by the top of the Trentonian Stage. The top of this carbonate sequence generally is younger in the basin center (uppermost Edenian), and older toward the eastern basin margin (top of the Black River stage), consistent with the westward progradation and associated overstep by the overlying clastic wedge. The middle unit is comprised of the Cincinnatian (Upper Ordovician) through Niagaran (Lower Silurian) strata, a westward-transported clastic sequence that was derived from an eastern source. Cayugan (Upper Silurian) strata make up the basal portion of the upper unit, a carbonate sequence that terminates at the top of the Lower Devonian Helderbergian Stage. Figure 1 is a correlation diagram of the Ordovician and Silurian units of the Central Appalachians.
and Silurian units of the Central Appalachians.

The earliest appearance of the Ordovician-Silurian clastic sequence exposed in northern and central Virginia and adjacent West Virginia is the Martinsburg Formation. These strata are equivalent to late Champlainian Trenton age limestone in southern Virginia (Twenhofel and others, 1954). Farther southwest in Virginia and Tennessee, equivalent intervals are occupied by the Bays-Moccasin redbeds, which comprise the Blount delta, an early phase (Blount phase of Rodgers, 1971, p. 1165) of sedimentation associated with the Taconic Orogeny. The Martinsburg is a coarsening-upward clastic unit whose upper, sandy intervals pass

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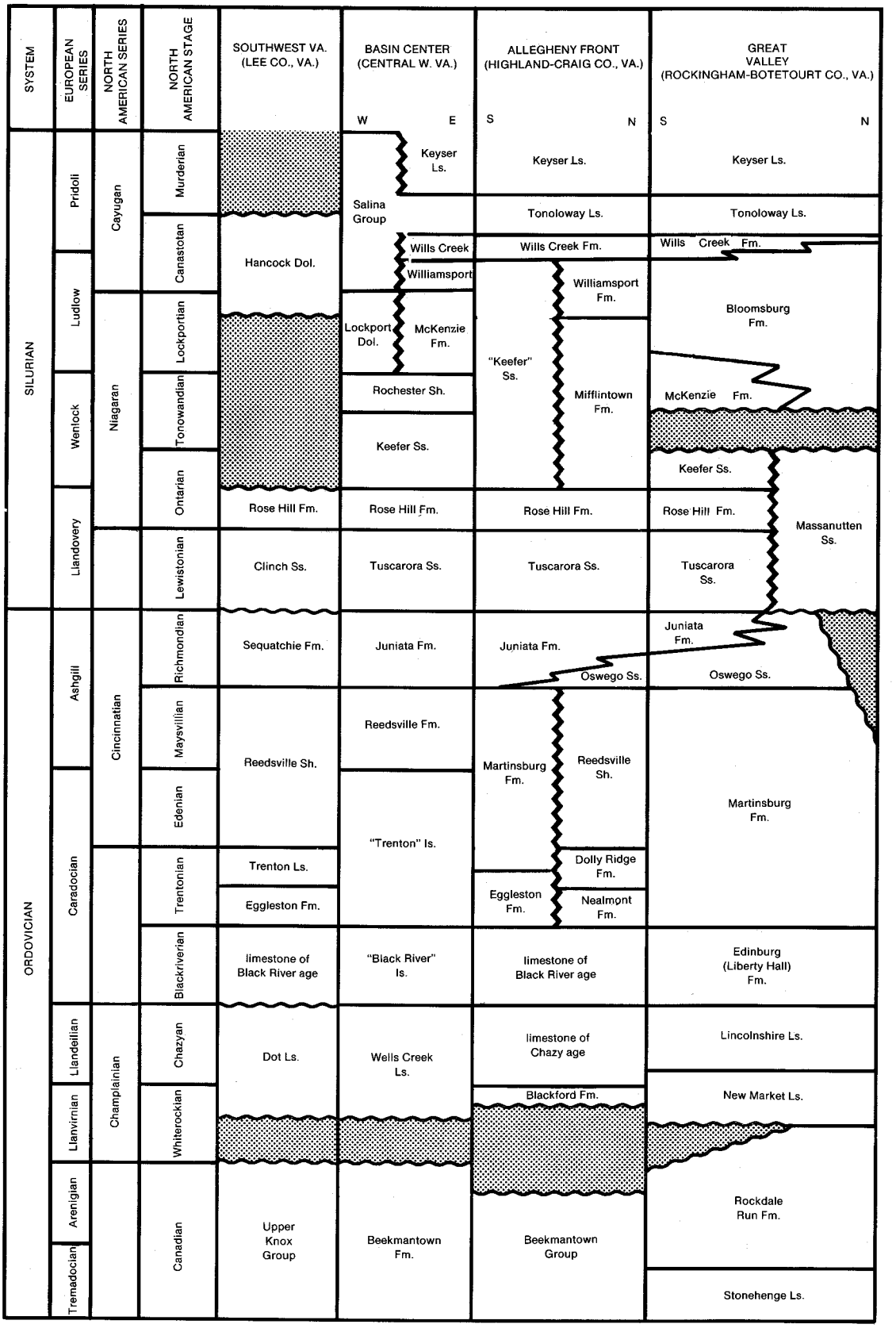

Figure 1. Ordovician-Silurian correlation chart, modified from Swartz and others (1942), Twenhofel and others (1954), Dennison (1982) and Rader (1982).

westward into interbedded marine shales, siltstones, and limestones of the Reedsville Formation. These units are in turn overlain by the Oswego Sandstone or the Juniata Formation. The Juniata Formation is a redbed sequence that is well developed in the deep subsurface of the Appalachian basin. Throughout most of the Valley and Ridge, the Oswego lies below the Juniata. In the eastern portion of the Valley and Ridge, the Juniata changes facies into the Oswego Sandstone. Together the Oswego and Juniata represent the southern portion of the Queenston "delta complex" in Virginia, West Virginia, and Maryland and are the primary units discussed in this study.

The Juniata and the Oswego (where the Juniata is absent) are everywhere overlain by the Tuscarora Sandstone, the first of at least five tongues of quartzarenite that extended into the basin from an eastern source during the Silurian. Each sandstone pulse is bounded above and below by a marine transgressive unit. These sandstones are a prominent part of the section through the Upper Niagaran, above which lies the Cayugan (Upper Silurian) and Helderberg (lowermost Devonian) carbonate sequence.

Purpose

This study is an investigation of the Ashgillian strata of the northern two-thirds of Virginia, eastern West Virginia, and western Maryland. Ashgillian (upper Cincinnatian, uppermost Ordovician) strata that were studied in detail include the upper portion of the Martinsburg and Reedsville formations, the Oswego Sandstone, and the Juniata Formation. The purposes of this investigation are to interpret the physical stratigraphy, sedimentology, and paleoenvironmental history of these units and to refine the interpretation of the Ordovician-Silurian boundary.

Acknowledgements

This investigation originally constituted a dissertation (Diecchio, 1980b) completed at the University of North Carolina under the supervision of John M. Dennison, whose guidance is gratefully acknowledged. Many people have provided field assistance, assistance in collecting subsurface data, and have critically read this manuscript. These people include Katharine L. Avary, Mervin J. Bartholomew, Janet A. Diecchio, Thomas M. Gathright II, Robert C. Milici, Douglas G. Patchen, William J. Perry, Jr., and Eugene K. Rader. Research funds were provided by Columbia Gas Transmission Corporation, the Virginia Division of Mineral Resources, and the West Virginia Geological and Economic Survey.

Location and Geologic Setting

The strata investigated were all deposited within the Central Appalachian basin. The study area is within the Valley and Ridge province, where the late Ordovician strata crop out, and occur in the subsurface of synclinoria, and in the Appalachian Plateau province, where the units are present in the subsurface. The study area includes portions of the states of Virginia, West Virginia, and Maryland. Figure 2 is a map of the study area showing the outcrop trace of the Upper Ordovician units, outcrop and subsurface control localities, and lines of cross sections.

Figure 3 is a simplified tectonic map that shows only those structural features that affect the distribution of Upper Ordovician outcrops throughout the study area. West of the North Mountain and Pulaski faults all of the latest Ordovician units crop out in anticlinal exposures. East of these faults the units crop out in the Massanutten synclinorium and the Salem (Catawba) syncline and in the Ingles Mountain and Read-Coyner Mountain windows.

Methods

Stratigraphic sections were measured at each outcrop locality (Figure 2) with a Jacob's staff except where the orientation of the beds prohibited this, in which case the section was measured by plane table and alidade. Sections were described according to lithology, bedding characteristics, paleontology, and sedimentologic features (Appendix I).

Cross-bed dip directions were measured to indicate paleocurrent directions. The orientation of the cross-bed was then corrected for tilt by measuring strike and dip of true bedding and using a computer program by Parks (1974) to reorient the cross-beds to original horizontality. Other programs by Parks (1974) were used to calculate vector means and to plot rose diagrams for the cross-bed paleocurrents at each outcrop at which cross-bed data were taken.

Azimuths of primary sedimentary linear features were measured directly in the field using a reorientation device and method described by Diecchio (1980a). Channel troughs were recognized in some outcrop exposures. Where possible, strike and dip were measured at three points along the channel surface transverse to the channel axis. After

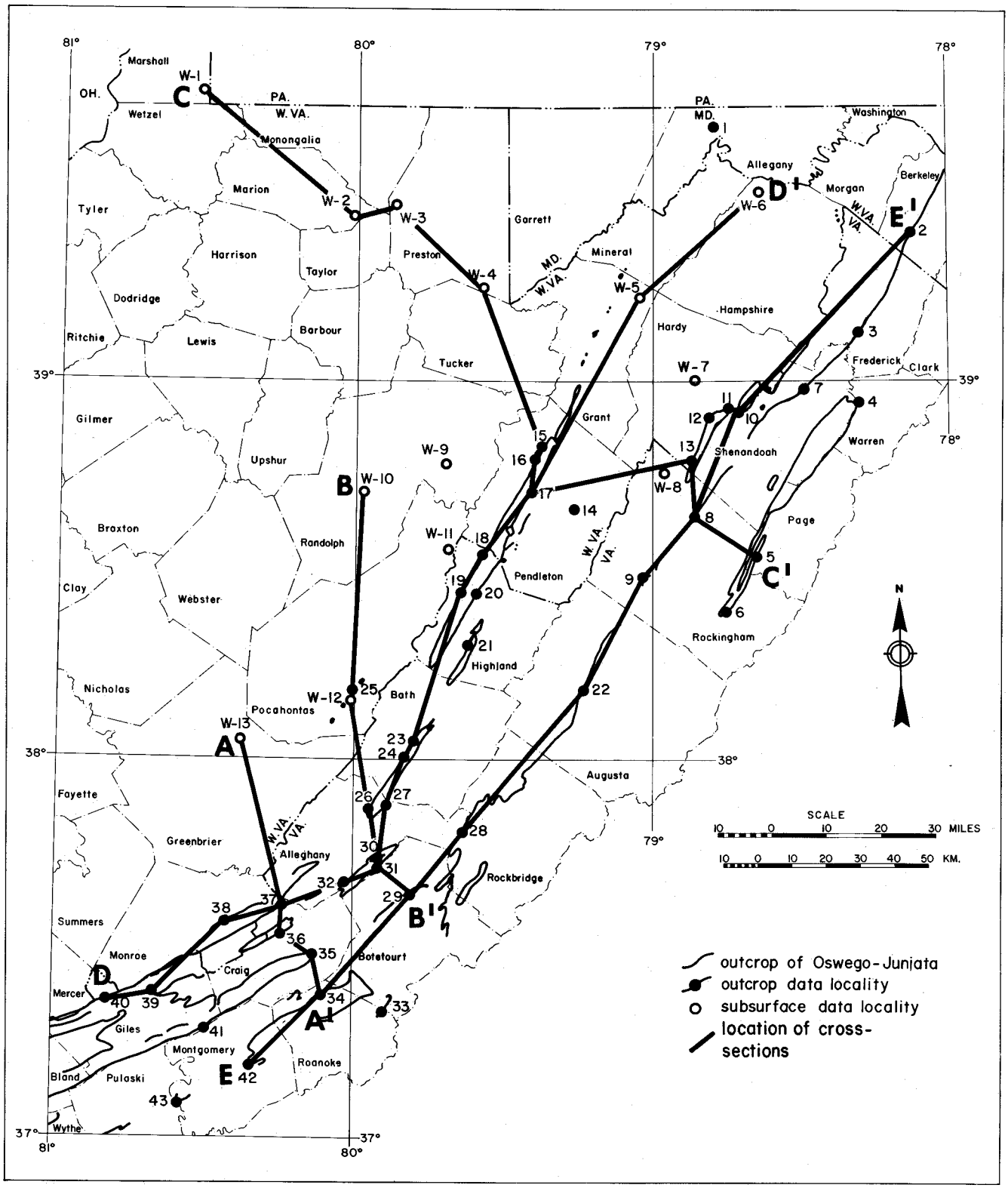

Figure 2. Location map. Locality numbers refer to measured sections or deep wells in the appendixes.

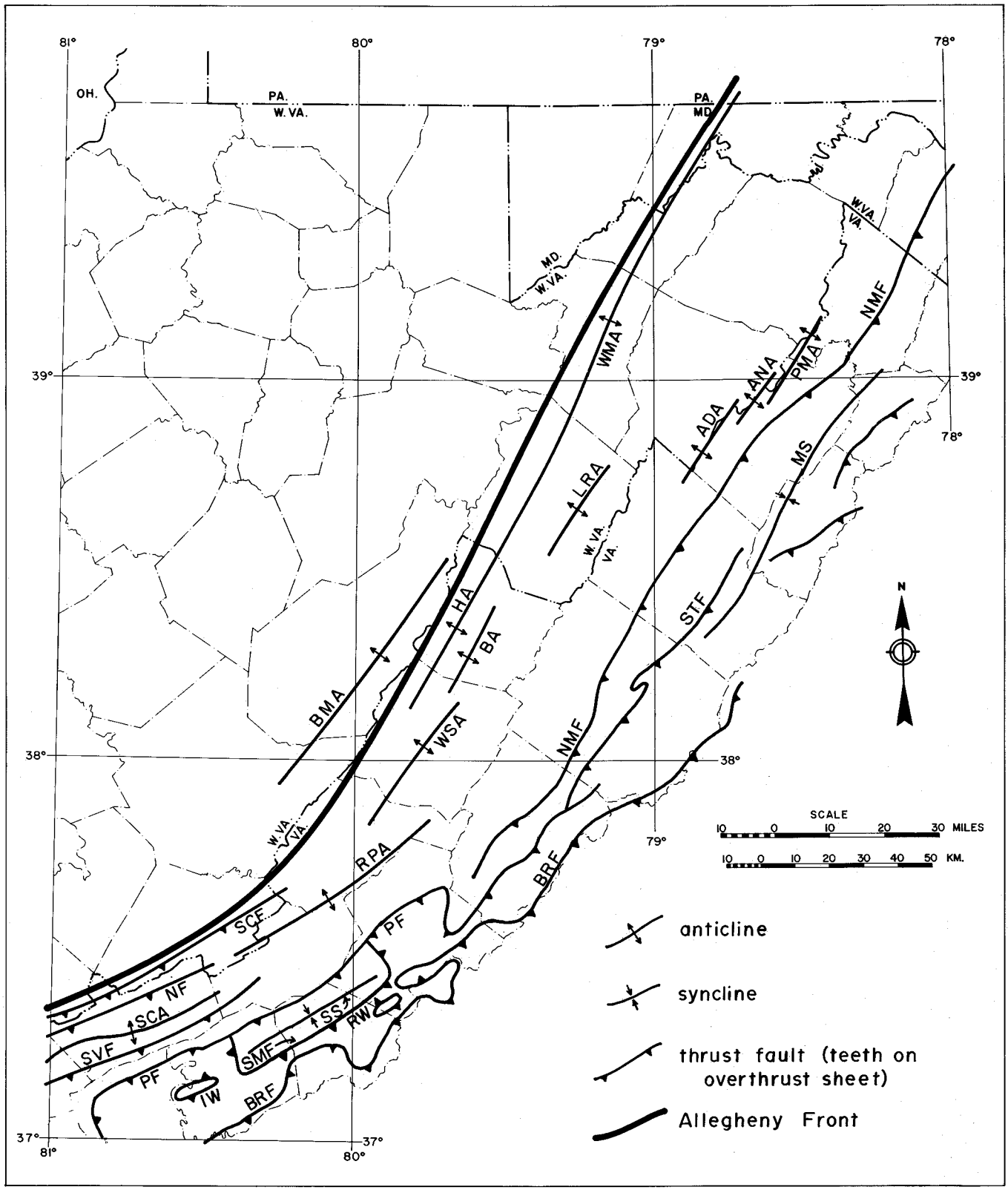

Figure 3. Tectonic map showing structural features that control the occurrence of the Oswego-Juniata in outcrop. Modified from Bartholomew and others (1980), Milici and others (1963) and Rodgers (1970, pl. 1). ADA-Adams Run anticline; ANA-Anderson Ridge anticline; BA-Bolar anticline; BMA-Browns Mountain anticline; BRF-Blue Ridge fault; HA-Hightown anticline; IW-Ingles Mountain window; LRA-Long Ridge anticline; MS-Massanutten synclinorium; NMF-North Mountain fault; PF-Pulaski fault; PMA-Paddy Mountain anticline; RPA-Rich Patch anticline; RW-Read-Coyner Mountain window; SCA-Sinking Creek anticline; SCF-St. Clair fault; SMF-Salem fault; STF-Staunton fault; SS-Salem (Catawba) syncline; SVF-Saltville fault; WMA-Wills Mountain anticline; WSA-Warm Springs anticline.

these values were reoriented to original horizontality, they were plotted on a stereo net in an attempt to determine the direction of channel flow.

Thirty-one samples of Oswego Sandstone and sandstone beds within the Juniata Formation were thin sectioned and lithology was visually estimated to allow classification of the sandstone and characterization of provenance. The samples selected for thin sectioning were widely spaced stratigraphically and in some cases consisted of only one sample for an entire outcrop exposure. Petrography was not done in any great detail.

Well data were investigated to allow characterization of the strata in the subsurface. Data taken from gamma ray and neutron logs, Geologs, and microscopic inspection of well cuttings are included in Appendix II.

Outcrop and subsurface stratigraphic data were compiled, analyzed, and correlated as a basis for stratigraphic and paleoenvironmental analysis, aided by isopach and lithofacies maps. All interpretative stratigraphic data are plotted on palinspastic base maps. Figure 4 is considered a conservative pre-deformational (palinspastic) restoration of the locations of outcrops and control points. It should be emphasized that because of the allochthonous nature of many of the outcrop belts along the leading edge of the North Mountain and Pulaski faults, and east of these faults, the pre-deformational positions of many of the control points may be much farther east or south than shown in Figure 4.

Background and Previous Work

The various state geological surveys are responsible for initially setting up the stratigraphic framework of the Ordovician System in the study area. Bassler (1919, Maryland Geological Survey) regarded the Oswego as the uppermost member of the Martinsburg, and the Juniata as being either Ordovician or Silurian in age. Butts (1940, Virginia Geological Survey) differentiated the Martinsburg from the Reedsville, regarded the Oswego as a discrete formation and placed the Ordovician-Silurian systemic boundary at the top of the Juniata. Woodward (1951, West Virginia Geological Survey) was in general agreement with Butts, but he did not use the name Reedsville, although he made mention of its typical lithology. Woodward's report superceded the old West Virginia Geological Survey usage of the Medina Group (Lower Silurian), as initiated by Vanuxem (1840), which included the Gray Medina (Oswego), Red Medina (Juniata) and White Medina (Tuscarora). McBride's (1962) stratigraphic and sedimentologic study of the Martinsburg of northern Virginia to New York showed that it is a marine turbiditic unit which was deposited along strike at the eastern edge of the basin and which changed facies basinward or westward into the Reedsville marine shale and limestone. Kreisa (1980, 1981) proposed that, for the most part, the Martinsburg in southwestern Virginia is a storm-generated, open marine platform deposit.

A sedimentologic study by Yeakel (1962) showed that the post-Martinsburg through Tuscarora sediments of northern Virginia to New York were deposited in shallow water, largely by fluvial processes, and were dispersed westward from the eastern edge of the basin. Horowitz (1966) proposed a deltaic origin for the Upper Ordovician clastic wedge in the same general area, grading upward from prodelta turbidites and delta forset deposits of the upper Reedsville to the marine topset and eventually to subaerial topset beds of the Oswego. Horowitz also showed (1965, p. 31-32) that the red-green color boundary of the Juniata and Oswego does not correspond to lithologic grain size boundaries. This latter point was emphasized by Thompson (1970a, p. 1257; 1970b, p. 601-602). Meckel (1970), in a study of Paleozoic alluvial deposits in Virginia, West Virginia, Maryland, and Pennsylvania, included the Bald Eagle, Juniata, and Tuscarora formations in the strata that he considered nonmarine.

STRATIGRAPHIC FRAMEWORK

A correlation diagram of the strata that are considered in this study is provided as Figure 5. These strata are Ashgillian in age and include the interval from the top of the Martinsburg or Reedsville Formation (base of the Maysville Stage) to the base of the Silurian Tuscarora or Massanutten sandstones (base of the Silurian). Pre- and post-Ashgillian strata were not investigated in detail but were dealt with only as they relate to the overlying or underlying Ashgillian strata.

Martinsburg Formation and Equivalent Strata

The Martinsburg Shale was named by Geiger and Keith (1891, p. 161) from exposures near Martinsburg, West Virginia. As defined by Geiger and Keith, the Martinsburg comprises strata of late Trentonian, Edenian, and Maysvillian ages and is within the Caradoc and lower Ashgill Series (Twenhofel and others, 1954). At Martinsburg, West Virginia, within the Massanutten synclinorium, the top of the Martinsburg Formation and overlying

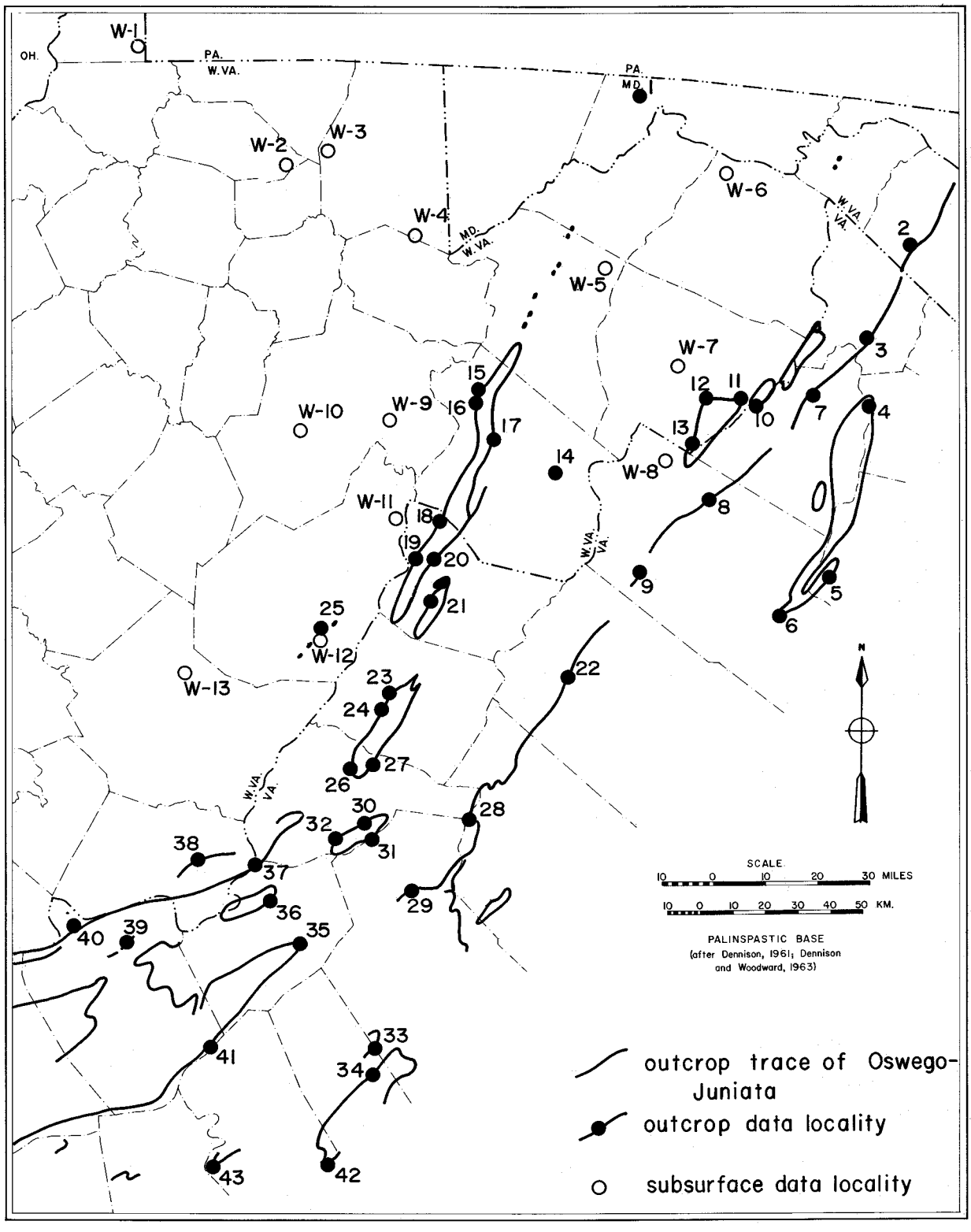

Figure 4. Location of Oswego-Juniata outcrop and control points on pre-deformational (palinspastic) base. Palinspastic base map modified from Dennison (1961, pl. 2) and Dennison and Woodward (1963). North arrow indicates present-day north.

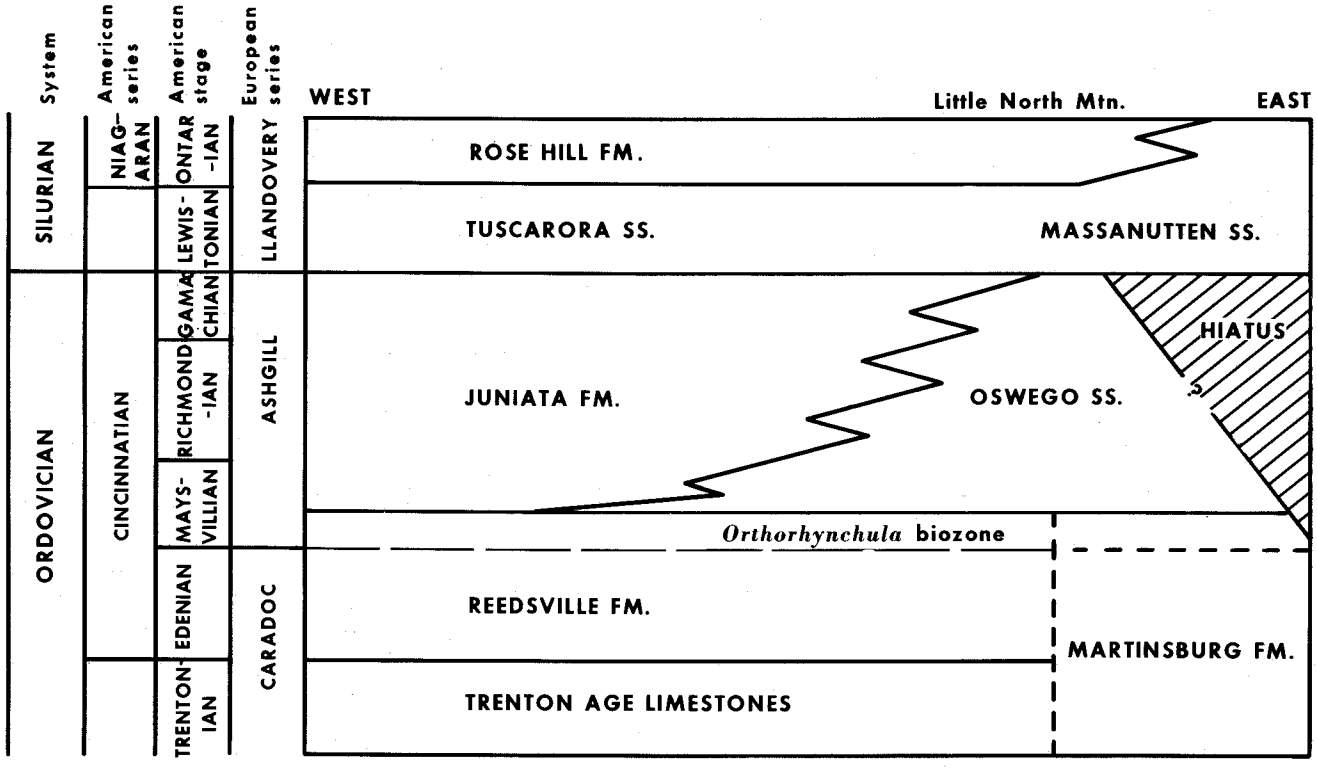

Figure 5. Correlation diagram of upper Ordovician and lower Silurian strata within the study area. Not to scale.

formations have been removed by erosion. For this reason, the top of the Martinsburg is not defined at its type locality. The lower part of the Martinsburg passes laterally into late Trenton age limestones. The upper Martinsburg grades laterally into the Reedsville Shale.

The Reedsville Shale was named for strata exposed near Reedsville, Pennsylvania by Ulrich (1911, p. 27). These strata are Edenian and Maysvillian in age (Twenhofel and others, 1954). As defined above, the Reedsville is time-equivalent to the upper portion of the Martinsburg in Pennsylvania and overlies late Trentonian age limestones. In this manner, as was originally designated, the Reedsville and Martinsburg may be differentiated on the basis of the presence or absence of late Trenton age limestone beneath the shale. Butts (1940, p. 219), using this criterion in Virginia, recognized the Reedsville as a distinct unit only in Lee and Wise counties.

Lithologically, the Martinsburg and Reedsville are somewhat different. Woodward (1951, p. 334) emphasized this but used the term Martinsburg for any shale equivalent in age to the Martinsburg. The Martinsburg is a gray to greenish gray, coarsening upward shale, siltstone and immature sand-

stone sequence that is of turbidite origin in northern Virginia and Pennsylvania (McBride, 1962, p. 69). The Reedsville grades upward from gray, calcareous, clay-shale to interbedded fossiliferous siltstone, clay-shale and limestone, and finally to fossiliferous immature sandstone (McBride, 1962, p. 40).

Generally, the uppermost beds of the Reedsville are sandstones and wackes that contain the distinctive *Orthorhynchula* assemblage biozone. Such strata occur west of Little North Mountain. East of Little North Mountain, equivalent strata are turbiditic, and the upper sandy beds do not contain the *Orthorhynchula* fauna. On this basis, strata of Edenian and early Maysvillian age east of Little North Mountain will be referred to herein as Martinsburg Formation. West of Little North Mountain, equivalent strata will be referred to as the Reedsville Formation.

It should be noted that what is referred to herein as Reedsville has been referred to by Kreisa (1980, 1981) as Martinsburg in southwestern Virginia. What is significant is that, according to Kreisa, his Martinsburg (my Reedsville) contains graded beds which are storm deposits, different from those of turbidite origin (McBride, 1962) in what I call Martinsburg.

The Martinsburg and Reedsville formations are incompetent units, and are usually disrupted structurally. For this reason, thickness determinations are not reliable (Butts, 1940, p. 209). Woodward (1951, p. 341) and Chen (1977, p. 69) have compiled isopach maps of the Martinsburg (including the Reedsville). Woodward's data are summarized in Figure 6.

In the Massanutten Mountain area, the Martinsburg consists of a lower black shale and limestone unit, a middle sandstone and shale unit, and an upper sandstone unit (Rader and Biggs, 1976, p. 22). The upper sandstone facies is much better developed in this area than west of Little North Mountain. This is the facies that was informally referred to as the Cub sandstone by Thornton (1953, p. 66-69) after exposures of siltstone and very fine grained sandstone along Cub Run on the eastern flank of the Massanutten synclinorium. Along Cub Run, this facies contains sedimentary features, such as ball and pillow structures, indicative of soft sediment deformation. This sandy upper facies of the Martinsburg in the Massanutten area is barren of fossils except in its lower portion, where it is sparsely fossiliferous. This meager fauna is not typical of the *Orthorhynchula* fauna elsewhere (Secrist and Evitt, 1943). The Martinsburg Formation in this area is overlain by the Massanutten Sandstone.

West of the North Mountain fault the upper beds of the Reedsville Formation have a distinctive lithologic sequence. These strata grade upward from shale and limestone with interbedded siltstone and sandstone, to fossiliferous sandstone with some shale, to typical *Orthorhynchula* biozone strata that are massive sandstones to siltstones usually with abundant *Orthorhynchula* and *Lingula*. In some places, these uppermost beds have a reddish coloration. The top of the *Orthorhynchula* facies, when present, is at the top of the Reedsville Formation. It is overlain either by evenly bedded to cross-bedded gray sandstone of the Oswego, or by red, interbedded sandstone and mudstone of the Juniata.

In general, the Martinsburg and Reedsville formations are overlain by the Juniata in the western and southern portions of the study area, by the Oswego farther to the north and east, by the Massanutten Sandstone in the Massanutten synclinorium, and by the Juniata or Tuscarora Sandstone in the Salem (Catawba) syncline.

Oswego Sandstone

Prosser (1888, p. 946) named the Oswego Sandstone after exposures in Oswego County, New York. Willard and Cleaves (1939, p. 1174) proposed that the name Oswego was not appropriate in Pennsylvania where equivalent beds are conglomeratic. They adopted the name Bald Eagle for this Oswego-equivalent strata and defined it as the basal member of the Juniata Formation. Butts (1940, p. 219) chose to use the name Oswego in Virginia. Woodward (1951, p. 383) extended the name Oswego into West Virginia. Prior to Woodward's work, the Oswego was called the Gray Medina Sandstone by the West Virginia Geological Survey. The Gray Medina is the lowest unit of the Medina Group (named by Vanuxem, 1840) which was then regarded as basal Silurian. The Oswego is tentatively assigned a Maysvillian age (Twenhofel and others, 1954).

The Oswego is an immature arenite that ranges in lithology from litharenite to sublitharenite and is locally feldspathic, usually gray to greenish gray and contains limonitic specks (Figure 7). It is well-bedded and commonly cross-bedded. The litharenite of the Oswego is comprised of the following grain types, in decreasing abundance: monocrystalline quartz, polycrystalline quartz, sedimentary rock fragments (Figure 8a), metamorphic rock fragments, chert (Figure 8b, 8c), feldspar (predominantly potassium feldspar), and igneous rock fragments (Figure 8d). Quartz abundance increases

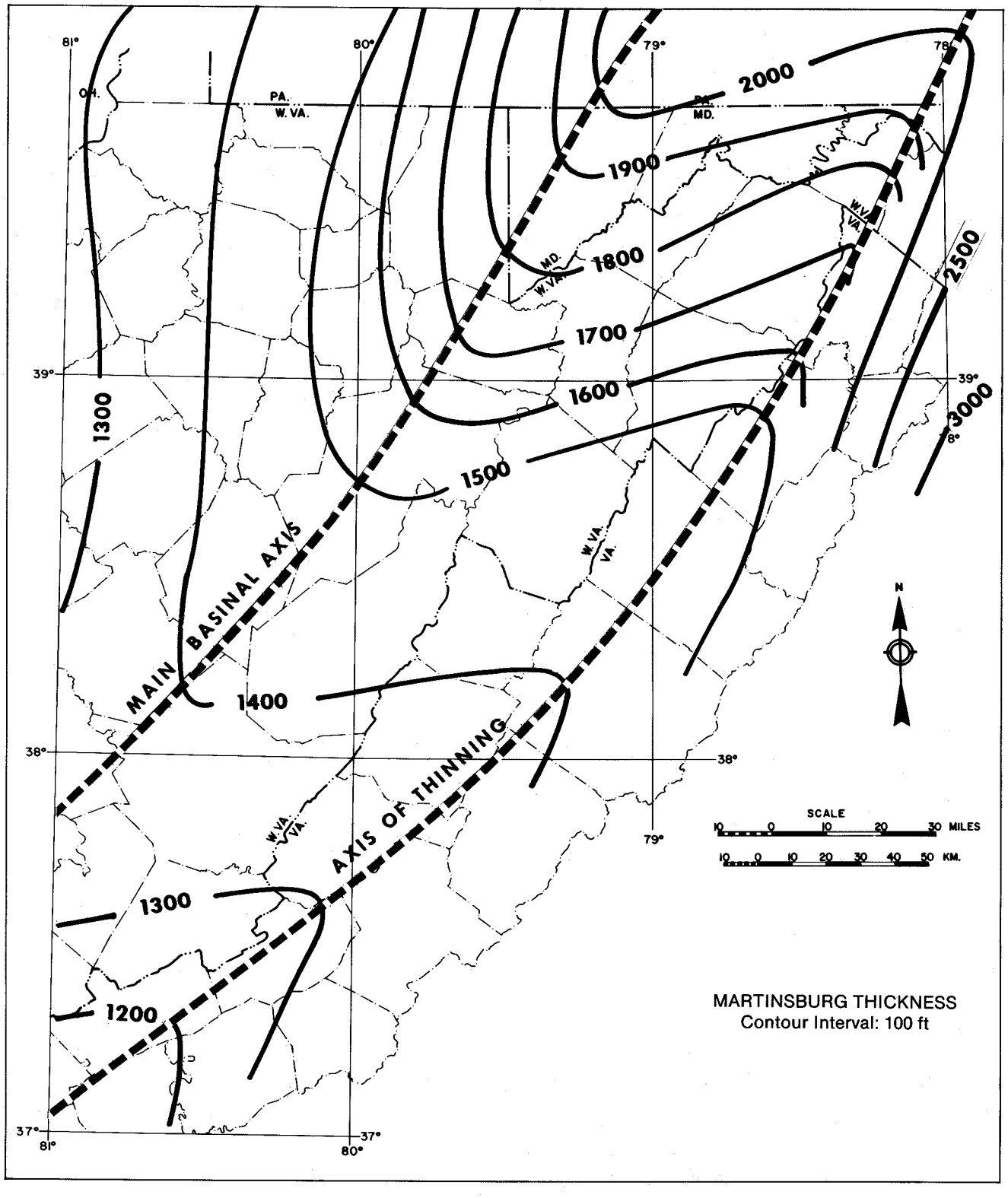

Figure 6. Isopach map of Martinsburg Formation and equivalent strata, after Woodward (1951, p. 341). Axis of thinning corresponds approximately to Shenandoah axis of Rader and Perry (1976a), and Roberts and Kite (1978b).

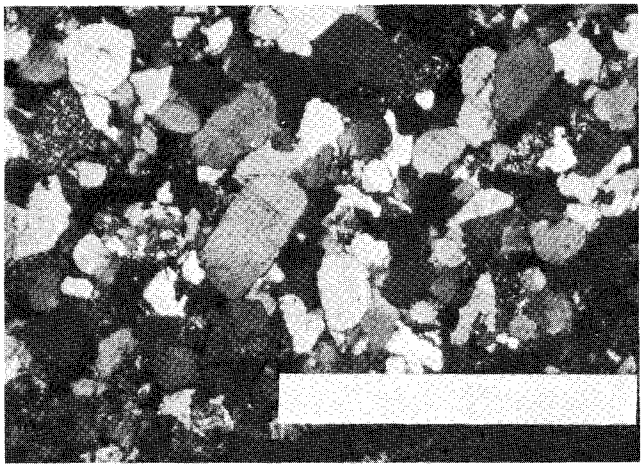

Figure 7. Photomicrograph of Oswego Sandstone, Hunkerson Gap, W. Va. Bar scale is 10 mm.

upward in section. Polycrystalline quartz becomes less abundant upward in section. In Rockingham County, Virginia, where the Oswego is thickest, and in adjacent counties, the Oswego is in part conglomeratic. Rounded pebbles, ranging up to 5 cm in diameter, consist of quartzite, chert, and volcanic and sedimentary rock fragments. Rader and Perry (1976b, p. 38) found conglomeratic clasts of oolitic dolomite, slate, and radiolarian chert in the Oswego at Brocks Gap, Virginia.

Fossils are very rare; however, bedding plane trace fossils were found in the Oswego at Brocks Gap. At Mills Gap, West Virginia, eurypterid impressions were found at the base of the Oswego Sandstone (Figure 9).

Figure 10 is an isopach map, on a palinspastic base, of the Oswego Sandstone throughout the study area. Thickness patterns form a bull's-eye pattern around Rockingham County, Virginia, where the Oswego attains a maximum thickness of 550 feet. The bull's-eye is somewhat elongate along structural strike. The Oswego is traceable southward into Botetourt and Alleghany counties, Virginia and is absent to the south and west. However, sandstone beds that are probably equivalent to the Oswego do occur at the base of the Juniata in these areas. The Oswego thins to less than 100 feet at the Allegheny Front. The Oswego thickness patterns also indicate a wedge of sediment extending southward from central Pennsylvania. This wedge is over 300 feet thick in the subsurface of northern West Virginia and the western tip of Maryland. The isopach patterns thus indicate two depocenters of Oswego Sandstone.

The Oswego is usually underlain by the *Orthorhynchula* biozone of the Reedsville Formation or equivalent beds of the upper Martinsburg. The basal Oswego contact is here defined as the lowest bedded, more resistant sandstone above the less resistant, more massive sandstones and siltstones of the *Orthorhynchula* biozone. The Oswego is overlain by the Juniata Formation except where the Juniata is absent (along the eastern margin of the Valley and Ridge), in which case the Oswego is overlain by the Tuscarora or Massanutten sandstone. The Oswego-Juniata boundary is here defined on the basis of the amount of shale or mudstone. The top of the Oswego is the base of the lowest shale or mudstone bed of appreciable thickness (1 foot or greater) above the sandstones of the Oswego, regardless of the color of the shale. This usually coincides with the lowest red strata except in the Adams Run and Anderson Ridge anticlines, and along Little North Mountain in Rockingham County, Virginia, where the upper part of the Oswego is red. Where the Juniata is absent, the top of the Oswego is placed at the base of the portion of the section that is predominantly quartzarenite. If red shaly interbeds are present, the base of the lowest red shale marks the top of the Oswego.

In areas where the Oswego is thickest, the Juniata is anomalously thin or absent. It is my opinion that, in these areas, the Oswego is equivalent to the Juniata. In other words, the Oswego in Rockingham and adjacent counties is a sandier, commonly non-red facies of the time-equivalent Juniata Formation.

Juniata Formation

The Juniata Formation was named by Darton (1896, p. 2) for exposures along the Juniata River in Pennsylvania and is equivalent to the Queenston Shale of New York and Ohio (Twenhofel and others, 1954), and to the Sequatchie Formation of Tennessee and southwestern Virginia (Butts, 1940, p. 221; Thompson, 1970c, p. 1273). The Juniata corresponds to the Red Medina Sandstone of earlier West Virginia Geological Survey usage (Woodward, 1951, p. 387), where it was considered to be of Silurian age. The Juniata is thought to represent the entire Richmond Stage of the Ordovician in Virginia, West Virginia, and Maryland, where the Gamachian Stage is possibly absent by unconformity (Twenhofel and others, 1954). These stage determinations, however, are *not* based upon paleontologic evidence.

The Juniata is usually mapped on the basis of its red color. It characteristically comprises, however, interbedded red and in places green shale to mudstone, and red to green siltstone to sandstone

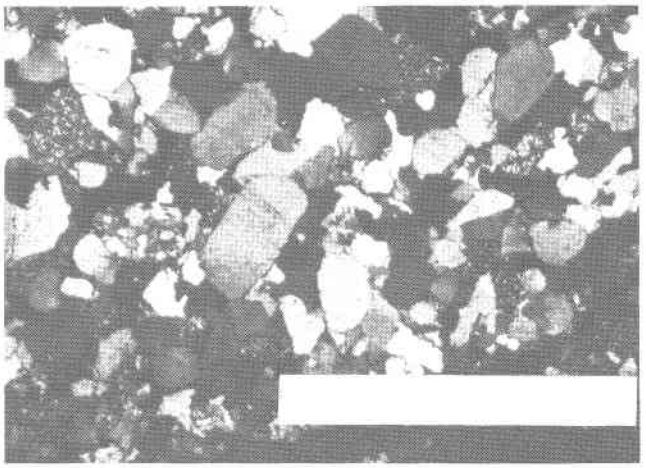

Figure 7. Photomicrograph of Oswego Sandstone, Hunkerson Gap, W. Va. Bar scale is 10 mm.

upward in section. Polycrystalline quartz becomes less abundant upward in section. In Rockingham County, Virginia, where the Oswego is thickest, and in adjacent counties, the Oswego is in part conglomeratic. Rounded pebbles, ranging up to 5 cm in diameter, consist of quartzite, chert, and volcanic and sedimentary rock fragments. Rader and Perry (1976b, p. 38) found conglomeratic clasts of oolitic dolomite, slate, and radiolarian chert in the Oswego at Brocks Gap, Virginia.

Fossils are very rare; however, bedding plane trace fossils were found in the Oswego at Brocks Gap. At Mills Gap, West Virginia, eurypterid impressions were found at the base of the Oswego Sandstone (Figure 9).

Figure 10 is an isopach map, on a palinspastic base, of the Oswego Sandstone throughout the study area. Thickness patterns form a bull's-eye pattern around Rockingham County, Virginia, where the Oswego attains a maximum thickness of 550 feet. The bull's-eye is somewhat elongate along structural strike. The Oswego is traceable southward into Botetourt and Alleghany counties, Virginia and is absent to the south and west. However, sandstone beds that are probably equivalent to the Oswego do occur at the base of the Juniata in these areas. The Oswego thins to less than 100 feet at the Allegheny Front. The Oswego thickness patterns also indicate a wedge of sediment extending southward from central Pennsylvania. This wedge is over 300 feet thick in the subsurface of northern West Virginia and the western tip of Maryland. The isopach patterns thus indicate two depocenters of Oswego Sandstone.

The Oswego is usually underlain by the *Orthorhynchula* biozone of the Reedsville Formation or equivalent beds of the upper Martinsburg. The basal Oswego contact is here defined as the lowest bedded, more resistant sandstone above the less resistant, more massive sandstones and siltstones of the *Orthorhynchula* biozone. The Oswego is overlain by the Juniata Formation except where the Juniata is absent (along the eastern margin of the Valley and Ridge), in which case the Oswego is overlain by the Tuscarora or Massanutten sandstone. The Oswego-Juniata boundary is here defined on the basis of the amount of shale or mudstone. The top of the Oswego is the base of the lowest shale or mudstone bed of appreciable thickness (1 foot or greater) above the sandstones of the Oswego, regardless of the color of the shale. This usually coincides with the lowest red strata except in the Adams Run and Anderson Ridge anticlines, and along Little North Mountain in Rockingham County, Virginia, where the upper part of the Oswego is red. Where the Juniata is absent, the top of the Oswego is placed at the base of the portion of the section that is predominantly quartzarenite. If red shaly interbeds are present, the base of the lowest red shale marks the top of the Oswego.

In areas where the Oswego is thickest, the Juniata is anomalously thin or absent. It is my opinion that, in these areas, the Oswego is equivalent to the Juniata. In other words, the Oswego in Rockingham and adjacent counties is a sandier, commonly nonred facies of the time-equivalent Juniata Formation.

Juniata Formation

The Juniata Formation was named by Darton (1896, p. 2) for exposures along the Juniata River in Pennsylvania and is equivalent to the Queenston Shale of New York and Ohio (Twenhofel and others, 1954), and to the Sequatchie Formation of Tennessee and southwestern Virginia (Butts, 1940, p. 221; Thompson, 1970c, p. 1273). The Juniata corresponds to the Red Medina Sandstone of earlier West Virginia Geological Survey usage (Woodward, 1951, p. 387), where it was considered to be of Silurian age. The Juniata is thought to represent the entire Richmond Stage of the Ordovician in Virginia, West Virginia, and Maryland, where the Gamachian Stage is possibly absent by unconformity (Twenhofel and others, 1954). These stage determinations, however, are *not* based upon paleontologic evidence.

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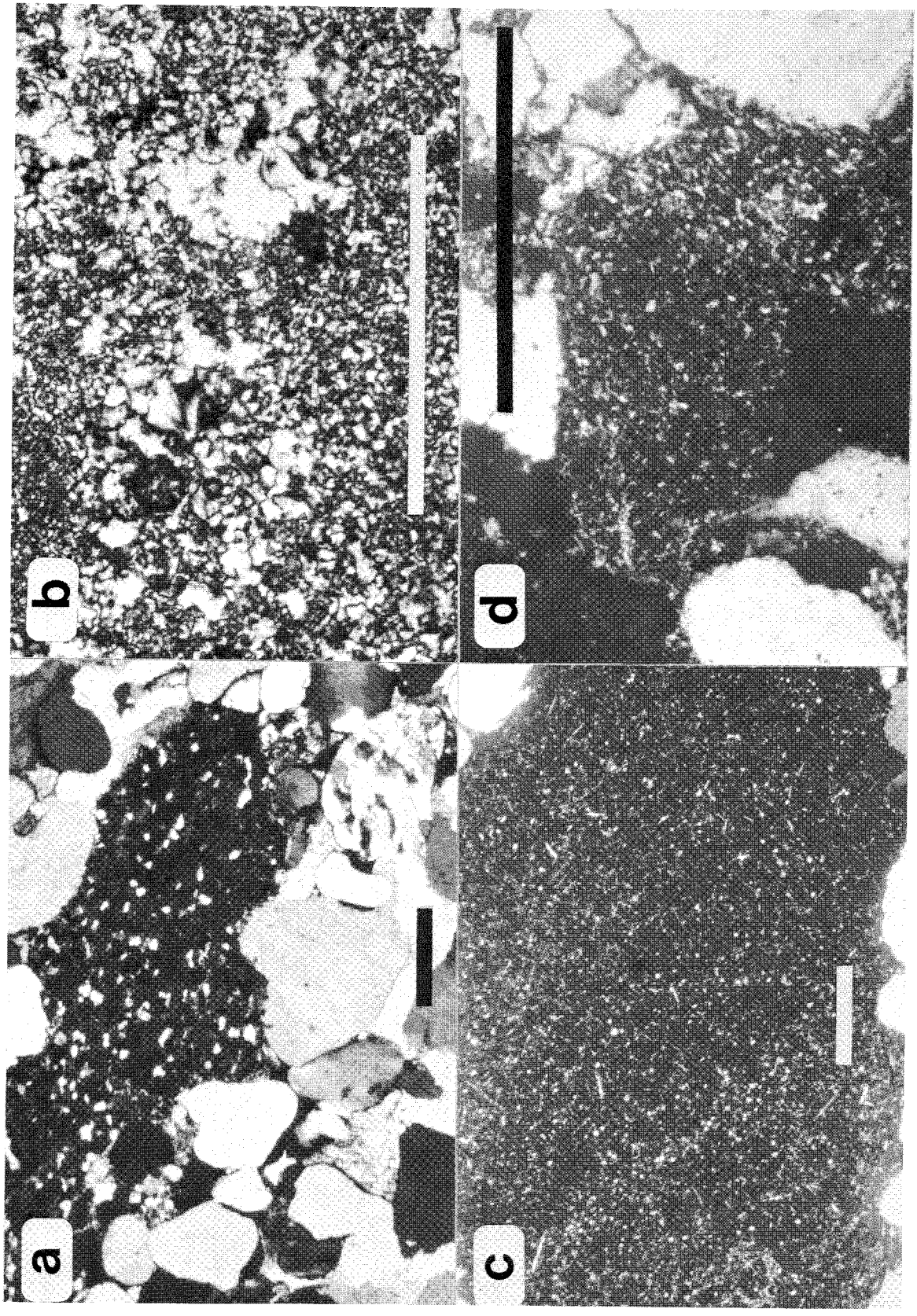
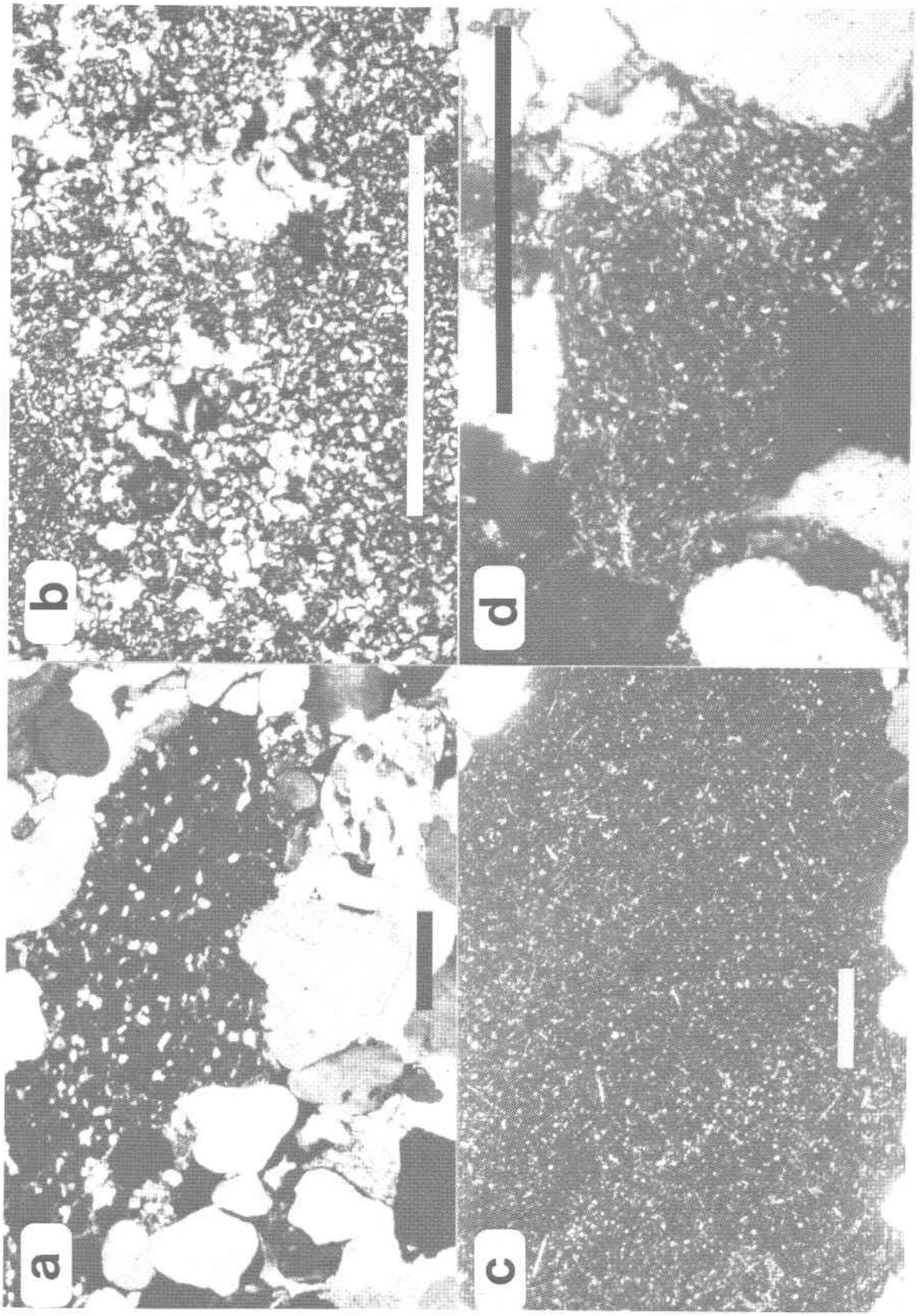


Figure 8. Photomicrographs of lithic clasts in the Oswego Sandstone: a) sedimentary rock fragment, Brocks Gap, Va.; b) enlarged view of chert clast, Brocks Gap, Va.; c) spiculitic chert clast, Brocks Gap, Va.; d) volcanic rock fragment, Hunkerson Gap, W. Va. All bar scales are 1 mm.



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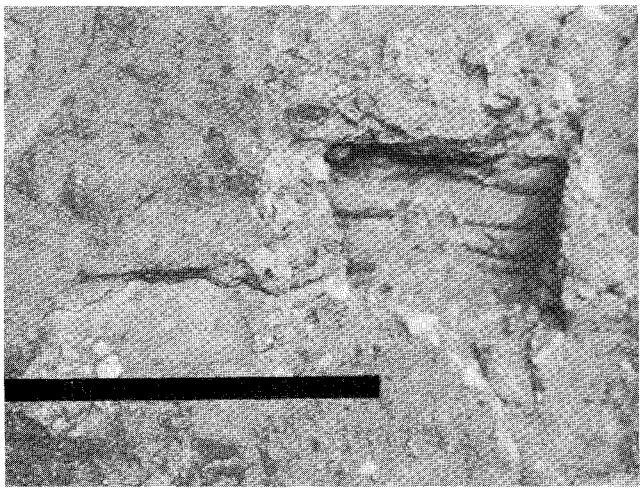


Figure 9. Eurypterid impression in lower Oswego Sandstone at Mills Gap, W. Va. (outcrop locality 2). Bar scale is 10 cm.

that usually ranges from argillaceous sublitharenite to argillaceous quartzarenite. The Juniata has been described as typically unfossiliferous (Butts, 1940, p. 228; Woodward, 1951, p. 400). It does, however, contain abundant trace fossils that range from vertical burrows (*Skolithos*) to bedding plane forms (*Cruziana*, and *Rusophycus*). Figure 11 shows some of these trace fossils. Basal red siltstone beds of the Juniata in places contain *Lingula*.

West of Little North Mountain the Juniata is commonly cyclically bedded, as shown in Figure 12. Figure 13 is a diagrammatic representation of an idealized cycle within the Juniata. A complete cycle consists of a lower cross-bedded arenite with a channeled basal contact and an upper burrowed surface, a middle unit of interbedded mudstone and vertically burrowed (*Skolithos*) arenite to wacke, and an upper unit of bioturbated mudstone. In places, channel sandstones in the lower unit contain rip-up clasts of red mudstones. Bedding plane trace fossils are usually found at the contact with the next higher cycle. The cycles are sometimes incomplete and range in thickness from a foot to over 15 feet. The cycles in the Juniata are similar to those described by Allen (1965) as being typical of alluvial strata. However, Juniata cycles are distinctly different in that they contain trace fossils, which belong to Seilacher's (1967) *Cruziana* and *Skolithos* facies (Figure 14), probably indicating marine to intertidal conditions, respectively. It should be emphasized that these cycles are only well developed where the Juniata exhibits its typical character. In those areas where the Juniata is changing facies into the Oswego (along Little North Mountain) these cycles are not well developed.

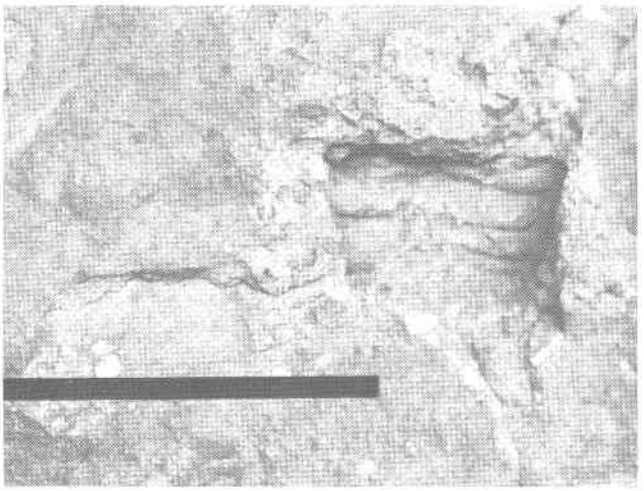
An isopach map of the Juniata Formation (Figure 15) shows that this unit is thickest at the western end of the Maryland panhandle where the Juniata exceeds 1700 feet. This appears to be part of a lobe of sediment that was transported southward from Pennsylvania into Maryland, West Virginia and Virginia. Within the study area the Juniata Formation thins to the west, south, and east and is absent at the eastern edge of the Valley and Ridge.

Lithologic variation in the Juniata Formation, where exposed in outcrop, is also shown in Figure 15. Lithofacies data for this map are taken only from those outcrop localities that are both complete and well exposed, therefore providing the most reliable sandstone/shale ratios. The Juniata Formation coarsens to the east, where it is thinner.

Paleocurrent data from the Oswego and Juniata are presented in two maps. Figure 16 shows paleocurrent roses (histograms) of all cross-bed measurements at each outcrop and the vector mean for each outcrop. Figure 17 is a summary diagram of all paleocurrent data, including the vector means of Figure 16, and all linear features such as tool marks, flute casts, ripple marks, channel axes, and oriented trace fossils. Data from each outcrop were analyzed to see if the direction of current changed with position in section. No significant variation was found.

To the west and north, the Juniata passes laterally into the Queenston Formation (a thinner, sandy and shaly facies) of Ohio and New York. According to Thompson (1970c), the fluvial Juniata passes southwestward into the laterally equivalent supratidal, intertidal and subtidal carbonates of the Sequatchie Formation in southwest Virginia and adjacent Tennessee. In southeastern Tennessee, Milici and Wedow (1977) subdivide the Upper Ordovician carbonates into the (upper to lower) facies equivalent Sequatchie and Shellmound formations, the Leipers Limestone, and the Inman Formation. To the east, the Juniata passes laterally into the Bald Eagle Sandstone or Conglomerate of Pennsylvania (Thompson, 1970a) and into the Oswego Sandstone in northern Virginia.

The Juniata is everywhere overlain by the Tuscarora Sandstone. The top of the Juniata is defined herein as the top of the highest red strata below the Tuscarora Sandstone. This upper contact is usually gradational (conformable) but occasionally is marked by a paraconformity as denoted by an abrupt contact.



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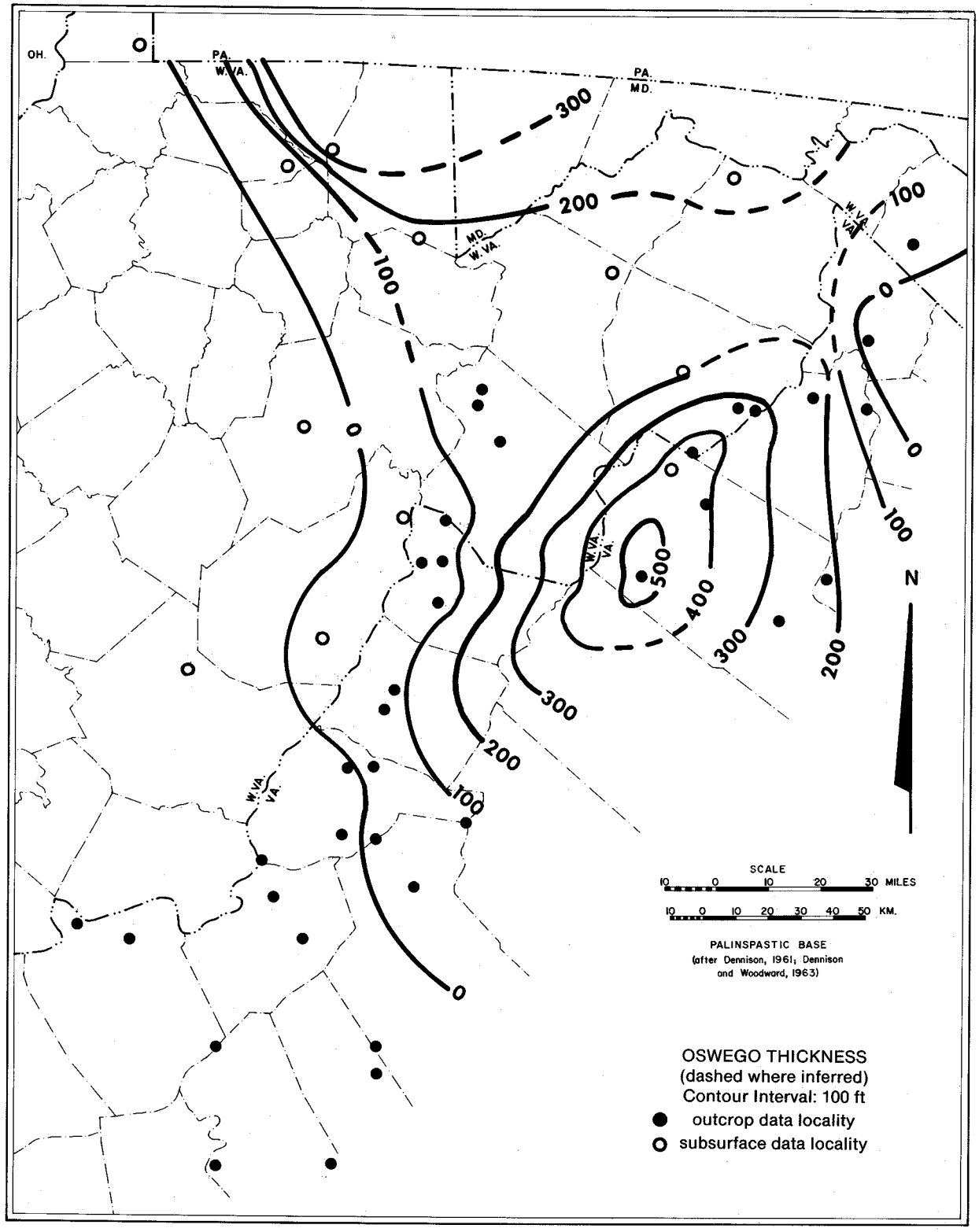

Figure 10. Isopach map of the Oswego Sandstone, on palinspastic base. North arrow indicates present-day north.

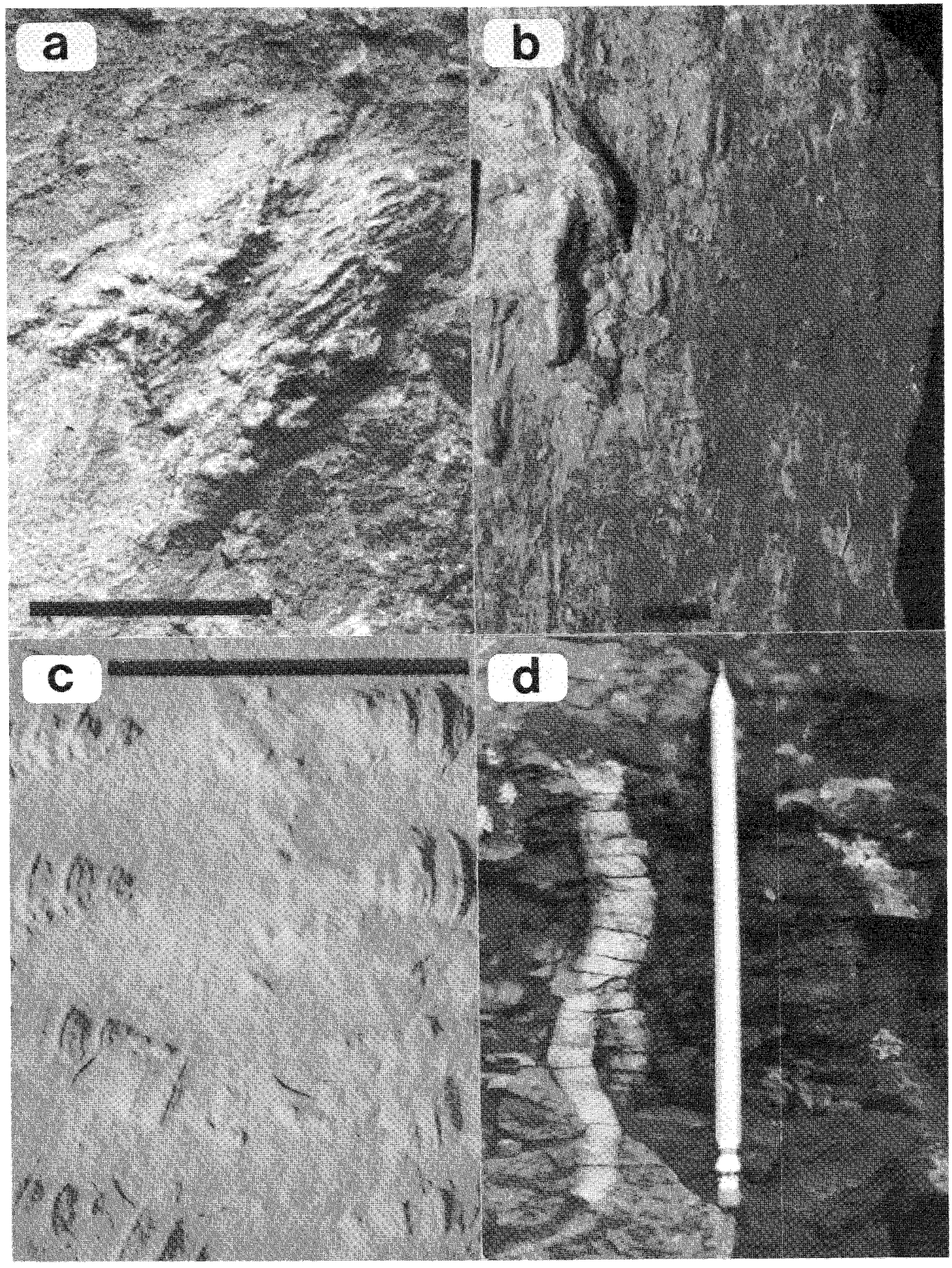

Figure 11. Trace fossils of the Juniata Formation: a) *Rusophycus*, Warm Springs, Va.; b) *Rusophycus* aligned with current (vertical in plane of page), Narrows, Va.; c) unnamed bedding plane trail, Cumberland, Md.; d) vertical burrow (? *Tigillites*), North Fork Mountain, W. Va. a, b, and c are sole markings. All bar scales are 2 cm.

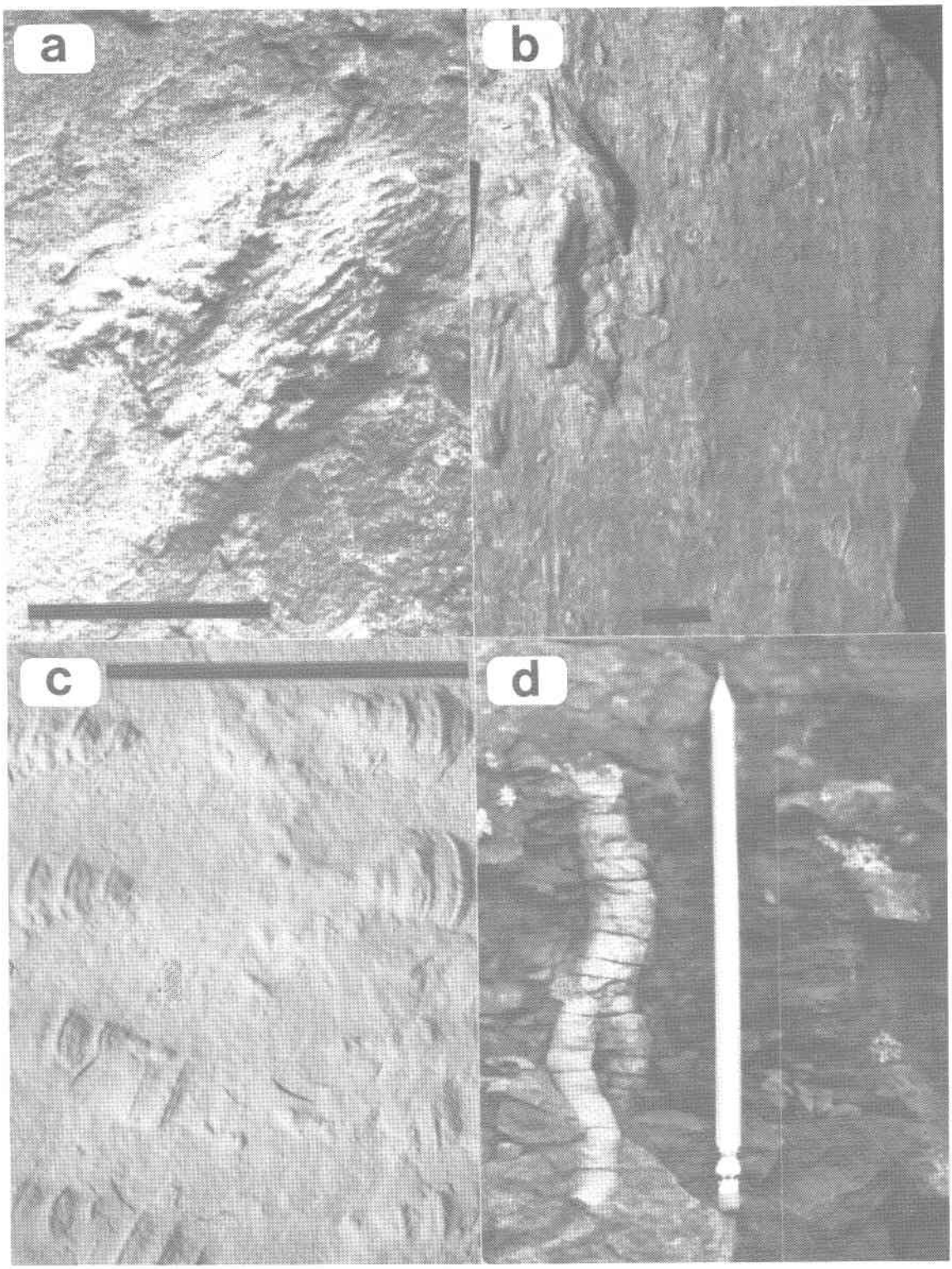

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Figure 12. Cyclical bedding in the lower Juniata Formation exposed along U. S. Highway 33 on North Fork Mountain, Pendleton County, West Virginia. Jacob's staff is 5 feet long, graduated in feet.

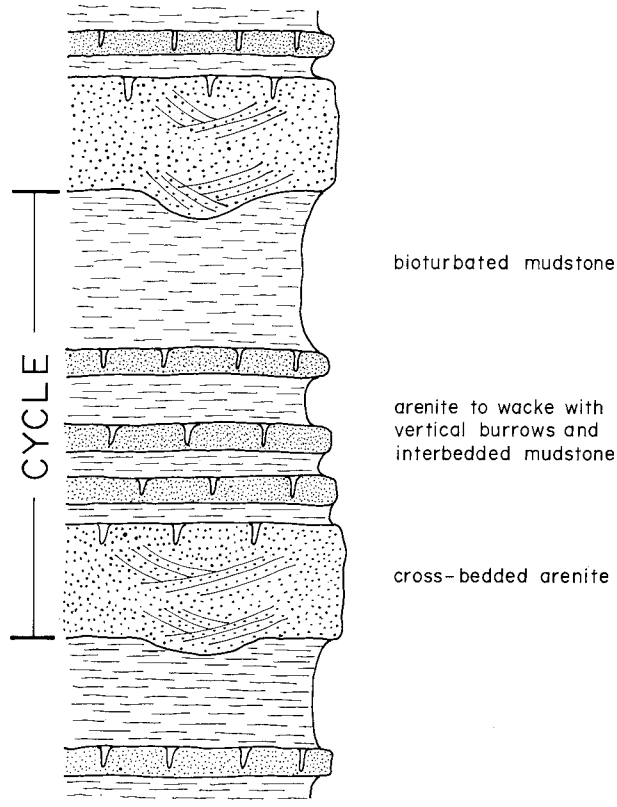


Figure 13. Diagrammatic representation of a typical cycle within the Juniata Formation. Vertical scale varies throughout the study area. Cycles are not always complete.

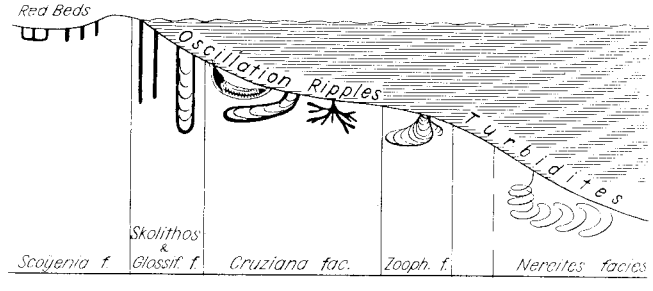
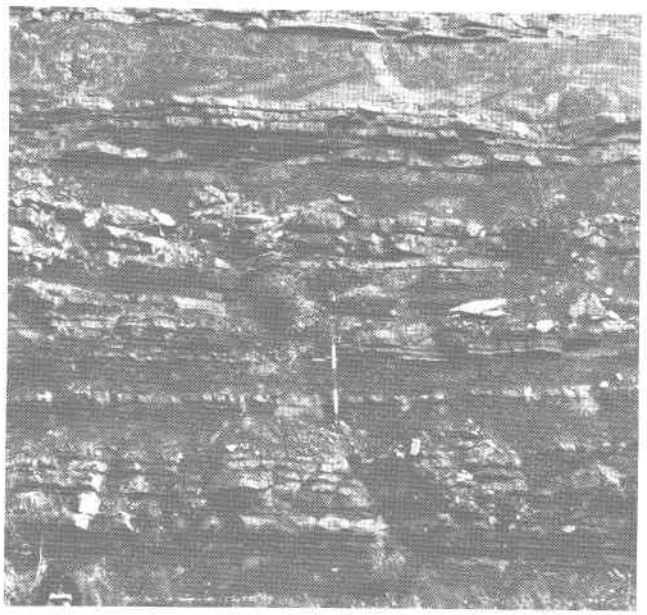


Figure 14. Depth zonation chart of trace fossil communities (after Seilacher, 1967, Figure 2).

Tuscarora Sandstone and Equivalent Strata

Darton (1896, p. 2) named the Tuscarora Sandstone after exposures along Tuscarora Mountain in Pennsylvania. The Tuscarora is synonymous with the Clinch Sandstone in Tennessee and southwestern Virginia. The name Tuscarora is used northeast of the New River, and the name Clinch southwest of the New River (Dennison, 1970, p. 7). The Tuscarora is equivalent, in part, to the Brassfield Limestone in the subsurface of West Virginia and Kentucky (Perry, 1962, p. 106), as well as to the lower portion of the Massanutten Sandstone in the Massanutten synclinorium (Dennison, 1970, p. 22), and the lower portion of the Shawangunk Conglomerate in Pennsylvania (Swartz and others, 1942). To the west, the Tuscarora passes laterally into the Cataract Formation of Ohio and the Medina Group of northwestern Pennsylvania and western New York (Piotrowski, 1981, Figure 2). The White Medina Sandstone of earlier West Virginia Survey usage (Woodward, 1941, p. 30) and the "Clinton sand" of drillers (Perry, 1962, p. 106) is equivalent to the Tuscarora of this report. The Tuscarora comprises the entire Lewistonian Series (previously called the Albion Series) within the study area (Swartz and others, 1942; Berry and Boucot, 1970, pl. 2).

Supermature quartzarenite, commonly composed almost entirely of monocrystalline quartz (Figure 18), is the characteristic lithology. In places the Tuscarora is conglomeratic, especially at its base. In the western portion of the Valley and Ridge, the Tuscarora is argillaceous and contains interbedded shale. The Tuscarora is typically devoid of body fossils, but does contain an assemblage of trace fossils (Diecchio, 1973, 1975).



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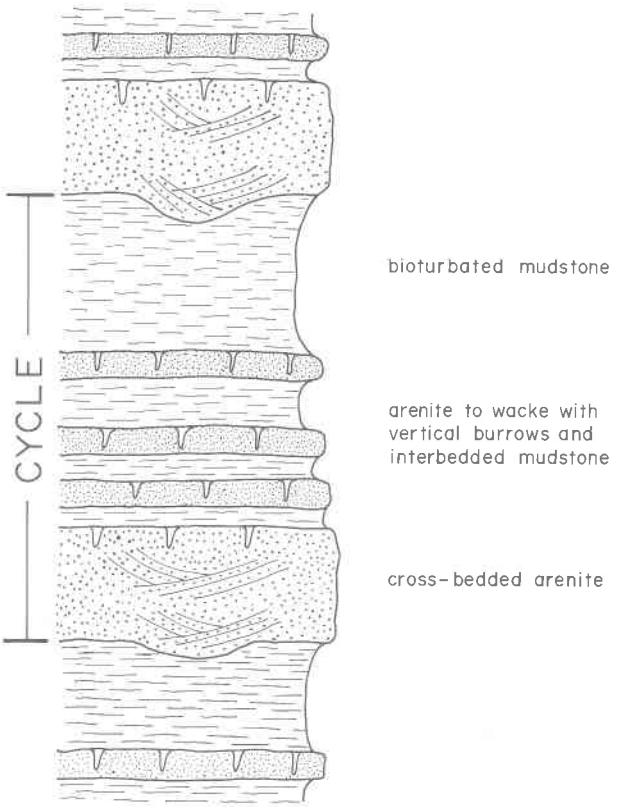

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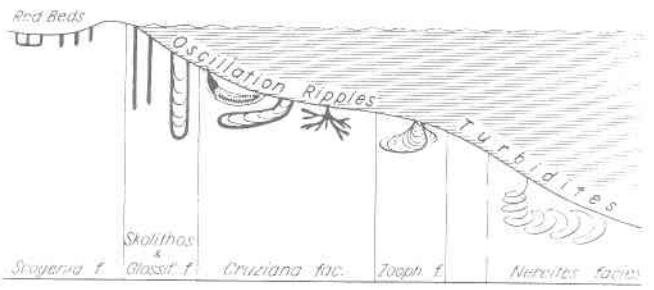

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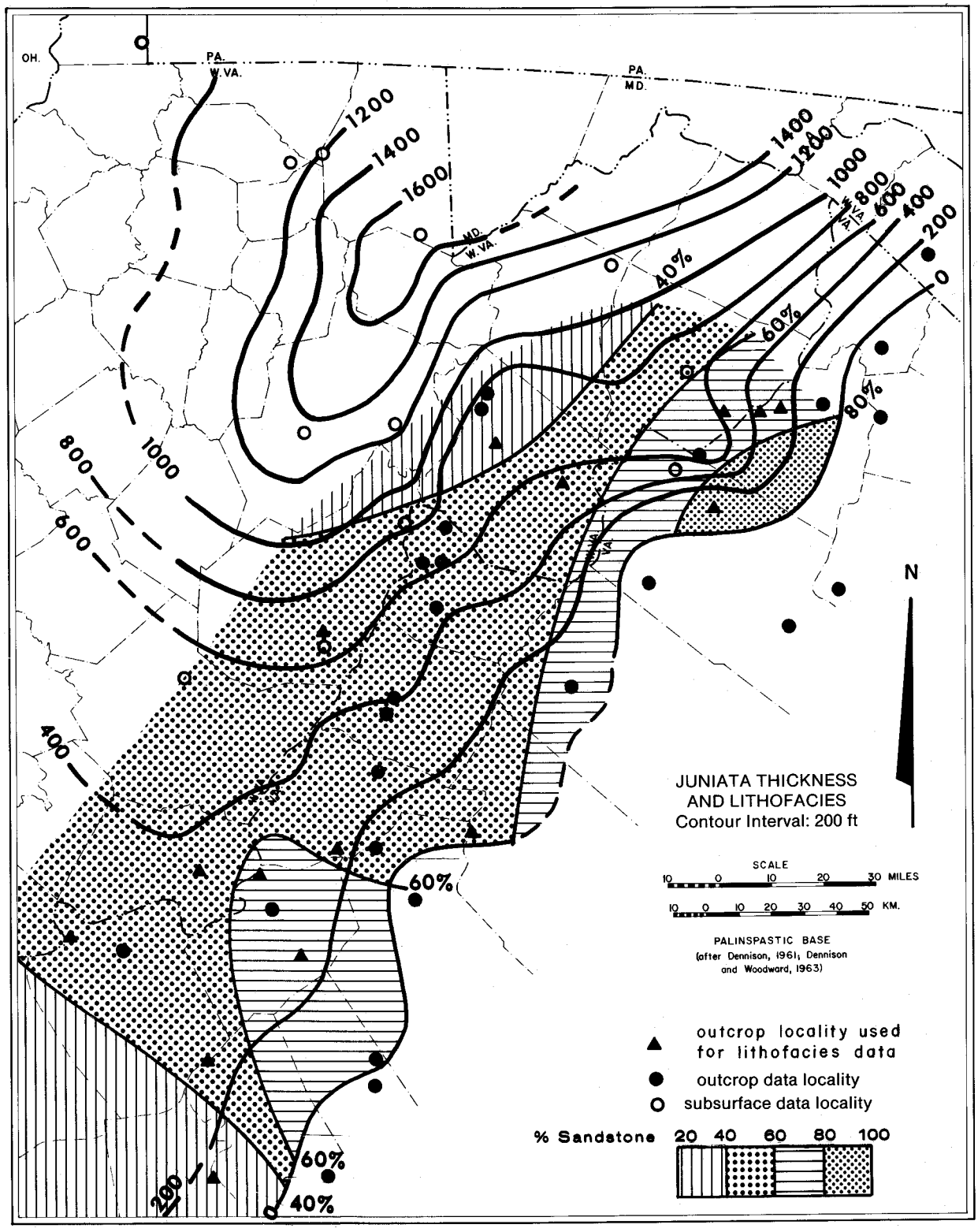


Figure 15. Isopach and lithofacies map of the Juniata Formation, palinspastic base. North arrow indicates present-day north.

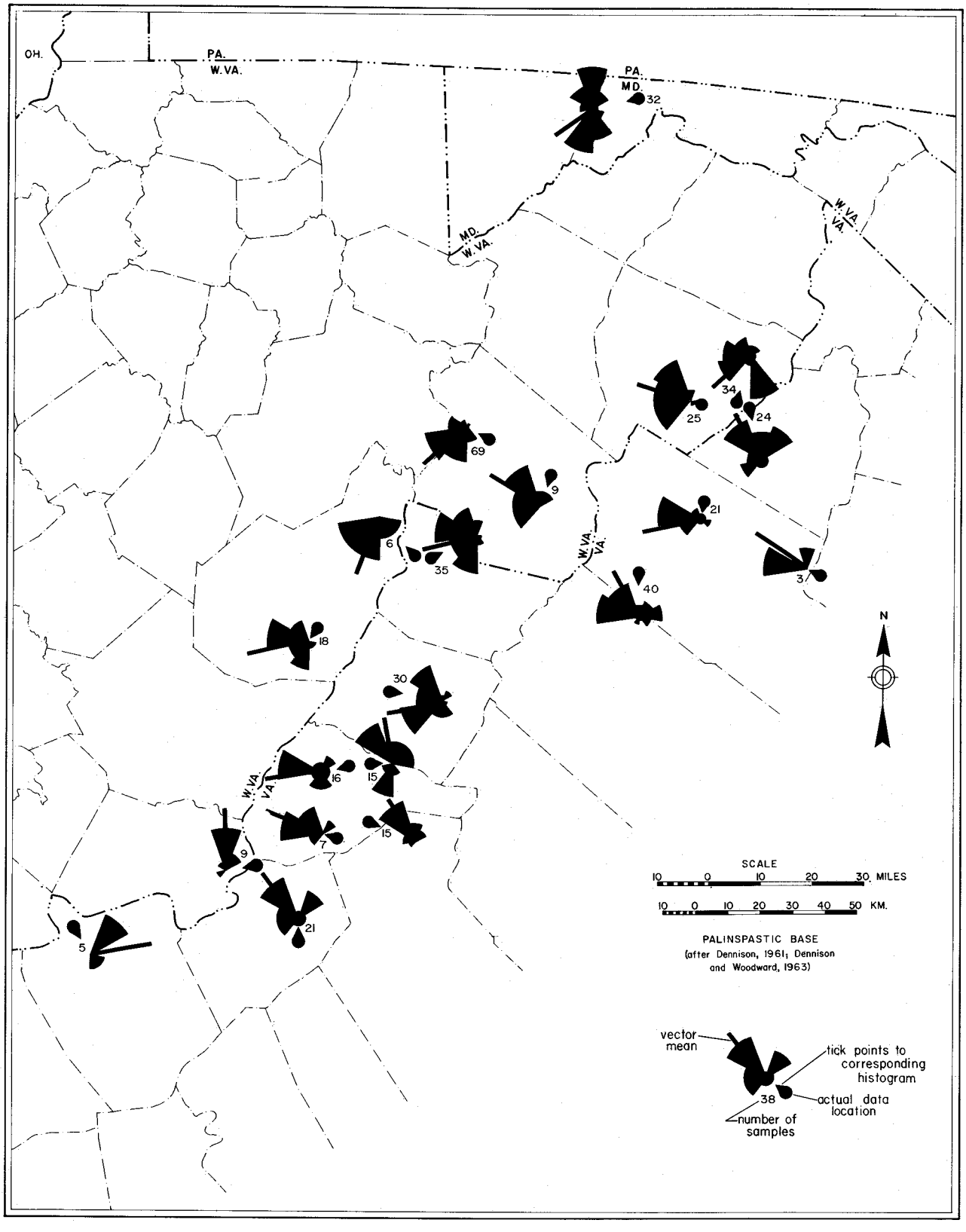


Figure 16. Paleocurrent map, based on cross-bed data, of Oswego and Juniata strata. Histograms show dispersion of current data. Directions specified are the directions toward which the currents flowed. Bars indicate vector mean values. North arrow indicates present-day north.

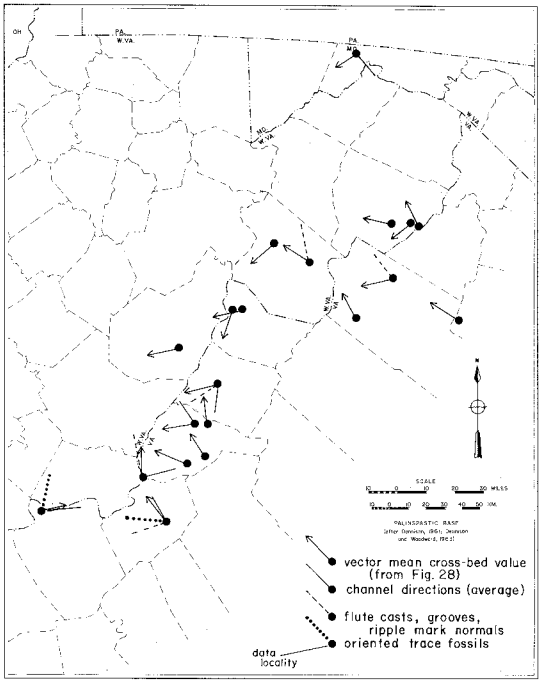


Figure 17. Summary map of all paleocurrent data. Dots indicate data points. North arrow indicates present-day north.

The Massanutten Sandstone was named after exposures on Massanutten Mountain by Geiger and Keith (1891, p. 161), but the exposures they refer to are at Harpers Ferry, where the Massanutten does not crop out. Evidently they misidentified one of the Cambrian Chilhowee Group sandstones, probably the Weverton, as Massanutten (Perry, 1977, p. A140; Nunan, 1979, p. 57-68). The Massanutten Sandstone should properly refer to the thick sandstones that overlie the Martinsburg and are overlain by the Bloomsburg redbeds (Cayugan or Niagaran) or McKenzie shales within the Massanutten synclinorium (Brent, 1960, p. 46; Rader and Biggs, 1976, p. 28). The Massanutten is, therefore, equivalent to horizons from the Tuscarora Sandstone to the Keefer Sandstone or Rochester Shale, thus representing most of the Lower Silurian (Llandovery to upper Wenlock) in the Massanutten synclinorium (Perry, 1977, p. A140; Pratt, 1979, p. 30-32). The Massanutten Sandstone is a typically unfossiliferous, supermature quartzarenite, locally conglomeratic, and of very similar lithology to the Tuscarora.

Figure 19 is an isopach map of the Tuscarora Sandstone and probable equivalent beds of the Massanutten Sandstone. This map represents the

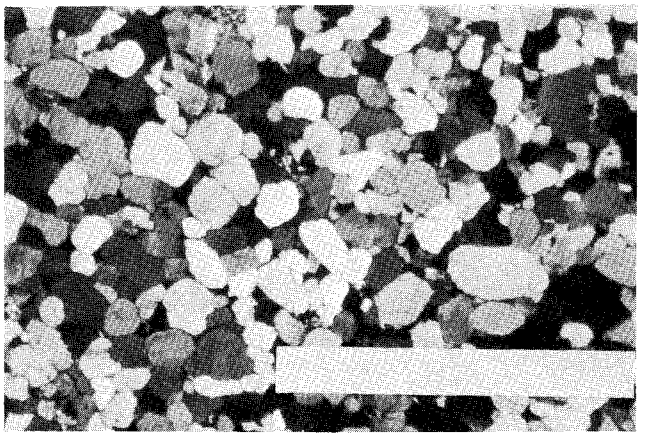


Figure 18. Photomicrograph of Tuscarora Sandstone, Cliff Dale Chapel, Va. Bar scale is 10 mm.

thickness of Lewistonian strata within the study area. These strata are thickest (over 800 feet) in the Massanutten Mountain area where they are represented by the lower Runkles Gap member (informal) of Pratt (1979, p. 18) of the Massanutten Sandstone. The Tuscarora thickens in the subsurface of central West Virginia and southwestern Pennsylvania, attaining a thickness of over 400 feet in northern West Virginia. This pattern implies the presence of two depocenters of Tuscarora sand within the study area. Another area in which the Tuscarora is thickened is near Eagle Rock, Virginia (outcrop locality 29). This anomaly is not evident in the isopach map but shows up in the stratigraphic cross sections and will be discussed in a later portion of this report. The Tuscarora shows an anomalous thinning in northern Rockingham County, Virginia and adjacent counties, along the proposed Shenandoah axis of Rader and Perry (1976a) and Roberts and Kite (1978a).

The Tuscarora is underlain by the Juniata Formation in the western portion of the Valley and Ridge and in the subsurface of West Virginia. Farther east, where the Juniata is absent, the Oswego Sandstone or the upper, sandy facies of the Martinsburg underlies the Tuscarora. In the Catawba syncline, the Tuscarora is underlain by the *Orthorhynchula* zone of the Reedsville Formation.

The Tuscarora is everywhere overlain by the Rose Hill Formation, except in the Catawba syncline, where the typical Rose Hill lithology (red to yellowish-gray shale, siltstone, and sandstone) is not well developed, and the Tuscarora is overlain by the Keefer Sandstone.

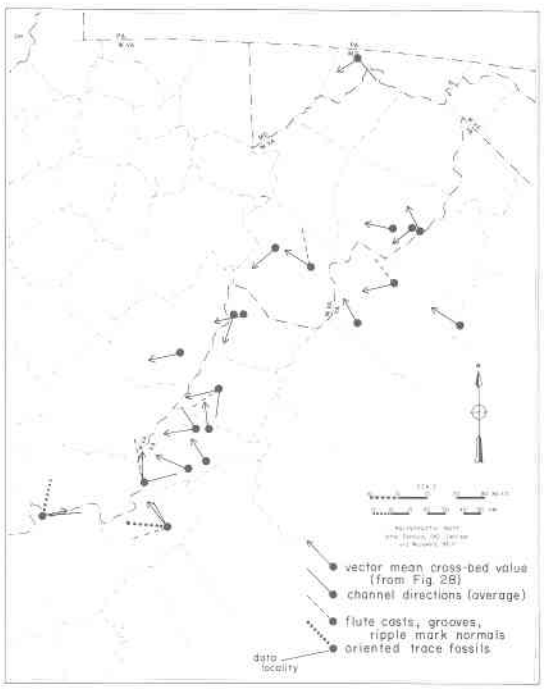


Figure 17. Summary map of all paleocurrent data. Dots indicate data points. North arrow indicates present-day north.

The Massanutten Sandstone was named after exposures on Massanutten Mountain by Geiger and Keith (1891, p. 161), but the exposures they refer to are at Harpers Ferry, where the Massanutten does not crop out. Evidently they misidentified one of the Cambrian Chilhowee Group sandstones, probably the Weverton, as Massanutten (Perry, 1977, p. A140; Nunan, 1979, p. 57-68). The Massanutten Sandstone should properly refer to the thick sandstones that overlie the Martinsburg and are overlain by the Bloomsburg redbeds (Cayugan or Niagaran) or McKenzie shales within the Massanutten synclinorium (Brent, 1960, p. 46; Rader and Biggs, 1976, p. 28). The Massanutten is, therefore, equivalent to horizons from the Tuscarora Sandstone to the Keefer Sandstone or Rochester Shale, thus representing most of the Lower Silurian (Llandovery to upper Wenlock) in the Massanutten synclinorium (Perry, 1977, p. A140; Pratt, 1979, p. 30-32). The Massanutten Sandstone is a typically unfossiliferous, supermature quartzarenite, locally conglomeratic, and of very similar lithology to the Tuscarora.

Figure 19 is an isopach map of the Tuscarora Sandstone and probable equivalent beds of the Massanutten Sandstone. This map represents the

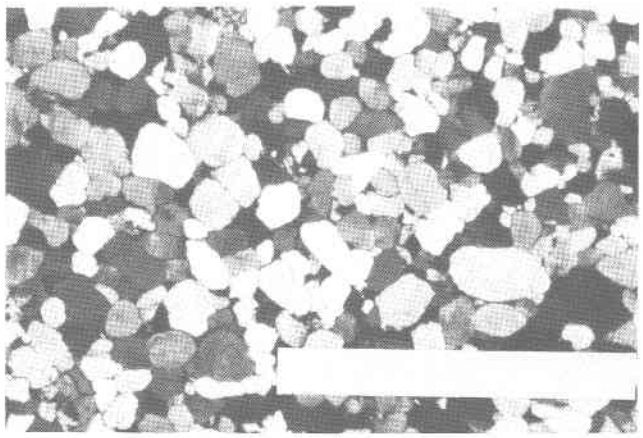


Figure 18. Photomicrograph of Tuscarora Sandstone, Cliff Dale Chapel, Va. Bar scale is 10 mm.

thickness of Lewistonian strata within the study area. These strata are thickest (over 800 feet) in the Massanutten Mountain area where they are represented by the lower Runkles Gap member (informal) of Pratt (1979, p. 18) of the Massanutten Sandstone. The Tuscarora thickens in the subsurface of central West Virginia and southwestern Pennsylvania, attaining a thickness of over 400 feet in northern West Virginia. This pattern implies the presence of two depocenters of Tuscarora sand within the study area. Another area in which the Tuscarora is thickened is near Eagle Rock, Virginia (outcrop locality 29). This anomaly is not evident in the isopach map but shows up in the stratigraphic cross sections and will be discussed in a later portion of this report. The Tuscarora shows an anomalous thinning in northern Rockingham County, Virginia and adjacent counties, along the proposed Shenandoah axis of Rader and Perry (1976a) and Roberts and Kite (1978a).

The Tuscarora is underlain by the Juniata Formation in the western portion of the Valley and Ridge and in the subsurface of West Virginia. Farther east, where the Juniata is absent, the Oswego Sandstone or the upper, sandy facies of the Martinsburg underlies the Tuscarora. In the Catawba syncline, the Tuscarora is underlain by the *Orthorhynchula* zone of the Reedsville Formation.

The Tuscarora is everywhere overlain by the Rose Hill Formation, except in the Catawba syncline, where the typical Rose Hill lithology (red to yellowish-gray shale, siltstone, and sandstone) is not well developed, and the Tuscarora is overlain by the Keefer Sandstone.

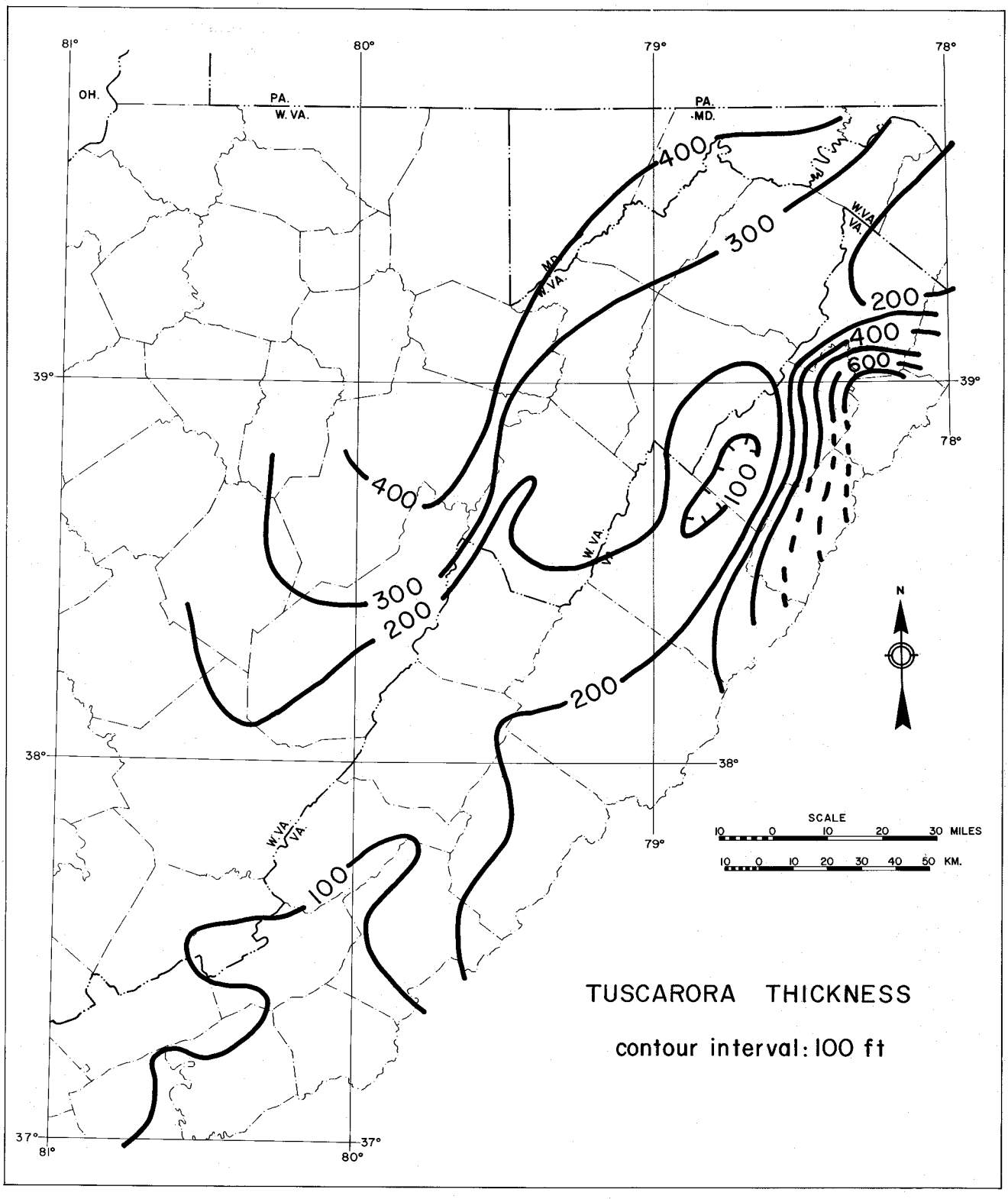


Figure 19. Isopach map of the Tuscarora Sandstone, modified after Dennison and Wheeler (1975, p. 57). Includes lower member of Massanutten Sandstone.

REGIONAL DEPOSITONAL PATTERNS

Five stratigraphic cross sections were constructed to characterize the interrelationships of the strata throughout the study area. For each section, exposed strata from the upper Martinsburg or Reedsville through at least the lowermost Tuscarora are depicted. Locations of the stratigraphic sections are shown on Figure 2. Sections A-A' (Figure 20), B-B' (Figure 21), and C-C' (Figure 22) are normal to structural strike, whereas sections D-D' (Figure 23) and E-E' (Figure 24) are parallel to strike. These sections are based on measured sections (Appendix I) and well logs (Appendix II).

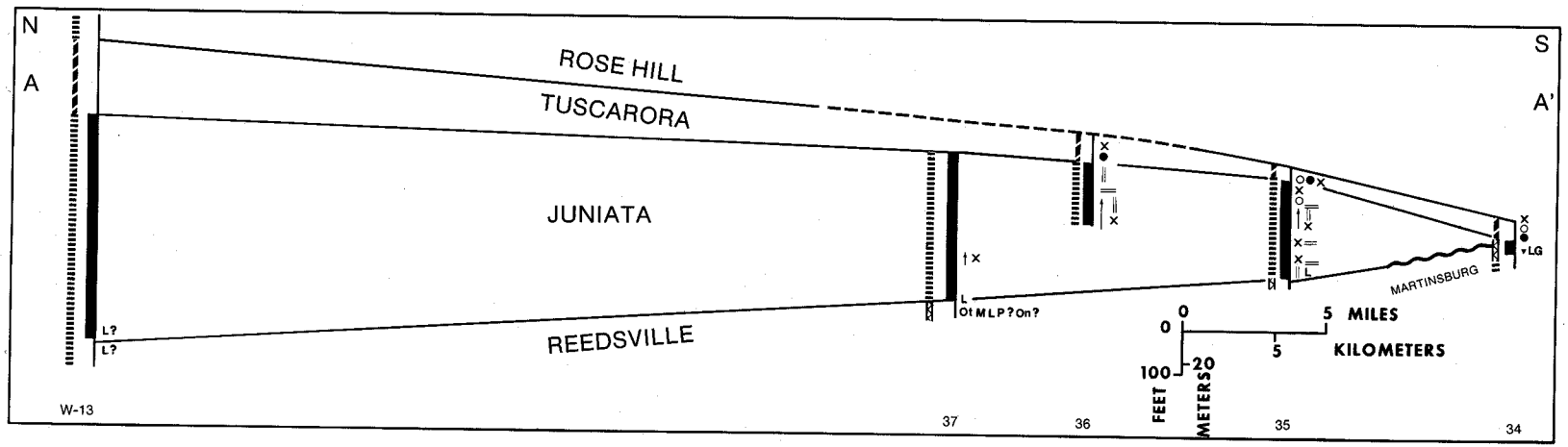
Deposition of Upper Martinsburg and Equivalent Strata

The uppermost beds of the Martinsburg and Reedsville formations were investigated in order to define the contact between the Martinsburg or Reedsville formations and the overlying Oswego, Juniata, Tuscarora, or Massanutten formations. The upper Reedsville strata generally include interbedded, fossiliferous shales, siltstones and limestones that grade upward into siltstone and shale that contain *Orthorhynchula* , *Ambonychia*, and *Lingula*, typical of Bretsky's (1969, p. 201, 207; 1970, p. 58, 62) *Orthorhynchula-Ambonychia* nearshore community and more informally referred to as the *Orthorhynclula* biozone. The uppermost portion of the Reedsville, however, is typically a massive mudstone that usually contains only *Lingula*. This sequence was not found by the writer at Massanutten Mountain (see Figure 22, locality 5). Instead, a sparsely fossiliferous sequence of interbedded sandstone and shale was found to be overlain by an apparently barren sequence of sandstone and shale. Secrist and Evitt (1943) noted that the fauna in these strata at Massanutten Mountain are not typical of the upper Martinsburg (Reedsville) elsewhere. They also noted the presence of *Lingula* in this uppermost sequence. Bretsky (1969, pl. 2; 1970, Figure 6) also noted this atypical upper Martinsburg strata at Massanutten, as well as along Little North Mountain in Rockingham County, Virginia and in the Paddy Mountain anticline. Bretsky (1969, p. 201, 207; 1970, p. 56, 62) reports that at these places the *Sowerbyella -Onniella* offshore community is overlain by a barren interval, and that the *Orthorhynchula - Ambonychia* nearshore community is missing. Thickness data of the Martinsburg and equivalent strata (Figure 6) suggest that the absence of the nearshore community coincides somewhat with an area where the section is thicker, indicating a higher sedimentation rate.

McBride (1962, p. 82) has shown that paleocurrents in the Martinsburg, at the eastern edge of the the basin, flowed along present structural strike in northern Virginia. These paleocurrent directions are consistent with the presence of an active positive area or axis of thinning (see Figure 6) further west which might act as a barrier and deflect the currents along strike. Another explanation is that the current flow indicates direction of longshore or contour currents, but this is less likely if the strata are deposited by turbidity currents. Also, it should be noted that these currents are from southwest to northeast, toward the area of maximum thickness of the Martinsburg as shown in Figure 6.

The question should be raised whether the absence of the nearshore community east of Little North Mountain is because of deeper water in that area during late Martinsburg time or to removal of the nearshore strata during a later erosional episode. The presence of the positive axis and the direction of current flow suggest that deeper water conditions were present in the eastern portion of the Valley and Ridge. This does not, however, preclude the possibility of later uplift and erosion.

Figure 25 shows two possible interpretations of the biostratigraphy at the top of the Martinsburg and Reedsville formations along the line of stratigraphic cross section C-C' (Figure 23). Figure 25 shows that the *Lingula* population (very nearshore zone containing *Lingula* only) at the top of the Martinsburg and Reedsville formations is present everywhere, as are the lower, offshore fauna (*Sowerbyella-Onniella* community). These two biofacies are separated by the nearshore community (*Orthorhynchula-Ambonychia* community) in the west (Reedsville), whereas this community is missing toward the east (Martinsburg). Figure 25a shows an interpretation that accommodates an erosional removal of the nearshore community in the east. Where the nearshore community is missing, the offshore community is overlain by strata that are sparsely populated by *Lingula*. If erosion had occurred, it would have taken place before the deposition of the Lingula-bearing strata. These overlying strata are a sandier unit (Cub sandstone of Thornton, 1953, at Massanutten Mountain, outcrop localities 4, 5, 6; basal Oswego Sandstone at Brocks Gap, outcrop locality 8). Figure 25b presents an interpretation which attributes the absence of the nearshore community to deeper water con-



LIST OF SYMBOLS

	reddish to brownish strata	×	cross-bedding	L	*Lingula*
	non-red strata	‖	vertical trace fossils	Ot	*Orthorhynchula*
	significant covered interval	=	horizontal trace fossils	M	*Modiolopsis*
	disconformity	●	conglomerate	On	*Onniella*
	facies change	○	clay balls	A	*Ambonychia*
	cyclical repetition of beds	▱	shale chips	P	*Plectonotus*
	predominantly sandstone or siltstone	▼	phosphate nodules	G	gastropods
	interbedded sandstone and mudrock	□	dark shale or carboraceous material	b	bryozoa
	predominantly mudrock	f	fossiliferous	□pl	plant fossils in dark shale
	mudrock with interbedded limestone				

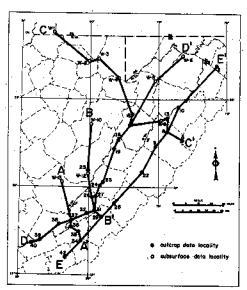
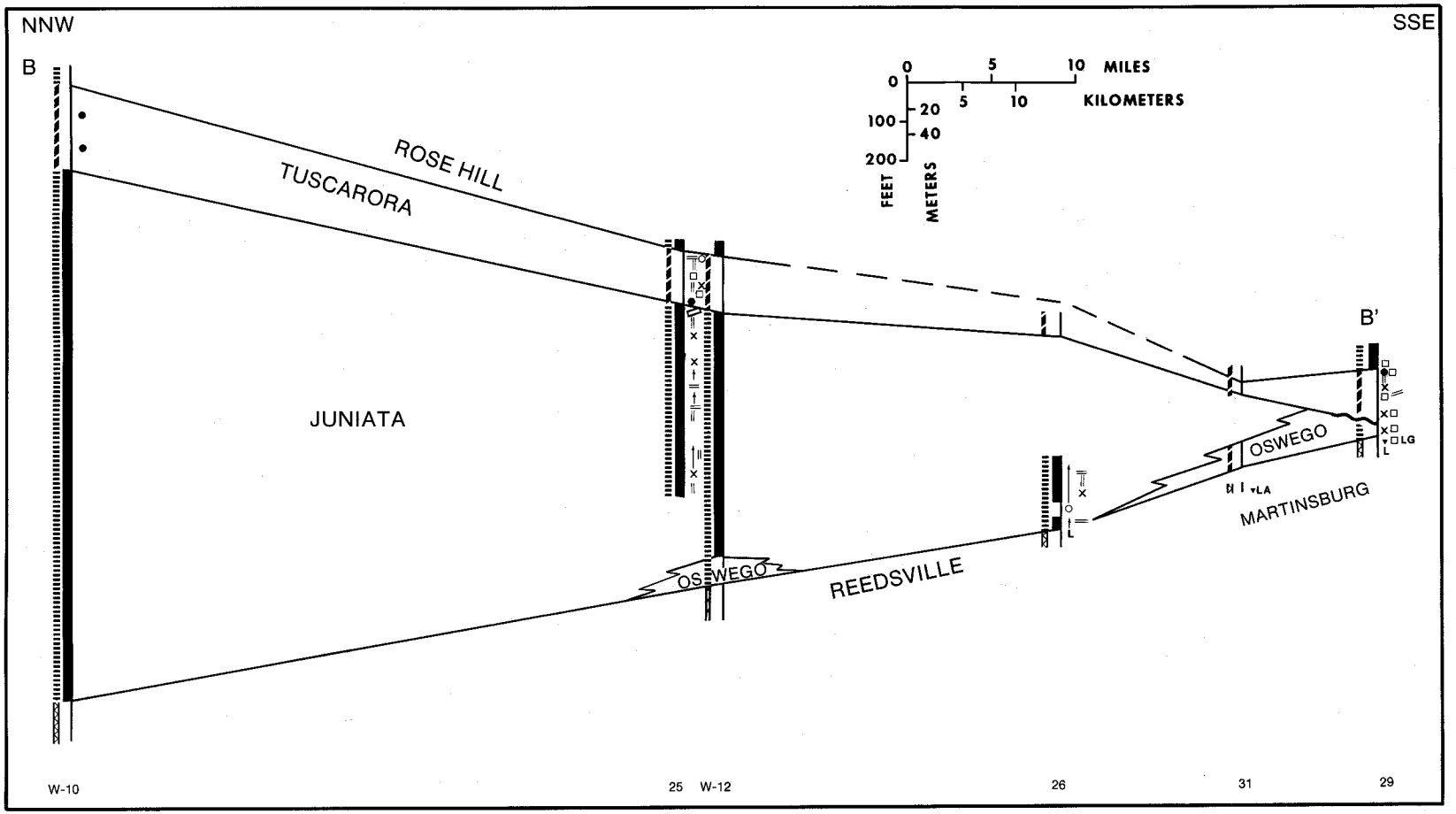


Figure 20. Stratigraphic cross section A-A'



LIST OF SYMBOLS

reddish to brownish strata	×	cross-bedding	L *Lingula*
non-red strata	‖	vertical trace fossils	Ot *Orthorhynchula*
significant covered interval	=	horizontal trace fossils	M *Modiolopsis*
disconformity	●	conglomerate	On *Onniella*
facies change	○	clay balls	A *Ambonychia*
cyclical repetition of beds	▱	shale chips	P *Plectonotus*
predominantly sandstone or siltstone	▼	phosphate nodules	G gastropods
interbedded sandstone and mudrock	□	dark shale or carboraceous material	b bryozoa
predominantly mudrock	f	fossiliferous	□pl plant fossils in dark shale
mudrock with interbedded limestone			

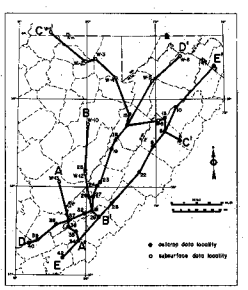


Figure 21. Stratigraphic cross section B-B'

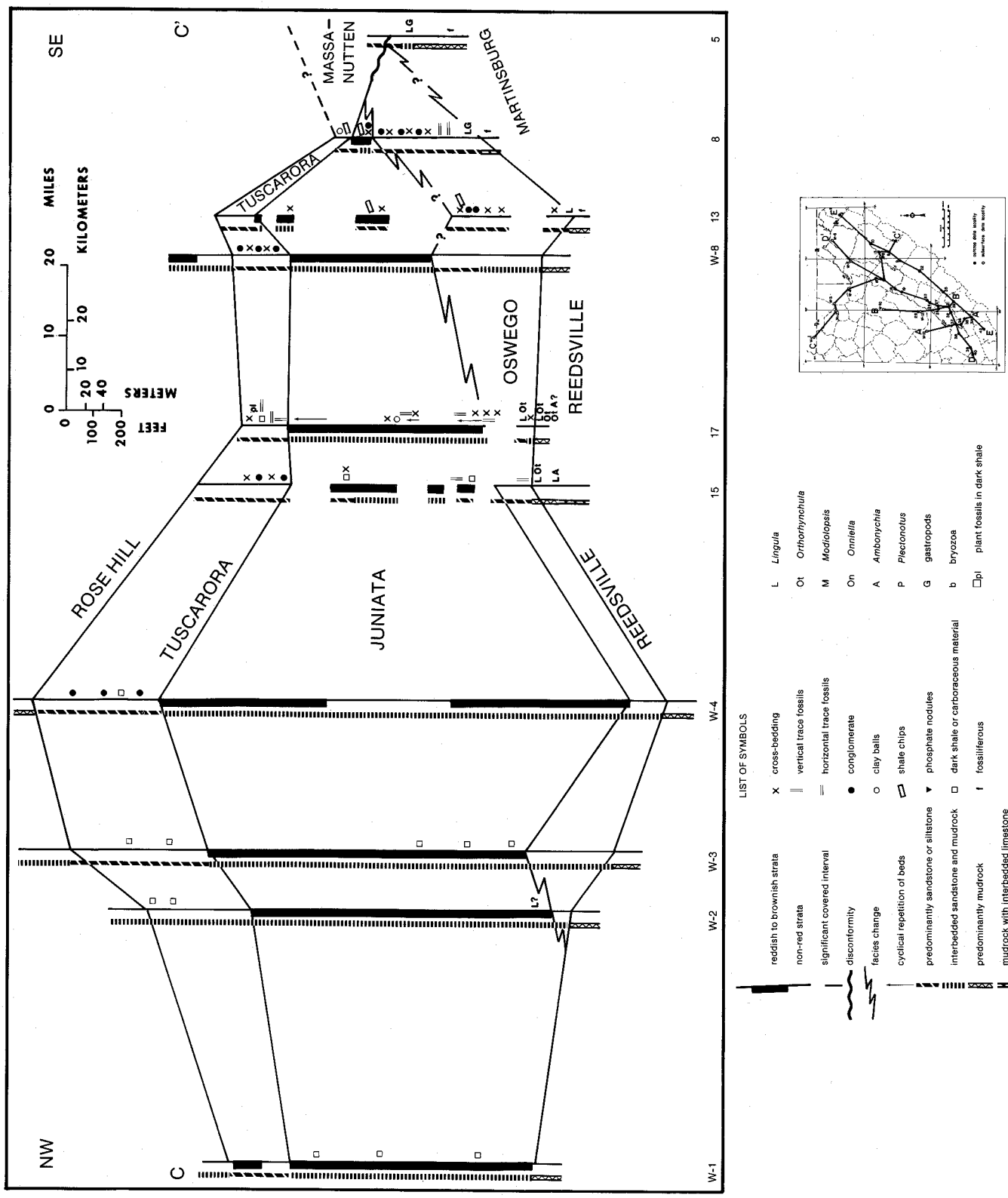
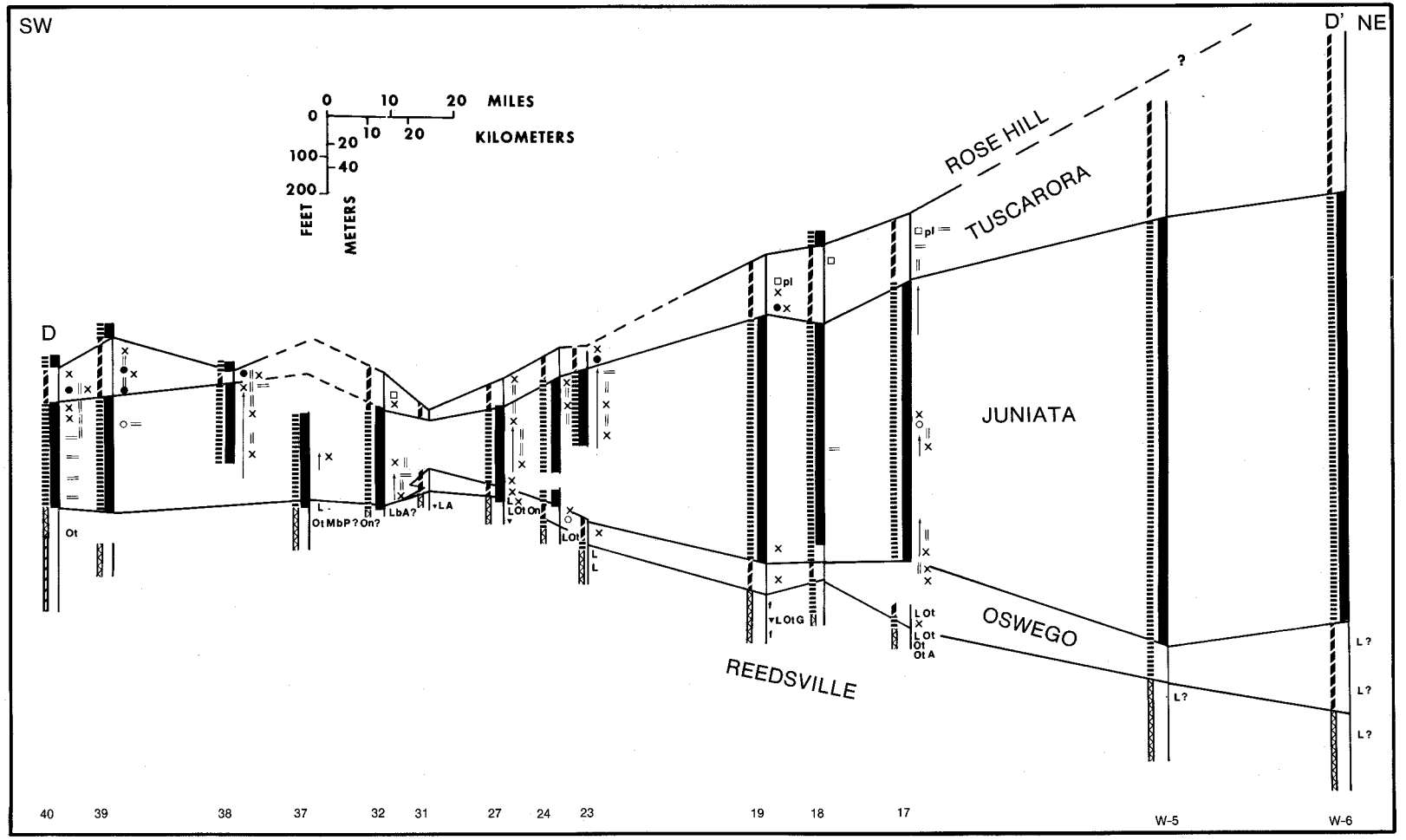


Figure 22. Stratigraphic cross section C-C'



LIST OF SYMBOLS

reddish to brownish strata	×	cross-bedding	L	*Lingula*
non-red strata	‖	vertical trace fossils	Ot	*Orthorhynchula*
significant covered interval	=	horizontal trace fossils	M	*Modiolopsis*
disconformity	●	conglomerate	On	*Onniella*
facies change	○	clay balls	A	*Ambonychia*
cyclical repetition of beds	▭	shale chips	P	*Plectonotus*
predominantly sandstone or siltstone	▼	phosphate nodules	G	gastropods
interbedded sandstone and mudrock	□	dark shale or carboraceous material	b	bryozoa
predominantly mudrock	f	fossiliferous	□pl	plant fossils in dark shale
mudrock with interbedded limestone				

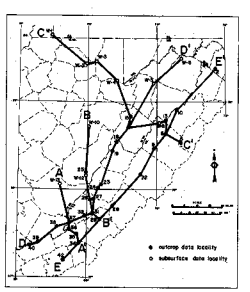


Figure 23. Stratigraphic cross section D-D'

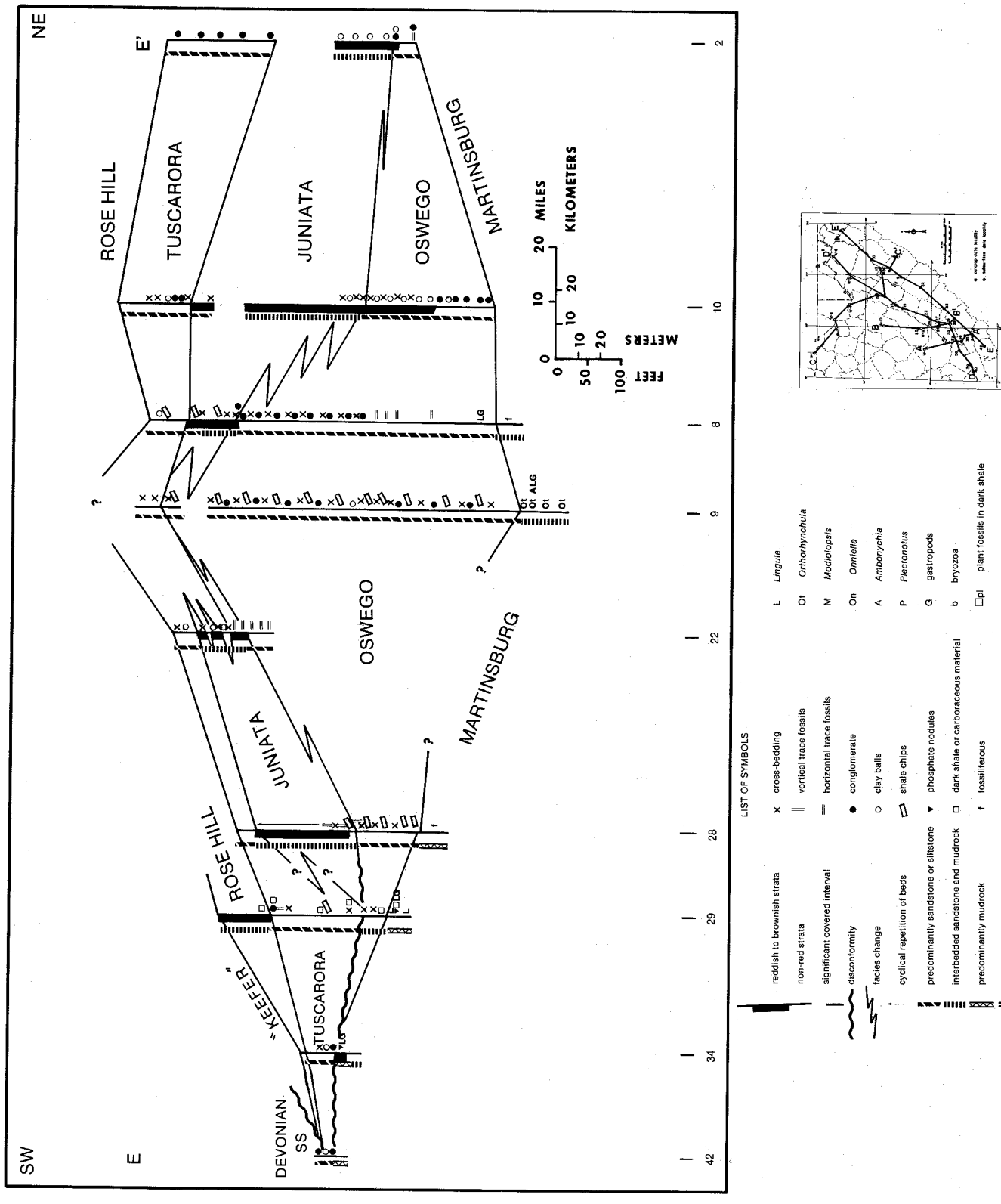


Figure 24. Stratigraphic cross section E-E'

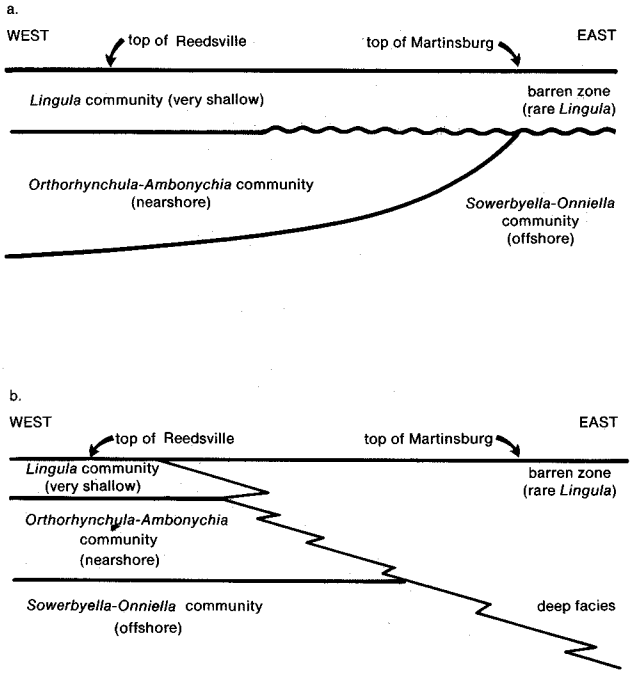


Figure 25. Two interpretations of the biostratigraphy at the top of the Martinsburg and Reedsville formations in northern Virginia: a) based on an unconformity at the base of the *Lingula* zone; b) based on a facies change from shallow to deep water assemblages. Barren zone indicates area of high sedimentation rate.

ditions. The shallow *Lingula* zone, in this interpretation, is missing in the east because of the presence of deeper water and a high rate of sedimentation which may have filled the basin and may also have prevented inhabitation by *Orthorhynchula.* In this case, the barren strata are synchronous with the *Orthorhynchula-Ambonychia* community, and their upper portion equivalent to the *Lingula* community. I favor the second hypothesis (Figure 25b).

Figure 26 is my interpretation of the paleogeography that existed in the study area in latest Martinsburg time. Axes of subsidence are delineated on the basis of isopach patterns (Figure 6). The shallow marine area is delineated on the basis of the known extent of the *Orthorhynchula -Ambonychia* and *Lingula* communities. In the subsurface, these communities are inferred from the presence of fossil fragments and phosphatic fragments. This is the basis for the inferred presence of shallow marine conditions in the western portion of the study area, which should be considered tentative.

The eastern limit of the shallow marine area coincides in part with the Shenandoah axis of Rader and Perry (1976a) and Roberts and Kite (1978a).

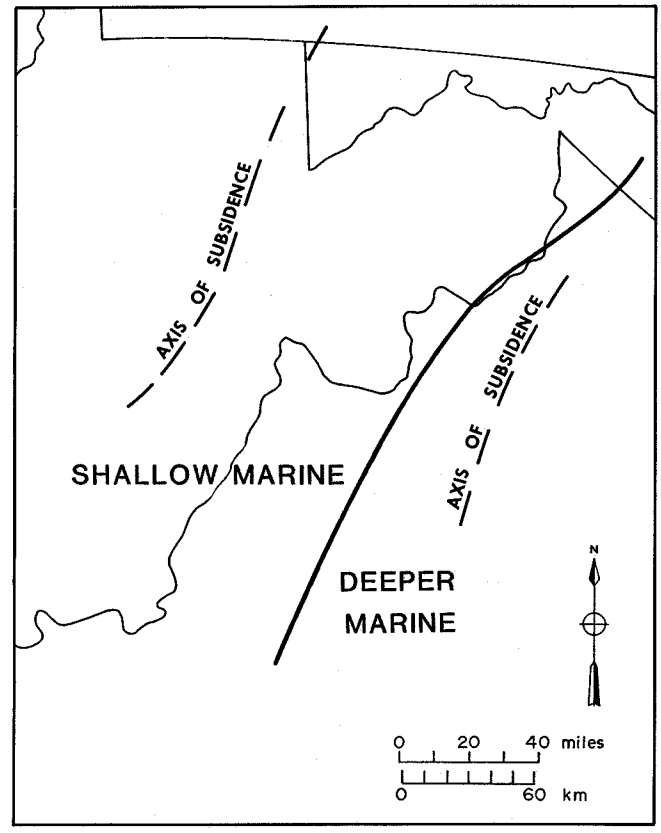


Figure 26. Interpretive paleogeography within the study area during early Maysville time or during the deposition of youngest Martinsburg or Reedsville strata. North arrow indicates present-day north. Palinspastic base.

The shallow marine area coincides with the area in which Reedsville deposition is controlled by storm generated currents on a marine shelf, as proposed by Kreisa (1980, 1981) for what he calls the Martinsburg Formation. The eastern deeper marine area coincides with the area in which Martinsburg deposition is controlled by turbidity currents (McBride, 1962).

Deposition of Oswego and Juniata Strata

Horowitz (1965, p. 31-32) and Thompson (1970a, p. 1257; 1970b, p. 601-602) have shown that, in Pennsylvania, lithologic boundaries, as determined by sand-shale ratios, between Oswego (Bald Eagle) and Juniata strata do not correspond to red/green coloration boundaries. I also found this to hold true in Virginia and West Virginia. Both Horowitz (1965, p. 116-117) and Thompson (1970b, p. 612-614) have concluded that the color differences are diagenetic and in fact the strata were all originally

red and the green coloration has been produced by diagenetic reduction of the red oxidized iron. On the other hand, Milici and Wedow (1977) showed that for equivalent strata in southeastern Tennessee, red coloration was associated with intertidal and supratidal facies, and is, therefore, controlled by depositional environment.

It was noted during this study that red coloration tends to be better developed where there is more shale in the section, although the lateral or vertical change from sandstone to sandstone with interbedded mudrocks does not always correspond to the red/green color boundary. In essence, it appears that, although the presence of shale or mudstone does not directly control the color of the strata, the ratio of thickness of red strata to thickness of green strata is directly proportional to the amount of shale or mudstone in the section.

The observation that the relative abundance of red strata is crudely and inversely proportional to the sandstone/shale ratio of the strata is further emphasized by Figure 15. This Juniata lithofacies map shows that although the thickest shaly strata are located beneath the Appalachian Plateau and appear to thicken into Pennsylvania, equivalent strata become sandier eastward where they crop out in the Valley and Ridge. This implies that one source of sand is within or east of the Valley and Ridge in Virginia.

Subsurface data show an increase in sandstone/shale ratio northward. Gamma ray and neutron logs (Appendix II) show that, compared with other wells in the area, the Juniata strata penetrated in the Preston 119 well (W-4) are thicker and sandier. This implies that there is indeed a northern source area and that this source was supplying sand to the basin. The pattern that emerges is that in late Ordovician time sedimentation within the study area was controlled by two sources, one from the north (Pennsylvania), and one from the east.

Mudstone is common in the Juniata in all areas, except along the eastern basin margin, where the unit becomes sandier as it changes facies into the Oswego Sandstone. Likewise, the Juniata is commonly red in all areas, except along the eastern basin margin where it changes facies into the non-red Oswego Sandstone.

Except for color, the Oswego Sandstone is lithologically quite similar to the sandstone beds of the Juniata. Whether the Juniata overlies the Oswego, or the Juniata is absent and replaced by the Oswego facies, the lithology of the sandstone seems to be essentially the same. Apparently the basal sandstone units are the most immature and the sandstone becomes more mature upward in section. The immature basal sands range from litharenite to feldspathic litharenite and grade upward to sublitharenite and often to quartzarenite in the uppermost portion of the Ordovician (lithologic terms are according to Folk, 1974, p. 129).

As discussed previously, the Juniata is characterized by cyclical sedimentation (Figures 12, 13), and the cycles contain trace fossils (Figure 11) that indicate marine to intertidal conditions. The upward progression from no trace fossils to vertical burrows to bedding plane trails, that is preserved in complete cycles, is interpreted, according to Seilacher's depth zonation (Figure 14), as indicating deepening water, or more quiescent marine conditions, upward in each cycle. It is further assumed that the trace fossils (*Skolithos, Cruziana, Rusophycus)* indicate marine conditions (Seilacher, 1967). The red coloration of the sediment, and the cyclical nature of this sequence, suggest that the Juniata was land-derived, and was deposited in very nearshore (subtidal to supratidal) conditions. A possible environment of deposition is a broad coastal lowland or delta plain that received sediment by alluvial processes but either was constantly or intermittently submerged by shallow marine water.

The fact that the Juniata is characterized by cyclical sedimentation, combined with the fact that the cycles contain the repeated characteristics of shallow water deposition, suggest that the Juniata was deposited during a low stand of sea level, but while sea level was rising and/or the land was subsiding. This thick sequence of shallow water sediments indicates progradation during this relative sea level rise. Because the cycles represent repetition of the same, graded, shallow marine sequence through as much as 700 feet of vertical section, the cyclic units appear to have accreted at about the same rate at which sea level rose, or the basin subsided, or both. Either the sea was coincidentally rising at the same average rate at which the sediments were being deposited, or the Juniata sediments were undergoing compaction or subsidence. The first possibility is unlikely, because if rates of sedimentation varied throughout the study area and if sea level was rising, then some cycles would be deposited above sea level, some below, and the nature of the cycles, therefore, would vary with sedimentation rate. The cycles, however, are surprisingly similar throughout the study area. This equilibration between sedimentation rate and relative sea level rise, therefore, cannot be used as evidence of a eustatic sea level rise. In fact McKerrow (1979) has shown that on a worldwide basis, sea level was falling during the Ashgillian.

The mechanism of subsidence is, therefore, favored as an explanation for the apparent rise of sea level in this area during latest Ordovician time.

As shown on Figures 16 and 17, on the eastern basin margin, Juniata and Oswego paleocurrents flowed from southeast to northwest, indicating a pattern of sediment dispersal into the basin. This is consistent with textural variation in these sediments, coarser to the southeast. In the central portion of the study area (Bath and Highland counties, Virginia; Pocahontas, Pendleton, and Hardy counties, West Virginia), paleocurrent trends are bimodal and indicate an average direction of flow toward the southwest. This change indicates either that the currents shifted from offshore to longshore, the shift occurring in the area that today lies between Little North Mountain and the Allegheny Front, or that the sedimentation west of the Little North Mountain was controlled by a different depositional system. The two transport modes are not 180 degrees opposed but indicate a westerly and southerly component of transport. Such a pattern suggests that longshore drift is probably responsible for sediment distribution in this area. If so, the onshore component of drift was in a southerly direction, the offshore component in a westerly direction, and net transport oriented toward the southwest. The paleocurrent data in western Maryland and Giles County, Virginia do not fit these patterns. Figure 27 shows an interpretation of the paleogeography during deposition of the Juniata and Oswego strata. In the area of investigation there appears to be a sediment source to the north in Pennsylvania. Other workers (Yeakel, 1962; Meckel, 1970) have considered the Juniata and Oswego (Bald Eagle) to be nonmarine in Pennsylvania. Based on their work, on isopach data (Figure 15), and on the fact that the Juniata appears to become sandier in the subsurface where it is thickest (well W-4), it is inferred that a shoreline existed in northern West Virginia and western Maryland, as shown in Figure 27. Another source area is present in the east, based on isopach data of Oswego strata (Figure 10) and paleocurrent trends (Figure 16). The thickest single expression from this source is the Silurian Massanutten Sandstone.

The two detrital source areas that were active during the time of deposition of the Oswego and Juniata strata were situated so as to produce a somewhat restricted body of water in what is now the Valley and Ridge in the northern portion of the study area. This restriction or embayment was bounded on the east by the newly formed source area at the eastern basin margin (Appalachia or

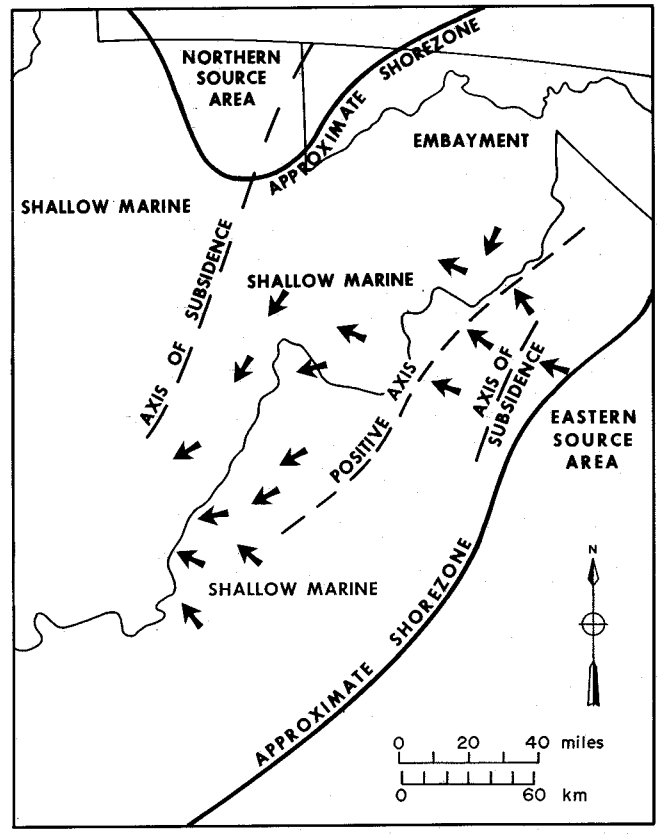


Figure 27. Interpretive paleogeography within the study area during late Richmond time or during the latter stages of deposition of Oswego and Juniata strata. Arrows indicate inferred direction of sediment dispersal. North arrow indicates present-day north. Palinspastic base.

the Taconic highlands), on the west by the southward accreting sediment of the Queenston delta complex, and on the north by the junction of these two sources in Pennsylvania. In essence, the Queenston delta complex in Pennsylvania was probably also derived from an eastern source and then dispersed southward into West Virginia. Further north, according to Patchen (1978, p. 383) and Zerrahn (1978, p. 1758), the Queenston sediments dispersed northward into New York.

The embayment that existed in northern Virginia and adjacent West Virginia was probably an area of coastal lowlands situated between the eastern eroding landmass (Appalachia) and the prograding lobe(s) of sediment. Eurypterid impressions (Figure 9) in the Oswego in Berkeley County, West Virginia are evidence that brackish water conditions existed in this embayment during Maysville time. These areas were probably not swamps or

marshes because of the probable non-existence of terrestrial plants but may have been suitable for plants to begin to develop a means by which to adapt to nonmarine conditions.

The axes of subsidence indicated on Figure 27 are intended to show areas where sedimentation took place at a high rate because of syndepositional subsidence. These troughs may have been deep areas in late Martinsburg time, but were probably no longer deep in latest Ordovician time, having become, progressively shallower because of the high rate of influx of Juniata and Oswego clastic material.

A positive axis is shown on Figure 27, and its position lies within the shallow marine area that was proposed to exist during late Martinsburg time (Figure 26). This axis separates the area of offshore (northwestward) sediment transport from the area of longshore (southwestward) sediment transport and may have been a subtle topographic feature in late Ordovician time. The northern portion of this axis also generally coincides with the zone in which the Juniata changes facies into the Oswego.

LATERAL RELATIONSHIPS

One of the primary results of this study is an interpretation of the lateral or facies relationships between the Oswego and Juniata formations. As shown on stratigraphic cross sections C-C', D-D', and E-E' (Figures 22, 23, 24) the typical Oswego lithology (gray to green sandstone) occurs below the Juniata redbeds throughout most of the study area. This is not the case, however, in Rockingham County, Virginia (Figure 22, locality 8; Figure 24, localities 8, 9), where the Juniata is absent or has thinned to a feather edge. Here the Oswego is anomalously thick. This is depicted on Figure 24 at Brocks Gap (locality 8) and Cooper Mountain (locality 9), near the area where the Oswego attains its maximum thickness (see Figure 10). At these localities there is no apparent hiatus (such as an abrupt contact) at the top of the Oswego. It is, therefore, probable that at these locations the Oswego is a time-equivalent facies of the Juniata.

In the Salem (Catawba) syncline, the local absence of the Juniata appears to be because of disconformity (see section E-E', Figure 24). In this general vicinity the Juniata thins and pinches out to the south, but as determined from the outcrops at Catawba Mountain (locality 34) and at Fagg (locality 42), the pinchout seems to be because of erosional truncation. The Tuscarora at Catawba Mountain is conglomeratic and rests directly upon the Martinsburg (Reedsville of this report). The Oswego and Juniata are both missing. The *Orthorhynchula* biozone here is stained red at the top, possibly because of the pre-erosional proximity of the Juniata redbeds to the uppermost beds of the Reedsville. At Fagg, five feet of Silurian sandstone (Tuscarora or "Keefer"), representing the only preserved Silurian, overlies the Reedsville and underlies the Devonian Ridgeley (Oriskany) Sandstone. This section at Fagg indicates local emergent conditions during most of the Silurian, or pre-Oriskany erosion of the Silurian. The disconformity is least developed where the Juniata is thick. Because the Juniata and Oswego are facies-related, the absence of either of these units is not adequate criterion for defining a hiatus. Only where both of these units are thin or absent should the possibility of a hiatus be considered.

ORDOVICIAN-SILURIAN BOUNDARY

Stratigraphic relationships discussed previously place constraints on an interpretation of the nature of the Ordovician-Silurian boundary. This systemic boundary is customarily placed at the base of the Tuscarora or Massanutten sandstones. This is based upon lithostratigraphic correlation of unfossiliferous strata within the study area with fossiliferous strata elsewhere. Nowhere within the study area has the uppermost Ordovician or lowermost Silurian strata yielded fossils that would help define the systemic boundary.

Petrologically, the late Ordovician strata are litharenites to sublitharenites with interbedded mudstones and shales and the early Silurian strata are quartzarenites. The systemic boundary marks a fairly abrupt disappearance of unstable lithic fragments and clay from the stratigraphic column and hence an abrupt change from immature sandstones below to mature sandstones above.

As is evident from the cross sections, the Tuscarora has the general geometry of a blanket sand. The base of this blanket is the Ordovician-Silurian boundary. Two areas where the Tuscarora does not have a blanket geometry are in the Massanutten area (Figure 22, outcrop locality 5) and in the area around Eagle Rock, Virginia (Figures 20 and 24, outcrop locality 29). At each of these localities, the Tuscarora is unusually thick, the Juniata is missing, and the Oswego is relatively thin or absent. Therefore, at these locations, the possibility exists that the lower Tuscarora is facies-equivalent to the Juniata and/or the Oswego.

In the Massanutten area the Juniata is absent because it has changed facies into the Oswego Sandstone (Figures 22, locality 8 and 24, locality

9). The Oswego, however, is disconformably absent at Massanutten Mountain, where the Massanutten Sandstone overlies the sandy facies of the upper Martinsburg (Cub Sandstone of Thornton, 1953). The base of the Silurian is, therefore, interpreted as a disconformity in the Massanutten synclinorium, as determined by an abrupt contact and the lack of coarse-grained Oswego Sandstone. The Oswego may have once been here and later eroded away, but the Juniata probably never existed in the Massanutten area. The possibility also exists that the sandy facies at the top of the Martinsburg (Cub Sandstone) is a lateral facies of the Oswego. If so, the length of the hiatus would be much less significant. This interpretation supports the contention that the base of the Massanutten Sandstone is the base of the Silurian, but is arbitrary because of the lack of biostratigraphic control. At Eagle Rock (outcrop locality 29, Figures 21 and 24) the Tuscarora is unusually thick, the Juniata is absent, and the Oswego is thin and poorly developed. There is no evidence of facies relationships between Juniata and Oswego strata in this area. The Juniata is interpreted to be missing in part because of a change in facies from a red mudstone to a clean quartzarenite, and that the lower Tuscarora here is equivalent to the uppermost Juniata elsewhere. An unconformity probably exists here at the top of the Oswego (presence of phosphatic pebbles); however, it is not well developed, and the Oswego seems to grade upward into the Tuscarora. Further southwest, the unconformity becomes more pronounced. This interpretation allows the possibility that the lowermost Tuscarora at Eagle Rock is equivalent to the upper Juniata. This interpretation is reinforced by the presence of a 45-foot-thick transitional zone, containing quartz sandstone with interbedded red shale, at the top of the Juniata Formation at Buffalo Gap (outcrop locality 22, Figure 24).

In the central portion of the Valley and Ridge outcrop belt within the study area, the lithologic change that denotes the Ordovician Silurian boundary (base of the Tuscarora Sandstone) is a gradational contact. For this reason, the systemic boundary is, in these places, conformable and therefore not a hiatus. This is lithostratigraphic evidence for the presence of the Gamachian Stage in a portion of the study area. A disconformable systemic boundary, such as is present in the Massanutten and Catawba synclinoria and along the northern portion of the North Mountain fault, may represent the absence of some, if not all of the Gamachian. A probably paraconformable systemic boundary, such as is present in the western anticlines of the Valley and Ridge, probably represents the absence of only a minor portion of the upper Gamachian.

SEA LEVEL HISTORY

In the Late Cambrian and Early Ordovician, marine lime muds were being deposited. During the Blackriverian (Upper Ordovician), muds (Liberty Hall) and gravels (Fincastle) were deposited, marking the onset of Taconic sedimentation within the study area. Following this, flysh, (Martinsburg) and equivalent sediments (units) were deposited, beginning in Trentonian time and continuing until the Maysvillian.

In early Maysville time sea level was lowered, as denoted in the Appalachians by a change from a deeper water fauna upward to a shallower water fauna in the upper Reedsville Formation. The shallow faunal zone is missing from the upper Martinsburg in the Massanutten area probably because conditions here were too deep, or otherwise unsuitable for inhabitation by shallow water species.

Sedimentation continued through the remainder of the Cincinnatian with the contemporaneous deposition of the Oswego and Juniata sediments. These units were deposited during the low stand of sea level. As the strata were deposited, they were compacted and the basin subsided isostatically. Sea level may have been rising slowly, or it may have been fluctuating during the Late Ordovician glacial episode.

The sea level drop that was responsible for the shallow marine nature of the post-Eden strata (upper Reedsville) was also responsible at least in part for the development of the pre-Silurian unconformity in southwestern Virginia. This is the sea level drop that produced the Taconic discontinuity of Wheeler (1963, p. 1506). It was pointed out by Johnson (1971, p. 3286) that the Taconic discontinuity should not be associated with the Taconic orogeny. Dennison and Head (1975, p. 1097) more properly designated this hiatus as the Cherokee discontinuity. This sea level lowering, which was probably glacioeustatic (Dennison, 1976), began in early Maysville time and lasted throughout the remainder of the Ordovician. Sea level rose, probably eustatically, in earliest Silurian time Gray and Boucot, 1972; Berry and Boucot, 1973; Dennison and Head, 1975; McKerrow, 1979). This sea level rise was to a large degree responsible for the widespread deposition of the Tuscarora and equivalent sandstones.

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APPENDIXES

Definition of Terms Used in Appendixes

sandstone: 75-100% sand size grains, 0-25% silt + clay*

quartzarenite: 95-100% quartz
litharenite: 0-75% quartz, % lithic fragments exceeds % feldspar
sublitharenite: 75-95% quartz, % lithic fragments exceeds % feldspar

* if term sandstone is used without a more specific term, this indicates that a mineralogic determination was not made.

mudrocks: 0-75% sand size grains, 25-100% (usually 75-100%) silt + clay.

siltstone: massive to bedded, predominantly silt.
mudstone: crumbly to bedded, clay and silt mixture.
silt-shale: fissile, predominantly silt.**
clay-shale: fissile, predominantly clay.**

** if term shale is used without a size prefix, size determination was not made. Term indicates a fissile mudrock.

weathering terms:

chippy - small, flat pieces
platy - large flat pieces
lath-shaped - long, flat pieces
crumbly - blocky or equidimensional pieces

bedding thickness designations:
(after Ingram, 1954):

very thickly bedded (100+ cm)
thickly bedded (30-100 cm)
medium bedded (10-30 cm)
thinly bedded (3-10 cm)
very thinly bedded (1-3 cm)
thickly laminated (0.3-1.0 cm)
thinly laminated (less than 0.3 cm)

Numerical color designations are from the Geological Society of America. Rock Color Chart (Goddard and others, 1970).

Locations of outcrops on 7.5-minute topographic quadrangles are designated using the following scheme:

NW	NC	NE
WC	C	EC
SW	SC	SE

Appendix I: Measured sections

Listing of Outcrop Localities:

1 Cumberland
2 Mills Gap
3 Fawcett Gap
4 Passage Creek
5 Catherine Furnace
6 Harshberger Gap
7 Fetzer Gap
8 Brocks Gap
9 Cooper Mountain
10 Great North Mountain/ Route 691
11 Long Mountain/Rte. 691
12 Black Fox Hollow
13 Hunkerson Gap
14 Long Ridge
15 Roy Gap
16 Harper Gap
17 North Fork Mountain/ Rte. 33
18 Hardscrabble
19 Lantz Mountain/Rte. 250
20 Monterey Mountain/Rte. 250
21 Trimble
22 Buffalo Gap
23 Warm Springs
24 Hot Springs
25 Minnehaha Springs
26 Falling Spring Falls
27 Warm Springs Mountain/Airport Rd.
28 North Mountain/Rte. 770
29 Eagle Rock
30 Johnson-Porter Mountain
31 Hooks Mill
32 Cliff Dale Chapel
33 Read Mountain
34 Catawba Mountain/Rte. 311
35 Meadow Creek Falls
36 Potts Mountain/Rte. 311
37 Peters Mountain/Rte. 311
38 Gap Mills
39 Johns Creek Mountain/Rte. 601
40 Narrows
41 Gap Mountain/Rte. 460
42 Fagg
43 Ingles Mountain

LOCALITY 1 - CUMBERLAND

Section measured in the Narrows, along Wills Creek, just northwest of Cumberland, Maryland; Allegany County, Maryland; Cumberland, Md.-Pa.-W.Va. 7.5-minute quadrangle (SE, EC); 30°39.9'N. 78°46.8'W. Upper portion of Tuscarora measured along railroad tracks on west side of Wills Creek at the northeast end of Haystack Mountain. Lower Tuscarora and Juniata measured along railroad tracks on east side of Wills Creek at the southwest end of Wills Mountain.

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured		
Interbedded shale and sandstone. Shale, medium gray (N5), grading upward to olive gray (5Y4/1), chippy to platy; sandstone, fine, to siltstone, yellowish gray (5Y8/1), grading upward to medium light gray (N6) with light brownish gray (5YR6/1) mottles.	---	---
Tuscarora Formation: 302 ft. (92.0 m). Sandstone is quartzarenite.		
Sandstone, medium to fine, yellowish gray (5Y8/1) to light gray (N7), stained brownish black (5YR2/1).	1 (0.3)	1 (0.3)
Shale, medium light gray (N6), weathers dark yellowish orange (10YR6/6), chippy to platy.	1 (0.3)	2 (0.6)
Sandstone, medium to coarse, very light gray (N8) to yellowish gray (5Y8/1), stained brownish black (5YR2/1), medium to thickly bedded, cross-bedded, some pinch and swell bedding, occasional light gray (N7) mud balls.	5 (1.5)	7 (2.1)
Interbedded sandstone and shale. Sandstone, medium to fine, medium light gray (N6) to light gray (N7), occasionally stained dark yellowish orange (10YR6/6) and brownish black (5YR2/1), medium to thinly bedded, evenly bedded, Skolithos; silt-shale and clay-shale, medium gray (N5), chippy, thinly bedded	9.5 (2.9)	16.5 (5.0)
Sandstone, medium to fine, light gray (N7), stained brownish black (5YR2/1), thinly bedded, slight pinch and swell, otherwise evenly bedded, some cross-bedding.	13.5 (4.1)	30 (9.1)
Sandstone with interbedded shale. Sandstone, medium to fine, white (N9) to light gray (N7), stained brownish black (5YR2/1), thinly to thickly bedded, pinch and swell bedding, some cross-bedding (especially in upper 2 meters); clay-shale to silt-shale (5%), medium dark gray (N4). Arthrophycus on base of sandstone beds above shale beds.	40.5 (12.3)	70.5 (21.5)
Sandstone and shale, same as above, but with rare (1%) interbeds of shale.	13.5 (4.1)	84 (25.6)
Sandstone, same as above, but with some cross bedding, channelling, contorted bedding, and Arthrophycus(?), but no shale.	59 (18.0)	143 (43.6)
Sandstone, same as above, but coarse to fine.	54.5 (15.6)	197.5 (60.2)
Sandstone, coarse to fine, pinkish gray (5YR8/1) to very light gray (N8), weathers dark yellowish orange (10YR 6/6), surface stained brownish black (5YR2/1), very thickly to thinly bedded.	40.5 (12.3)	238 (72.5)
Covered.	34 (10.4)	272 (82.9)
Sandstone, medium to very fine, grayish pink (5YR8/2), weathers black (N1), medium to very thickly bedded, cross-bedded	20 (6.1)	292 (89.0)
Covered.	4.5 (1.4)	296.5 (90.4)
Sandstone, fine to very fine, grades from pale red (5R6/2) at base to pinkish gray (5YR8/1) at top, weathers light brown (5YR5/6) and black (N1), massive, clay balls at base.	5.5 (1.7	302 (92.0)
Juniata Formation: 304+ ft (92.7+ m). Upper 5.0 ft (1.5 m) is transitional to Tuscarora.		
Covered	3 (0.9)	305 (93.0)
Sandstone (quartzarenite) fine, pale red (5R6/2), weathers light brown (5YR5/6) to black (N1), massive.	2 (0.6)	307 (93.6)
In the cycles below, the sandstone, unless otherwise specified, grades from litharenite at the base of the section to sublitharenite at the top of the cyclically bedded interval, fine to very fine, grayish red (5R4/2), weathers olive black (5Y2/1) and light brown (5YR5/6), somewhat argillaceous, especially so when Skolithos is present, and has a slightly higher than normal specific gravity; the mudstone is grayish red and chippy to platy; the siltstone is bedded and grayish red.		
Cycle. Lower 0.7 m sandstone with Skolithos; grades upward into 1.2 m silt-shale with Skolithos; grades upward into mudstone	8.5 (3.5)	315.5 (99.7)
Cycle. Lower 1.8m sandstone, planar cross-beds, interbedded silt-shale; grades upward into interbedded silt-shale and mudstone, Skolithos in mudstone.	11.5 (3.5)	327 (99.7)
Covered. (top of cycle)	3 (0.9)	330 (100.6)
Cycle. Lower 1.5 m cross-bedded sandstone with interbedded silt-shale; grades upward into silt-shale with interbedded sandstone.	10 (3.0)	340 (103.6)
Cycle (?). Lower 0.7 m sandstone with interbedded silt-shale, grades upward into 0.3 m silt-shale; grades upward into 0.5 m cross-bedded sandstone with limonitic specks and interbedded silt-shale; grades upward into 1.8 m sandstone with Skolithos interbedded with silt-shale; grades upward into bioturbate mudstone with large Chondrites and rare interbeds of sandstone with Skolithos.	21 (6.4)	361 (110.0)
Cycle. Lower 0.9 m sandstone with interbedded silt-shale; grades upward into bioturbate mudstone with interbedded sandstone, both with Skolithos.	7 (2.1)	368 (112.2)
Cycle. Lower 0.9 m sandstone with Skolithos; grades upward into bioturbate silt-shale to mudstone, with interbedded sandstone with Skolithos.	12 (3.7)	380 (115.8)
Cycle. Lower 0.9 m sandstone with bedding plane trails and interbedded silt-shale; grades upward into bioturbate mudstone with large Chondrites.	6 (1.8)	386 (117.7)
Cycle. Lower 1.8 m sandstone with Skolithos and interbedded silt-shale; grades upward into bioturbate silt-shale to mudstone with large Chondrites.	11 (3.4)	397 (121.0)
Cycle. Lower 1.4 m sandstone with bedding plane trails and interbedded silt-shale; grades upward into 1.0 m mudstone; grades upward into 0.9 m silt-shale with Skolithos; grades upward into bioturbate mudstone to silt-shale with Planolites (?).	15.5 (4.7)	412.5 (125.7)
Cycle. Lower 0.9 m sandstone, cross-bedded, with Skolithos, channeling, and silt-shale interbeds; grades upward into bioturbate mudstone with interbedded sandstone.	12 (3.7)	424.5 (129.4)
Cycle. Lower 2.0 m cross-bedded sandstone with shaly partings and limonitic specks, channel at base; grades upward into interbedded sandstone and silt-shale with some channeling.	8.5 (2.6)	433 (132.0)
Cycle. Lower 0.5 m sandstone; grades upward into bioturbate mudstone.	10 (3.0)	443 (135.0)
Cycle. Lower 0.5 m cross-bedded sandstone with Skolithos, limonitic specks; grades upward into mudstone to silt-shale with Skolithos in lower portion, bedding plane trails and Cruziana at top.	6 (1.8)	449 (136.9)
Cycle. Lower 1.5 m sandstone with Skolithos at base, rare interbedded silt-shale, limonitic specks, and some channeling; grades upward into bioturbate mudstone with Skolithos and greenish gray (5GY6/1) splotches.	15 (4.6)	464 (141.4)

Cycle. Lower 0.6 m sandstone with Skolithos that changes laterally into interbedded sandstone and silt-shale; grades upward into bioturbate silt-shale to mudstone with Skolithos in lower portion, bedding plane trails at top, and greenish gray (5GY6/1) splotches.	7.5 (2.3)	471.5 (143.7)
Cycle. Lower 0.5 m sandstone with Skolithos; grades upward into silt-shale.	4 (1.2)	475.5 (144.9)
Cycle. Sandstone with Skolithos; grades upward into silt-shale.	2.5 (0.8)	478 (145.7)
Cycle. Sandstone at base; grades upward into silt-shale. Base of cycle is channeled into lower cycle.	1 (0.3)	479 (146.0)
Cycle. Lower 0.5 m sandstone with Skolithos; grades upward into silt-shale.	2.5 (0.8)	481.5 (146.8)
Cycle. Lower 0.5 m sandstone with Skolithos, base is channeled into lower cycle; grades upward into 0.3 m silt-shale; grades upward into 0.5 m sandstone with Skolithos; grades upward into silt-shale with Skolithos.	6 (1.8)	487.5 (148.6)
Cycle. Lower 1.8 m cross-bedded sandstone with Skolithos, mud voids, and silt-shale interbeds, channeled at base; grades upward into 0.9 m interbedded sandstone and silt-shale; grades upward into silt-shale to mudstone with interbedded sandstone.	12.5 (3.8)	500 (152.4)
Cycle. Interbedded sandstone and silt-shale; sandstone is cross-bedded and more abundant at base, silt-shale is more abundant upward; Skolithos in lower 3.0 m.	14 (4.3)	514 (156.7)
Cycle. Lower 0.5 m cross-bedded sandstone; grades upward into 0.9 m interbedded sandstone with Skolithos and mudstone; grades upward into mudstone.	8.5 (2.6)	522.5 (159.3)
Mudstone, grayish red (5R4/2), crumbly, few interbeds of very fine, grayish red sandstone with Skolithos.	31.5 (9.6)	554 (168.9)
Sandstone (litharenite), very fine, grayish red (5R4/2), weathers olive black (5Y2/1) and dark yellowish orange (10YR6/6), thickly to thinly bedded, planar cross-beds, pinch and swell bedding, Skolithos, interbedded grayish red silt-shale.	15 (4.6)	569 (173.4)
Interbed sandstone and silt-shale to mudstone. Sandstone (litharenite), very fine, grayish red (5R4/2), weathers olive black (5Y2/1), medium to very thinly bedded; silt-shale to mudstone, grayish red, crumbly to platy, medium to very thinly bedded.	2.5 (0.8)	571.5 (174.2)
Sandstone (litharenite), fine, grayish red (5R4/2), planar cross-beds, Skolithos; interbedded grayish red silt-shale to mudstone, platy to crumbly.	1.5 (0.5)	573 (174.7)
Mudstone, grayish red (5R4/2), crumbly.	7 (2.1)	580 (176.8)
Interbedded sandstone and silt-shale to mudstone. Litharenite, fine to very fine, grayish red (5R4/2), weathers olive black (5Y2/1), very thinly to medium bedded, planar cross-beds, Skolithos; silt-shale to mdst, grayish red (5R4/2), medium to very thinly bedded, chippy to crumbly.	8 (2.4)	588 (179.2)
Mudstone, grayish red (5R4/2), crumbly.	3 (0.9)	591 (180.1)
Sandstone (litharenite), fine to very fine, grayish red (5R4/2) weathers olive black (5Y2/1), medium to thinly bedded, planar cross-beds, Skolithos, interbedded grayish red silt-shale. Lower beds not exposed.	15 (4.5)	606 (184.7)

LOCALITY 2 - MILLS GAP

Section measured along West Virginia Highway 51, just south of junction with West Virginia Highway 45, at Mills Gap through North Mountain, approximately 1.4 miles northwest of Gerrardstown, W.Va.; Berkeley County, W.Va.; Tablers Station, W.Va. 7.5-minute quadrangle (SW); 39°23.3'N. 78°06.7'W (Woodward, 1941, p. 61). Section is overturned.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 166 ft (50.6 m). Top of section is covered. Top of exposure is assumed to be top of Tuscarora. Woodward reports 117 ft. of Tuscarora. Sandstone is quartzarenite.		
Sandstone, medium to very coarse, pinkish gray (5YR8/1), parting surface stained orange on dip slopes, locally conglomeratic, 1 cm maximum diameter quartz pebbles, somewhat friable.	97 (29.6)	97 (29.6)
Sandstone, same as above, but more commonly conglomeratic (maximum diameter 0.5 cm), and not friable.	69 (21.0)	166 (50.6)
Paraconformity		
Juniata Formation: 176 ft (53.6 m)		
Covered.	92 (28.0)	258 (78.6)
Sandstone, medium to fine, to mudstone, grayish red (5R4/2), thickly to very thinly bedded, clasts and interbeds of grayish red silt-shale and clay-shale.	48 (14.6)	306 (93.2)
Covered.	16 (4.9)	322 (98.1)
Covered, but with broken-up outcrop of litharenite at top, medium to fine grayish red (5R4/2), with grayish red shale balls.	20 (6.1)	342 (104.2)
Oswego Sandstone: 33 ft (10.0 m). Sandstone is litharenite.		
Sandstone, medium to fine, dark yellowish orange (10YR6/6) near base, grading upward to pale red (10R6/2) and pale reddish brown (10R5/4) in upper 0.6 m, occasionally conglomeratic, some clay balls limonitic specks near base, seems to be graded (fines upward).	8 (2.4)	350 (106.6)
Covered.	21 (6.4)	371 (113.0)
Conglomeratic sandstone, medium to very coarse, light gray (N7) to pale red (10R6/2), weathers dark yellowish orange (10YR6/6), somewhat massive, angular to subrounded clasts of quartzite, white and black chert, and shale, maximum diameter 3 cm, bedding plane trails eurypterid impressions.	4 (1.2)	375 (114.2)
Lower beds are covered, probably Reedsville.		

LOCALITY 3 - FAWCETT GAP

Section exposed along State Road 629 at Fawcett Gap through Little North Mountain, approximately 3.2 miles north of Marlboro, Va.; Frederick County, Va., Hayfield, Va. 7.5-minute quadrangle (SC); 30°07.5'N, 78°18.5W (Butts and Edmundson, 1939, plate 25b).

Outcrop contains an exposure of about 5 ft (1.5 m) of Silurian quartzarenite(?Tuscarora Sandstone) that is overlain by dark gray Devonian Marcellus Shale, and underlain by gray to greenish gray shale of the Reedsville Formation

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LOCALITY 4 - PASSAGE CREEK

Section measured along State Road 678 and Passage Creek at northeast end of Massanutten Mountain (Blue Hole), approximately 3.6 miles south-

east of Strasburg, Va.; Shenandoah County, Va. (just west of Warren County line); Strasburg, Va. 7.5-minute quadrangle (C); 38°56.7'N, 78°18.1'W (Secrist & Evitt, 1943, p. 362; Pratt, 1979, p. 58-61).

	thickness ft (m)	total ft (m)
Massanutten Sandstone: not measured. Pratt reports 241 m of Tuscarora equivalent (Runkles Gap Member of Pratt).		
Sandstone, quartzarenite, conglomeratic (quartz pebbles), cross-bedded.	---	---
Disconformity		
Martinsburg Formation: 80+ ft (24.4+ m). Upper sandstone member (Cub Sandstone of Thornton, 1953). Sandstone is litharenite.		
Covered.	42 (12.8)	42 (12.8)
Sandstone, very fine, to siltstone, slightly feldspathic, dark gray (N3) to light olive gray (5Y5/2), weathers pale yellowish brown (10YR6/2) to olive gray (5Y4/1), medium to very thinly bedded, occasional ball and pillow, limonitic specks, slightly micaceous.	32 (9.8)	74 (22.6)
Sandstone, very fine, to siltstone, olive gray (5Y4/1), weathers light olive gray (5Y5/2), limonitic specks, fossiliferous, Rafinesquina, Ruedemannia, cephalopods, fossils seem to be concentrated in lenses of friable sandstone.	6 (1.8)	80 (14.6)
Lower beds were not measured.		

LOCALITY 5 - CATHERINE FURNACE

Section measured along Cub Run Road at gap in First Mountain just east of Catherine Furnace, approximately 2.2 miles northwest of Grove Hill, Va.; Page County, Va.; Tenth Legion, Va. 7.5-minute quadrangle (EC); 38°33.4'N. 78°37.9'W (Secrist and Evitt, 1943, p. 36; Thornton, 1953, p. 67-68; Roberts and Kite, 1978b, p. 36). Section is overturned.

This is the type section of the Cub Sandstone that was informally named by Thornton (1953).

	thickness ft (m)	total ft (m)
Massanutten Sandstone: 61+ ft (18.6+ m), Roberts and Kite report 650 ft of Massanutten Sandstone. Sandstone is quartzarenite.		
Sandstone, medium to very coarse, very light gray (N8). Not measured.	---	---
Covered.	41 (12.5)	41 (12.5)
Sandstone, medium to coarse, light gray (N7).	5 (1.5)	5 (14.0)
Covered. Sandstone boulders.	15 (4.6)	61 (18.6)
Disconformity		
Martinsburg Formation 409+ ft (124.6 m).		
upper sandstone member: 209 ft (63.7 m). Sandstone is litharenite to sublitharenite. (Cub Sandstone of Thornton, 1953).		
Sandstone, fine to very fine, grayish orange (10YR7/4) to dark yellowish brown (10YR4/2), weathers grayish brown (5YR3/2) medium to thinly bedded, spheroidal weathering.	45 (13.7)	106 (32.3)
Interbedded silt-shale and sandstone. Silt-shale, olive gray (5Y4/1) to moderate yellowish brown (10YR5/4, weathers pale brown (5YR5/2), platy to chippy (60%); sandstone, very fine, to siltstone, grayish orange (10YR7/4) to dark yellowish brown (10YR4/2), weathers grayish brown (5YR3/2), medium to thinly bedded (40%).	24 (7.3)	130 (39.6)
Interbedded sandstone and shale, Sandstone, very fine, to siltstone, olive gray (5Y4/1) to moderate yellowish brown (10YR5/4), weathers olive black (5Y2/1) to moderate brown (5YR4/4), thinly to thickly bedded, occasional limonitic specks, evenly bedded (70%); clay-shale to silt-shale, olive gray (5Y4/1), weathers light olive gray (5Y6/1), platy (30%). Fossiliferous layers and lenses in lower 6 m (20 ft), Ambonychia, gastropods. Secrist and Evitt report Lingula at middle of this unit.	80 (24.4)	210 (64.0)
Interbedded sandstone and shale. Sandstone, very fine, to siltstone, moderate yellowish brown (10YR5/4) to olive gray (5Y4/1), weathers brownish gray (5YR4/1), to olive black (5Y2/1), thinly to thickly bedded, limonitic specks (especially in upper 6 m), bedding slightly undulatory, spheroidal weathering in places (esp. in upper 1.5 m), occasional fossiliferous lenses and beds, Lophospira, Rafinesquina, Sowerbyella (90%); shale, olive gray (5Y4/1), chippy (10%).	60 (18.3)	270 (82.3
middle sandstone and shale member: 200+ ft (61.0+ m)		
Interbedded shale and siltstone. Clay-shale, olive gray (5Y4/1), weathers light olive gray (5Y6/1) to light brown (5YR6/4), platy to chippy (70%); siltstone, dark yellowish orange (10YR6/6), weathers light brown (10YR6/4), thinly to thickly bedded, micaceous, limonitic specks, jointed normal to bedding 30%. Rafinesquina, Sowerbyella, crinoids, bryozoa.	200 (61.0)	470 (143.2)
Lower beds not measured.		

LOCALITY 6 - HARSHBERGER GAP

Section measured along Massanutten Drive at gap in First Mountain, approximately 2.1 miles north-northwest of McGaheysville, Va.; Rockingham County, Va.; Elkton West, Va. 7.5-minute quadrangle (SW); 38°24.3'N, 78°44.5'W. (Roberts & Kite, 1978b, p. 33). Section is vertical to slightly overturned.

	thickness ft (m)	total ft (m)
Massanutten Sandstone: 22+ ft (6.7+ m). Roberts & Kite report 544 ft. of Massanutten.		
Sandstone (quartzarenite), medium to very fine, very light gray (N8), occasionally stained pale reddish brown (10R5/4) especially near base, conglomeratic in lower 0.3 m, quartz pebbles, 1.5 cm maximum diameter.	22 (6.7)	22 (6.7)
unnamed sandstone: 66 ft (20.1 m). Either lithostratigraphically equivalent to Juniata, or basal Massanutten. Sandstone is litharenite to sublitharenite.		
Sandstone, fine to very fine, light brown (5YR6/4) to pale reddish brown (10R5/4), friable, poorly exposed.	35 (10.7)	57 (17.4)
Sandstone, medium to fine, pale red (10R6/2) to pale brown (5YR5/2), weathers light brown (5YR6/4), medium bedded, very clayey (mudstone).	20 (6.1)	77 (23.5)
Conglomeratic sandstone, medium to fine, pale reddish brown (10R5/4) to moderate brown (5YR4/4), weathers pale brown (5YR5/2), rounded pebbles of quartzite, chert, shale, 9 cm maximum diameter.	5 (1.5)	82 (25.0)
Siltstone to sandstone, very fine, moderate yellowish brown (10YR5/4) to light brown (5YR6/4), weathers light olive gray (5Y5/2), massive, slightly friable; changes laterally into conglomeratic siltstone to sandstone, rounded quartzite pebbles, 3 cm maximum diameter.	6 (1.8)	88 (26.8)

Disconformity

Martinsburg Formation: 234+ ft (71.3+ m).

Upper sandstone member: 234+ ft (71.3+ m). Sandstone is litharenite. (Cub Sandstone of Thornton, 1953).		
Covered.	22 (6.7)	110 (33.5)
Siltstone to sandstone, very fine, moderate yellowish brown (10YR5/4), weathers light olive gray (5Y5/2), friable, crumbly, very poorly exposed.	6 (1.8)	116 (35.4)
Siltstone and sandstone. Siltstone, olive gray (5Y4/1), weathers moderate yellowish brown (10YR5/4); sandstone, very fine, olive gray, weathers moderate yellowish brown, some limonitic specks, interval is mostly covered.	200 (61.0)	316 (96.3)
Siltstone, same as above, but fossiliferous, Ambonychia (?)	1 (0.3)	317 (96.6)
Siltstone, same as above, but unfossiliferous.	5 (1.5)	322 (98.1)

Lower beds are not exposed.

LOCALITY 7 - FETZER GAP

Section measured in drainage ditch along State Road 600 on southeast slope of Little North Mountain, approximately 5.0 miles north of Woodstock, Va.; Shenandoah County, Va.; Woodstock, Va.,-W.Va. 7.5-minute quadrangle (NE); 38°57.8' N, 78°30.6'W. Section is steeply dipping to overturned, and is very poorly exposed.

	thickness ft (m)	total ft (m)
Tuscarora Sandstone: 341 ft. (103.9 m). Sandstone is quartzarenite.		
Mostly covered, scattered outcrops of sandstone, very fine, very light gray (N7), weathers light brown (5YR5/6).	114 (34.7)	114 (34.7)
Sandstone, fine to very fine, light olive gray (5Y6/1) to dark reddish brown (5YR5/6).	157 (47.9)	271 (82.6)
Covered.	10 (3.0)	281 (85.6)
Sandstone, medium to fine, yellowish gray (5Y8/1), weathered dark yellowish orange (10YR6/6), occasionally conglomeratic, rounded quartz pebbles, 2 cm maximum diameter.	60 (18.3)	341 (103.9)
Juniata Formation: 122 ft (37.2 m). Sandstone is quartzarenite to sublitharenite.		
Covered.	27 (8.2)	368 (112.2)
Sandstone, fine to very fine, pale red (5R6/2) to pale yellowish orange (10YR8/6), interbedded dark reddish brown (10R3/4) mudstone.	95 (29.0)	463 (141.1)
Oswego Sandstone: 219 ft (66.8 m). Sandstone is quartzarenite to sublitharenite.		
Sandstone, fine to very fine, light gray (N7) to pale red (10R6/2), weathered dark yellowish orange (10YR6/6), medium to very thinly bedded, occasionally conglomeratic, quartz, chert and siltstone pebbles, 4 cm maximum diameter.	133 (40.5)	596 (181.7)
Covered.	25 (7.6)	621 (189.3)
Sandstone, very fine, to siltstone, grayish orange (10YR7/4), limonitic specks, medium to very thinly bedded, interbedded grayish yellow green (5GY7/2) to grayish orange mudstone.	61 (18.6)	682 (207.9)
Reedsville Formation: 67 ft (20.4 m)		
Covered.	10 (3.0)	692 (210.9)
Siltstone to very fine sandstone, weathered dark yellowish orange (10YR6/6) to light olive gray (5Y5/2) to light brown (5YR5/6), occasionally fossiliferous, especially in lower horizons, crinoids, Cryptolithus, Rafinesquina.	57 (17.4)	749 (228.3)

Lower beds not measured.

LOCALITY 8 - BROCKS GAP

Section measured along State Highway 259 at Little North Mountain, between Chimney Rock and Gap Rock, on north side of the North Fork Shenandoah River, approximately 0.6 mile northwest of Cootes Stores, Va.; Rockingham County, Va.; Timberville, Va. 7.5-minute quadrangle (SW); 38°38.6'N, 78°51.8'W (Butts, 1940, p. 219-220; Woodward, 1951, p. 380; Woodward 1955, p. 8; Brent, 1960, p. 72-73; Hall, 1969, p. 40-41; Rader and Perry, 1976b, p. 37-45; Roberts and Kite, 1978b, p. 39-40). Section is overturned.

	thickness ft (m)	total ft (m)
Tuscarora Sandstone: 58.5 ft (17.8 m). Sandstone is litharenite to quartzarenite.		
Sandstone, fine to coarse, feldspathic, medium dark gray (N4) to greenish gray (5GY6/1), weathers olive black (5Y2/1) to moderate brown (5YR4/4), thickly to thinly bedded, limonitic specks, rare shaly partings, occasional layers with olive gray (5Y4/1) clay balls or shale pebbles, 2 cm maximum diameter.	44 (13.4)	44 (13.4)
Sandstone, medium to fine, medium gray (N5) to medium dark gray (N4), weathered brownish gray (5YR4/1) to light olive gray (5Y6/1), very thickly to thinly bedded, shale partings, cross-bedded, elongate shale pebbles, 6 cm maximum length.	14.5 (4.4)	58.5 (17.8)
Juniata Formation: 71.5 ft (21.4 m). Sandstone is litharenite to sublitharenite, unless otherwise specified.		
Sandstone, coarse to fine, medium dark gray (N4) to grayish red (5R4/2), weathered light brown (5YR5/6), thickly to very thickly bedded, shale partings, redder where adjacent to shale partings, partings seem to be accumulations of grayish red shale pebbles or clay balls.	19.5 (5.9)	78 (23.8)
Sandstone, coarse to fine, medium gray (N5) to light brownish gray (5YR6/1), medium to thickly bedded, planar cross-beds, heavy mineral layers.	3.4 (1.0)	81.4 (24.8)
Sandstone, medium to fine, grayish red (5R4/2) to brownish gray (5YR4/1), weathered brownish gray (5YR3/2); interbedded silt-shale, grayish red, platy to chippy.	0.6 (0.2)	82.0 (25.0)
Sandstone (quartzarenite), medium to fine, medium gray (N5) to light brownish gray (5YR6/1), weathered olive gray (5Y4/1) to yellowish gray (5Y8/1), medium to thickly bedded, planar cross-beds, heavy mineral layers.	7 (2.1)	89 (27.1)
Sandstone, medium to fine, grayish red (5R4/1) to brownish gray (5YR4/1), weathered brownish gray (5YR3/2), medium bedded; interbedded siltshale, grayish red (5R4/2), platy to chippy.	2 (0.6)	91 (27.7)
Sandstone, medium to fine, medium gray (N5) weathered olive gray (5Y4/1) to moderate brown (5YR4/4), medium bedded.	2.5 (0.8)	93.5 (28.5)
Sandstone, fine, medium dark gray (N4) to light brownish gray (5YR6/1), weathered light brown (5YR5/6), massive, redder	2.5 (0.8)	96 (29.3)

at top just below grayish red (5R4/2) silt-shale parting.		
Sandstone, fine to very fine, grayish red (5R4/2) to brownish gray (5YR4/1), weathered brownish gray (5YR3/2), massive, grayish red elongate shale chips, 4 cm maximum length; interbedded grayish red silt-shale.	4 (1.2)	100 (30.5)
Sandstone, medium to fine, medium dark gray (N4) to light brownish gray (5YR6/1), weathered light brown (5YR5/6), massive, grayish red shale chips at top, 4 cm maximum length.	7.5 (2.3)	107.5 (32.8)
Sandstone, fine to very fine, grayish red (5R4/2) to brownish gray (5YR4/1), weathered brownish gray (5YR3/2), massive; interbedded silt-shale, grayish red.	3.5 (1.1)	111 (33.8)
Sandstone, medium to fine, medium dark gray (N4) to light brownish gray (5YR6/1), weathered light brown (5YR5/6), massive, conglomeratic in places, rounded elongate clasts, 2 cm maximum length.	7 (2.1)	118 (36.0)
Sandstone, fine to very fine, grayish red (5R4/2) to brownish gray (5RY4/1), weathered grayish brown (5YR3/2), argillaceous, massive, grayish red shale chips, 7 cm maximum length.	11 (3.4)	129 (39.3)
Silt-shale to very fine sandstone, grayish red (5R4/2), platy to chippy.	1 (0.3)	130 (39.6)
Oswego Sandstone: 400 ft (121.9 m). Sandstone is litharenite to sub-litharenite. The conglomerates consist of light and dark gray chert pebbles, quartz pebbles, and volcanic rock fragments.		
Sandstone, fine to very fine, medium dark gray (N4), weathered grayish brown (5YR3/2) to lt brown (5YR5/6), massive, planar cross-beds, conglomeratic throughout, 2 cm maximum clast size.	12 (3.7)	142 (43.3)
Sandstone, fine to very fine, pale brown (5YR5/2) to grayish red (5R4/2), weathered brownish gray (5YR4/1), massive, grayish red shale chips, 10 cm maximum length.	3 (0.9)	145 (44.2)
Sandstone, fine to very fine, dark gray (N3) to light brownish gray (5YR6/1), weathered light olive gray (5Y6/1), massive, planar cross-beds, heavy mineral layers, locally conglomeratic, 2 cm maximum clast size.	6 (1.8)	151 (46.0)
Sandstone, medium to fine, dark gray (N3) to medium gray (N5), weathered brownish gray (5YR4/1), massive, cross-bedded, heavy mineral layers, locally conglomeratic, 1 cm maximum clast size, upper 0.3 m grades into grayish red (5R4/2) sandstone.	16 (4.9)	167 (50.9)
Sandstone, medium to coarse, pale brown (5YR5/2) to grayish red (5R4/2), weathered brownish gray (5YR4/1), massive, locally conglomeratic, 2 cm maximum clast size.	8 (2.4)	175 (53.3)
Sandstone, coarse to fine, dark greenish gray (5GY4/1) to medium gray (N5), weathered medium dark gray (N4) to light brown (5YR5/6), massive, cross-bedded, conglomeratic throughout, 4 cm maximum clast size.	42 (12.8)	217 (66.1)
Sandstone, coarse to fine, feldspathic, dark greenish gray (5GY4/1) to medium gray (N5), weathered medium dark gray (N4) to light brown (5YR 5/6), medium to thick bedded, cross-bedded, locally with heavy mineral layers, channeling, and trough cross-beds, pinch-and-swell bedding, conglomeratic throughout, 4 cm maximum clast size, rare interbeds of medium to fine, light olive gray (5Y6/1) quartzarenite.	108 (32.9)	325 (99.1)
Interbedded sandstone and silt-shale. Sandstone, medium to fine, medium gray (N5) to greenish gray (5GY6/1), weathers brownish gray (5YR4/1) to light brown (5YR5/6), medium to thinly bedded, planar cross-beds, slightly undulatory bedding; silt-shale, greenish gray (5GY6/1), medium to very thinly bedded, chippy to platy; ripple marks.	17 (5.2)	342 (104.2)
Sandstone, fine to very fine, medium dark gray (N4) to olive gray (5Y4/1), weathers light olive gray (5Y6/1) to light brown (5YR5/6), thickly bedded, shale partings, bedding plane trails.	28 (8.5)	370 (112.8)
Interbedded sandstone and silt-shale. Sandstone, very fine, feldspathic, dark gray (N3), weathers olive gray (5Y4/1) to light brown (5YR5/6), medium bedded; silt-shale, light olive gray (5Y6/1), chippy to platy; bedding plane trails.	7 (2.1)	377 (114.9)
Sandstone, very fine, feldspathic, dark greenish gray (5GY4/1) to dark gray (N3), weathers olive gray (5Y4/1) to light brown (5YR5/6), thinly to very thinly bedded, calcareous, bedding plane trails at base.	50 (15.2)	427 (130.1)
Reverse fault. Movement estimated to be 50 ft. Approximately 25 ft. of this interval is included in description, leaving approximately 25 ft. of section that is inaccessable and not described.	25 (7.6)	452 (137.8)
Sandstone, very fine to siltstone, dark gray (N3), weathers brownish black (5YR2/1) to olive gray (5Y4/1), thickly to very thickly bedded.	28 (8.5)	480 (146.3)
Siltstone to very fine sandstone, medium dark gray (N4) to dark gray (N3), weathered dusky brown (5YR2/2) to moderate brown (5YR4/4), thinly to thickly bedded; interbedded silt-shale to clay-shale, dark gray (N3), weathers light olive gray (5Y6/1), partings to thickly bedded, chippy to platy.	15 (4.6)	495 (150.9)
Siltstone to very fine sandstone with interbedded silt-shale to clay-shale, same as above, but siltstone is calcareous, sparsely fossiliferous, Lingula, gastropods, fossiliferous zones weathered to dark yellowish orange (10YR6/6).	35 (10.7)	530 (161.5)
Reedsville Formation: 62+ ft. (18.9+ m)		
Interbedded clay-shale and silt-shale. Clay-shale, dark gray (N3), weathers medium dark gray (N4) to light olive gray (5Y6/1), fossiliferous; silt-shale, medium dark gray, weathered olive gray (5Y4/1), slightly calcareous, occasionally fossiliferous, fossiliferous zones weathered dark yellowish orange (10YR6/6).	21.5 (6.6)	551.5 (168.1)
Limestone (sparrite), medium to coarsely crystalline, dark gray (N3), weathered pale brown (5R5/2) to light brown (5YR5/6), interbedded dark gray clay-shale.	1.5 (0.5)	553 (168.6)
Interbedded clay-shale and silt-shale. Clay-shale, dark gray (N3), weathered medium dark gray (N4) to light olive gray (5Y6/1), fossiliferous, slightly calcareous; silt-shale, medium dark gray, weathered light olive gray (5Y4/1), thinly to very thinly bedded, chippy to lath-shaped, occasionally fossiliferous, slightly calcareous, fossiliferous zones weathered dark yellowish orange (10YR6/6), fossil hash in places.	2 (0.6)	555 (169.2)
Interbedded clay-shale and silt-shale, same as above, but clay-shale is non-calcareous, and silt-shale is apparently unfossiliferous.	11 (3.4)	566 (172.5)
Limestone (biosparrudite), medium to coarsely crystalline, dark gray (N3), weathered pale brown (5R5/2) to light brown (5YR5/6), crinoidal, fossils weathered in relief.	1 (0.3)	567 (172.8)
Interbedded clay-shale and silt-shale. Clay-shale, dark gray (N3), weathered medium dark gray (N4) to light olive gray (5Y6/1), fossiliferous; silt-shale, medium dark gray, weathered olive gray (5Y4/1), thinly to very thinly bedded, chippy to lath-shaped, slightly calcareous.	25 (7.6)	592 (180.4)
Lower beds not measured.		

LOCALITY 9 - COOPER MOUNTAIN

Section measured along State Road 732 at south end of Cooper Mountain, along Dry River, approximately 3.4 miles north-northeast of Ottobine, Va.; Rockingham County, Va.; Briery Branch, Va. 7.5-minute quadrangle (NE); 38°28.9'N, 79°01.6'W (Brent, 1960, p. 71; Roberts & Kite, 1978b, p. 38). Section is nearly vertical, slightly overturned. George Mattingly assisted in the description of the Reedsville Formation.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 36+ ft. (11.0+ m) top is covered. Brent reports a fault at top of exposed Tuscarora.		
Sandstone (quartzarenite), coarse to fine, very light gray (N8), occasionally medium gray (N5) and rarely dark gray (N3), weathered olive gray (5Y4/1) to pale yellowish brown (10YR6/2), medium to thickly bedded, massive appearance, planar cross-beds.	36 (11.0)	36 (11.0)
Oswego Sandstone: 553 ft. (168.5 m). Upper 8.8 m seem to be transitional to Tuscarora. Sandstone is sublitharenite to litharenite at base, and grades upward to quartzarenite.		
Sandstone, fine to siltstone, light olive gray (5Y5/2), to dusky yellow (5Y6/4), weathered olive gray (5Y4/1) to light olive gray, thinly to thickly bedded, obscure planar cross-beds, shale chips, often brecciated (as if broken by slippage).	29 (8.8)	65 (19.8)
Covered.	45 (13.7)	110 (33.5)
Sandstone, medium to very fine, medium dark gray (N4) to light brownish gray (5YR6/1), weathered light olive gray (5Y6/1) to olive gray (5Y4/1), thinly to thickly bedded, planar cross-beds, locally conglomeratic with shale chips, rarely grades into silt-shale.	91 (27.7)	201 (61.3)
Sandstone, very fine, olive gray (5Y4/1), weathered brownish gray (5YR4/1), thinly bedded, interbedded olive gray (5Y4/1) shale.	1 (0.3)	202 (61.6)
Sandstone, medium to fine, medium gray (N5) to olive gray (5Y4/1), weathered light olive gray (5Y6/1) to light brown (5YR6/4), medium to thinly bedded, obscure planar cross-beds, locally conglomeratic with shale chips, very rare shaly partings.	57 (17.4)	259 (78.9)
Covered.	8 (2.4)	267 (81.4)
Sandstone, medium to fine, dark gray (N3) to light brownish gray (5YR6/1), weathered moderate brown (5YR4/4) and light olive gray (5Y6/1), thinly to thickly bedded, massive appearance, planar cross-beds, locally conglomeratic with shale chips.	81 (24.7)	348 (106.1)
Sandstone, coarse to very fine, gray (N3) to light brownish gray (5YR6/1) weathered light olive gray (5Y6/1), thinly to thickly bedded, massive appearance, planar cross-beds, locally conglomeratic (mostly shale chips), channeling near top of interval, high heavy mineral content.	48 (14.6)	396 (120.7)
Covered.	6 (1.8)	402 (122.5)
Sandstone, medium to fine, medium dark gray (N4) to light brownish gray (5YR6/1), weathered light olive gray (5Y6/1) to light brown (5YR6/4), planar cross-beds, locally conglomeratic with shale chips, limonitic specks.	115.5 (35.2)	517.5 (157.7)
Sandstone, fine to very fine, feldspathic, dark gray (N3) to olive gray (5Y4/1), weathered light olive gray (5Y6/1) to light brown (5YR6/4), thinly to thickly bedded, planar cross-beds, rarely conglomeratic with shale chips.	29.5 (9.0)	547 (166.7)
Covered.	5 (1.5)	552 (168.2)
Sandstone, fine to very fine, dark gray (N3), weathers greenish gray (5GY6/1) to light olive gray (5Y6/1), medium bedded.	7 (2.1)	559 (170.4)
Sandstone, fine to very fine, dark gray (N3), weathers greenish gray (5GY6/1) to light olive gray (5Y6/1), medium bedded, limonitic specks, interbedded silt-shale (interval is mostly covered).	30 (9.1)	589 (179.6)
Reedsville Formation: 70+ ft. (21.3+ m)		
Interbedded sandstone, siltstone and shale. Sandstone, very fine, medium gray (N5), limonitic specks, shale pebbles; siltstone, olive gray (5Y4/1), fossiliferous; silt-shale, olive gray, fossiliferous; Orthorhynchula, crinoids.	5 (1.5)	594 (181.1)
Interbedded sandstone and siltstone. Sandstone, fine to very fine, medium gray (N5), limonitic specks; siltstone, olive gray (5Y4/1), Orthorhynchula, Ischyrodonta, Ambonychia, Bucania, Lingula (near top).	13 (4.0)	607 (185.1)
Siltstone, light olive gray (5Y6/1), abundant Orthorhynchula.	6 (1.8)	613 (186.9)
Sandstone, very fine, medium dark gray (N4), limonitic specks, occasional fossiliferous lenses, Orthorhynchula, Loxoplocus (?).	46 (14.0)	659 (191.2)
Lower beds not measured.		

LOCALITY 10 - GREAT NORTH MOUNTAIN/ROUTE 691

Section measured along State Road 691 at Great North Mountain, just east of Tibbet Knob trail, between Tibbet Knob and Middle Mountain, approximately 1.9 miles southwest of Wolf Gap, Va.; Shenandoah County, Va. and Hardy County, W.Va.; Wolf Gap, W.Va.-Va. 7.5-minute quadrangle (SW); 38°54.4'N, 78°42.8'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 111+ ft. (33.8+ m). Top not exposed. Sandstone is quartzarenite.		
Sandstone, fine to very fine, very light gray (N8), weathers grayish orange (10YR7/4), upper 5.5 m mostly covered.	21 (6.4)	21 (6.4)
Covered.	11 (3.4)	32 (9.8)
Sandstone, very fine, very light gray (N8) to grayish orange (10YR7/4), medium to thickly bedded, locally somewhat friable.	8 (2.4)	40 (12.2)
Conglomeratic sandstone, very light gray (N8), weathers grayish orange (10YR7/4), medium to thickly bedded, cross-bedded, rounded to subrounded quartz pebbles, 2 cm maximum diameter, less conglomeratic upward.	30 (9.1)	70 (21.3)
Sandstone, and conglomerate in alternating beds. Sandstone, medium to fine, very light gray (N8), locally stained grayish orangeish pink (5YR7/2), weathers grayish orange (10YR7/4), thinly to thickly bedded; quartz pebble conglomerate, rounded to subrounded, 2 cm maximum diameter.	27 (8.2)	97 (29.6)
Sandstone, same as above, non-conglomeratic cross-bedded, bedding plane trails.	14 (4.3)	111 (33.8)
Juniata Formation: 264.5 ft. (80.6 m). Upper 8.5 m is transitional to Tuscarora. Sandstone is sublitharenite to litharenite, unless otherwise specified.		

Covered.	18 (5.5)	129 (39.3)
Sandstone (quartzarenite), fine to very fine, light olive gray (5Y6/1), weathers moderate red (5R4/6) to light brown (5YR6/4), medium to very thinly bedded, cross-bedded.	10 (3.0)	139 (42.4)
Interbedded shale and siltstone. Shale, grayish red (5R4/2), chippy; siltstone, light olive gray (5Y6/1).	1 (0.3)	140 (42.7)
Covered.	51 (15.5)	191 (58.2)
Mudstone to silt-shale, grayish red (5R4/2), crumbly to chippy, some mottling; occasional interbeds of sandstone, fine, light brown (5R6/4) to pale red (5R6/2).	125 (38.2)	316 (96.3)
Interbedded sandstone and mudstone. Sandstone, very fine, light brown (5R6/4) to pale red (5R6/2), weathers light brown (5YR5/6) and pale yellowish brown (10YR6/2), medium to thickly bedded; mudstone to silt-shale, grayish red (10R4/2), medium to thickly bedded, crumbly to chippy.	24.5 (7.5)	340.5 (103.8)
Sandstone, fine, pale brown (5YR5/2) to grayish red (5R4/2), weathers olive gray (5Y4/1), thickly to very thinly bedded; obscure cross-beds, clay balls; occasional thin mudstone interbeds.	11.5 (3.5)	352 (107.3)
Silt-shale, grayish red (5R4/2), chippy to platy.	2 (0.6)	354 (107.9)
Sandstone, fine, pale brown (5YR5/2) to grayish red (5R4/2), weathers olive gray (5Y4/1), thickly to very thinly bedded, obscure cross-beds, clay balls, bedding plane trails, herringbone cross-beds at base; rare thin interbeds of grayish red mudstone.	20.5 (6.2)	374.5 (114.1)
Mudstone, grayish red (5R4/2), crumbly.	1 (0.3)	375.5 (114.5)
Oswego Sandstone: 199.5+ ft. (60.9+ m). Sandstone is sublitharenite to litharenite.		
Sandstone, medium to fine, pale brown (5YR5/2) to grayish red (5R4/2), weathers olive gray (5Y4/1), thickly to very thinly bedded, obscure cross-beds, clay balls, some channeling near top.	22 (6.7)	397.5 (121.2)
Sandstone, medium to fine, pale brown (5YR5/2) to grayish red (5R4/2), thickly to very thinly bedded, planar and herringbone cross-beds; interbedded grayish red mudstone to argillaceous sandstone, crumbly, thinly bedded. Interval is apparently cyclically bedded.	16.5 (5.0)	414 (126.2)
Sandstone, medium to fine, pale brown (5YR5/2) to grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, clay balls, occasionally flaggy. Interval is apparently cyclically bedded, each cycle having clay balls at the base and is flaggy at the top.	44 (13.4)	458 (139.6)
Sandstone, medium to fine, pale brown (5YR5/2) to grayish red (5R4/2), medium to very thinly bedded, grayish red clay balls.	21 (6.3)	479 (146.0)
Sandstone, medium to fine, locally conglomeratic, pale brown (5YR5/2), weathers moderate brown (5YR3/4) to olive gray (5Y4/1), thickly to very thinly bedded, mud balls at top, mud ball voids at base.	21 (6.4)	500 (152.4)
Sandstone, fine, to mudstone, moderate brown (5YR3/4), crumbly, mostly covered.	2 (0.6)	502 (153.0)
Sandstone, medium to fine, rarely conglomeratic, moderate brown (5YR3/4), weathers olive gray (5Y4/1), medium bedded, mud ball voids.	3 (0.9)	505 (153.9)
Sandstone, medium to fine, argillaceous, to mudstone, rarely conglomeratic, moderate brown (5YR3/4) to pale brown (5YR5/2), weathers grayish brown (5YR3/2), thinly to very thinly bedded, 3 cm maximum pebble diameter.	4 (1.2)	509 (155.1)
Sandstone, medium to fine, conglomeratic, moderate brown (5YR3/4) to dark yellowish brown (10YR4/2), weathers grayish brown (5YR3/2), medium to thinly bedded, pebbles of quartz and red siltstone, 5 cm maximum diameter.	9 (2.7)	518 (157.9)
Sandstone, medium to fine, moderate brown (5YR4/4), weathers grayish brown (5YR3/2), thinly to very thinly bedded.	3.5 (1.1)	521.5 (159.0)
Sandstone, medium to fine, locally conglomeratic, moderate brown (5YR4/4), weathers olive gray (5Y4/1), thickly to very thinly bedded, siltstone and sandstone pebbles (intraformational), 5 cm maximum diameter.	33.5 (10.2)	555 (169.2)
Sandstone, medium to fine, moderate brown (5YR4/4), weathers olive gray (5Y4/1), thinly bedded.	1 (0.3)	556 (169.5)
Covered.	2 (0.6)	558 (170.1)
Conglomeratic sandstone, medium to coarse, moderate yellowish brown (10YR5/4) to light brown (5YR5/6), weathers pale brown (5YR5/2), thickly to very thinly bedded, pebbles of quartz and siltstone, 4 cm maximum diameter, pebble size increases upward. Lower beds not exposed. Base of exposure is assumed to be approximate base of Oswego Sandstone.	17 (5.2)	575 (175.3)

LOCALITY 11 - LONG MOUNTAIN/STATE ROAD 691

Section measured along State Road 691 on southeast slope of a knob called 'Devils', just east of Virginia-West Virginia state line, approximately 1.9 miles due south of Trout Pond and 2.6 miles west of Wolf Gap; Shenandoah County, Va.; Wolf Gap, W.Va.-Va. 7.5-minute quadrangle (WC); 38°55.6'N, 78°44.3'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 42+ ft. (12.8+ m). Lower 8.9 m is transitional to Juniata. Sandstone is quartzarenite.		
Conglomeratic sandstone, medium to coarse, very light gray (N8), weathers medium light gray (N6), medium bedded, planar cross-beds, slickensides on bedding surfaces.	13 (4.0)	13 (4.0)
Sandstone, coarse to fine, pale yellowish brown (10YR6/2), weathers light gray (N7), medium bedded, cross-bedded.	11 (3.4)	24 (7.3)
Covered.	16 (4.9)	40 (12.2)
Sandstone, medium to fine, very light gray (N8).	1 (0.3)	41 (12.5)
Sandstone, very fine, grayish orange (10YR4/4), Skolithos.	1 (0.3)	42 (12.8)
Juniata Formation: 151 ft. (46.0 m) basal contact uncertain.		
Mostly covered, grayish red (5R4/2) mudstone float.	3.5 (1.1)	45.5 (13.9)
Sandstone (quartzarenite), fine to very fine, pale red (5R6/2) to grayish red (5R4/2), thinly bedded in lower half, medium to thinly bedded in upper half,	29 (8.8)	74.5 (22.7)

cross-bedded, Skolithos, clay balls, occasional limonitic specks, somewhat argillaceous, channeling in lower portion, rare grayish red silt-shale interbeds.		
Mudstone overlying and channeled into sandstone (cycle ?). Mudstone, grayish red, crumbly, Skolithos; sandstone (quartzarenite to sublitharenite), fine to very fine, pale red (5R6/2) to grayish red (5R4/2), Skolithos at top of sandstone, somewhat argillaceous.	6.5 (2.0)	81 (24.7)
Mudstone overlying and channeled into sandstone. Mudstone, grayish red (5R4/2), crumbly, Skolithos, bedding plane trails at base; sandstone (quartzarenite to sublitharenite), fine to very fine, to mudstone, pale red (5R6/2) to grayish red (5R4/2), cross-bedded, channeling at base.	11.5 (3.5)	92.5 (28.2)
In the cycles below, the sandstone is quartzarenite to sublitharenite, fine to very fine, pale red (5R6/2) to grayish red (5R4/2); the mudstone is grayish red and crumbly. Most of the cycles have channels as basal contacts.		
Cycle. Lower 0.3m sandstone; grades upward into mottled mudstone; Skolithos.	3.5 (1.1)	96 (29.3)
Cycle. Lower 0.6 m sandstone with Skolithos; grades upward into mottled mudstone.	5 (1.5)	101 (30.8)
Cycle. Lower 0.2 m sandstone; grades upward into mudstone.	2.5 (0.8)	103.5 (31.5)
Cycle (?). Alternating beds of sandstone and mudstone; mudstone abundance increases upward.	6 (1.8)	109.5 (33.4)
Cycle. Lower 0.6 m sandstone with Skolithos, grades upward into mudstone.	2.5 (0.8)	112 (34.1)
Cycles (6?). Alternating beds of sandstone and mudstone, with Skolithos.	7 (2.1)	119 (36.3)
Cycle. Lower 0.6 m sandstone; grades upward into mudstone.	7 (2.1)	126 (38.4)
In the cycles below, the sandstone is quartzarenite to sublitharenite, medium to very fine, pale reddish brown (10R5/4) to grayish red (5R4/2); the mudstone is grayish red and crumbly.		
Cycle. Lower 0.5 m sandstone; grades upward into mudstone with Skolithos.	11 (3.4)	137 (41.8)
Cycle. Lower 0.9 m sandstone; grades upward into mudstone.	4 (1.2)	141 (43.0)
Cycle. Lower 0.5 m sandstone; grades upward into interbedded mudstone and sandstone.	3 (0.9)	144 (43.9)
Cycle. Lower 0.5 m sandstone; grades upward into interbedded mudstone and sandstone.	4 (1.2)	148 (45.1)
Cycle. Lower 0.6 m sandstone, cross-bedded, Skolithos; grades upward into 1.8 m mudstone with Skolithos; grades upward into mudstone with Skolithos and lenses of sandstone.	14.5 (4.4)	162.5 (49.5)
Cycle. Lower 0.9 m sandstone, cross-bedded; grades upward into mudstone with Skolithos.	11.5 (3.5)	174 (53.0)
Covered; grayish red (5R4/2) mudstone float.	5 (1.5)	179 (54.6)
Sandstone, medium to fine, grayish red (5R4/2) to pale red (5R6/2), cross-bedded, limonitic specks, interbedded grayish red mudstone.	9 (2.7)	188 (57.3)
Covered; grayish red chippy silt-shale float.	5 (1.5)	193 (58.8)
Oswego Sandstone: 243+ ft. (74.1+ m). The Oswego here is a sublitharenite.		
Sandstone, medium to very fine, grayish red (5R4/2) to pale red (5R6/2), very thinly to thickly bedded, planar, trough and herringbone cross-beds, linomitic specks, clay balls, Skolithos 13.0 m below top, Rusophycus 9.0 m below top.	124 (37.8)	317 (96.6)
Partially exposed sandstone, same as above, many covered intervals.	119 (36.3)	436 (132.9)
Lower beds not exposed.		

LOCALITY 12 - BLACK FOX HOLLOW

Section measured along West Virginia Highway 59 at Cove Mountain, approximately 1.8 miles southeast of Lost City, W.Va.; Hardy County, W.Va.; Lost City, W.Va.-Va. 7.5-minute quadrangle (C,SC); 38°55.2'N, 78°49.0'W. Section is overturned.

	thickness ft (m)	total ft (m)
Juniata Formation: 108+ ft (32.9+) top not exposed. Sandstone is sublitharenite.		
Sandstone, medium to fine, grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, clay balls, rare grayish red shaly partings.	11 (3.4)	11 (3.4)
Covered.	11 (3.4)	22 (6.7)
Sandstone, fine, grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, clay balls, rare grayish red shaly partings.	21 (6.4)	43 (13.1)
Sandstone, fine to very fine, grayish red (5R4/2), thickly to very thinly bedded, grayish red clay balls, planar and herringbone cross-beds, rare grayish red shaly partings, rare interbeds of grayish red mudstone, Skolithos at base, bedding plane trails, Rusophycus, bilobate trails.	41 (12.5)	84 (25.6)
Sandstone, fine to very fine, grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, locally somewhat argillaceous, clay balls, rare grayish red shaly partings.	16 (4.9)	100 (30.5)
Mudstone, grayish red (5R4/2), crumbly.	1 (0.3)	101 (30.8)
Sandstone, fine, grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, clay balls, rare grayish red shaly partings.	6 (1.8)	107 (32.6)
Mudstone, grayish red (5R4/2), crumbly.	1 (0.3)	108 (32.9)
Oswego Sandstone: 182+ ft (55.4+ m). Sandstone is litharenite to sublitharenite.		
Sandstone, medium to fine, occasionally very coarse, grayish red (5R4/2), thickly to very thinly bedded, planar cross-beds, clay balls, rare grayish red shaly partings.	84 (25.6)	192 (58.5)
Covered.	46 (14.0)	238 (72.5)
Sandstone, medium to fine, grayish red (5R4/2), weathered pale red (10R6/2); medium to thinly bedded, planar cross-beds.	52 (15.8)	290 (88.4)

LOCALITY 13 - HUNKERSON GAP

Section measured in stream bed of Capon Run through gap in Cove Mountain, approximately 2.8 miles west of Orkney Springs, Va.; Hardy County, W.Va.; Orkney Springs, Va.-W.Va. 7.5-minute quad (WC); 38°47.8'N, 78°51.8'W (Roberts & Kite, 1978b, p. 41-42). Section is overturned.

	thickness ft (m)	total ft (m)

Tuscarora Formation: 149 ft (45.5 m). Sandstone is quartzarenite.		
Sandstone, conglomeratic, maximum pebble diameter 2 cm, interval not measured in detail.	125 (38.1)	125 (38.1)
Sandstone, fine to very fine, light gray (N7), thickly to very thinly bedded, cross-bedded, conglomeratic at base (0.5 cm maximum pebble diameter) and locally throughout interval.	24 (7.3)	149 (45.4)
Juniata Formation: 744 ft (226.8 m). Upper 6.4 m is transitional to Tuscarora.		
Siltstone to sandstone (quartzarenite). Grades upward from siltstone, grayish red (5R4/2) to light olive gray (5Y6/1); to sandstone, very fine, medium light gray (N6), thinly to very thinly bedded, unevenly bedded.	21 (6.4)	170 (51.8)
Covered.	56 (17.1)	226 (68.9)
Interbedded sandstone and siltstone. Sandstone (litharenite), medium to fine, to bedded mudstone, grayish red (5R4/2) to pale red (5R6/2), medium to thinly bedded, coarser beds are paler and cross-bedded; siltstone, grayish red (5R4/2), bedded.	57 (17.4)	283 (86.3)
Covered.	230 (70.1)	513 (156.4)
Sandstone (sublitharenite), fine to very fine, grayish red (5R4/2), thickly to thinly bedded, cross-bedded, partly covered.	49 (14.9)	562 (171.3)
Sandstone (litharenite), medium to fine, to bedded mudstone, grayish red (5R4/2), limonitic specks in places, thickly to very thinly bedded, cross-bedded, grayish red clay-shale chips.	98 (29.9)	660 (201.2)
Covered.	233 (71.0)	893 (272.2)
Oswego Sandstone: 459 ft (140.0 m)		
Sandstone (litharenite), medium to fine, feldspathic, brownish gray (5YR4/1), medium to thinly bedded, cross-bedded, grayish red (10YR4/2) shale chips.	15 (4.6)	908 (276.8)
Sandstone (litharenite), medium to very coarse, feldspathic, olive gray (5Y4/1) to olive black (5Y2/1), very thinly to very thickly bedded, locally conglomeratic, quartz and black chert pebbles, subangular, quartz pebbles maximum diameter 1 cm, chert clasts are 2 cm maximum, limonitic specks.	64 (19.5)	972 (296.3)
Sandstone (quartzarenite), medium to fine, rarely coarse, light olive gray (5Y6/1) to olive gray (5Y4/1), thickly to very thinly bedded, cross-bedded.	72 (22.0)	1044 (318.3)
Sandstone (sublitharenite), very fine, to bedded siltstone, greenish gray (5GY6/1) to olive gray (5Y4/1), medium to very thinly bedded, cross-bedded, partially covered.	54 (16.5)	1098 (334.8)
Covered.	146 (44.5)	1244 (379.3)
Sandstone (litharenite to sublitharenite), very fine, to bedded siltstone, medium gray (N5), thickly to very thinly bedded, locally cross-bedded, occasional limonitic specks, rarely fossiliferous, rare Lingula in lower 10.7 m.	108 (32.9)	1352 (412.2)
Reedsville Formation: 53+ ft (16.2+ m)		
Siltstone, medium gray (N5), medium to very thinly bedded, occasional massive, shaly partings, slightly calcareous at base to non-calcareous upward. locally fossiliferous.	53 (16.2)	1405 (428.4)
Lower beds not measured.		

LOCALITY 14 - LONG RIDGE

Section measured along U. S. Highway 33 at north end of Long Ridge, between Franklin, W.Va. and Oak Flat, W. Va., approximately 3.3 miles northeast of Franklin; Pendleton County, W.Va.; Franklin, W.Va. 7.5-minute quadrangle (EC); 38°40.1'N, 79°16.2'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured, base not exposed. (Approximately 37 m was measured less than 0.6 mi. east of the outcrop along Route 33.)		
Juniata Formation: 172 ft (52.4 m), top not exposed, contact with overlying Tuscarora approximated from float. Basal contact uncertain. Sandstone is quartzarenite.		
Covered. (thickness approximate)	80 (24.4)	80 (24.4)
Interbedded sandstone and silt-shale. Sandstone, fine, light olive gray (5Y6/1) and gray red (10R4/2), weathered light brown (5YR5/6), medium to thinly bedded, planar cross-beds (60%); silt-shale, grayish red, medium to very thinly bedded, platy to chippy (40%).	18 (5.5)	98 (29.9)
Mudstone, grayish red (10R4/2), crumbly to chippy, bioturbate, Skolithos.	7 (2.1)	105 (32.0)
Sandstone, fine to very fine, light olive gray (5Y6/1), weathered light brown (5YR5/6), medium bedded, limonitic specks; interbedded shale, grayish red, thickly to very thinly bedded, chippy, shale abundance increases upward.	21 (6.4)	126 (38.4)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (10R4/2), chippy, Skolithos (80%); sandstone, very fine, grayish red, rarely light olive gray (5Y6/1), medium to thinly bedded, somewhat argillaceous (20%).	10.5 (3.2)	136.5 (41.6)
Sandstone, fine to very fine, light olive gray (5Y6/1), weathered light brown (5YR5/6), medium to thinly bedded.	1.5 (0.5)	138 (42.1)
Interbedded sandstone and silt-shale. Sandstone, fine, grayish red (10R4/2), thinly bedded, somewhat argillaceous; silt-shale to mudstone, grayish red, medium to very thinly bedded, chippy to crumbly.	9.5 (2.9)	147.5 (45.0)
Sandstone, fine, light olive gray (5Y6/1), weathered light brown (5YR5/6), medium to thinly bedded, limonitic specks.	6 (1.8)	153.5 (46.8)
Interbedded sandstone and silt-shale. Sandstone, fine, grayish red (10R4/2), weathered light brown (5YR5/6), medium to thinly bedded; silt-shale, grayish red, medium to thinly bedded, chippy.	6.5 (2.0)	160 (48.8)
Sandstone, fine, light olive gray (5Y6/1), weathered light brown (5YR5/6), cross-bedded, limonitic specks.	2 (0.6)	162 (49.4)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (10R4/2), chippy; sandstone, very fine, grayish red.	1 (0.3)	163 (49.7)
Sandstone, very fine, light olive gray (5Y6/1), weathered light brown (5YR5/6).	0.5 (0.1)	163.5 (49.8)
Interbedded sandstone, mudstone and siltstone. Sandstone, fine, grayish red (10R4/2), weathered light brown (5YR5/6), medium to thinly bedded; mudstone, grayish red, medium bedded, crumbly; silt-shale, grayish red, thinly bedded, chippy; Skolithos.	8.5 (2.6)	172 (52.4)
Oswego Sandstone: 100+ ft (30.5+ m)		
Sandstone, medium to fine, light olive gray (5Y6/1) to dark gray (N3), thickly to	46 (14.0)	218 (66.4)

	thickness ft (m)	total ft (m)
very thinly bedded, planar cross-beds, limonitic specks; interbedded silt-shale, olive gray (5Y4/1) to dusky yellow (5Y6/4), very thinly bedded, vertical burrows and bedding plane trails, black shale clasts.		
Sandstone, medium to fine, greenish gray (5GY6/1), weathered light olive gray (5Y6/1), thickly to very thinly bedded, obscure cross-beds, limonitic specks, rare patches of light brownish gray (5YR6/1), shale chips.	34 (10.4)	252 (76.8)
Sandstone, medium to fine, greenish gray (5GY6/1) to grayish red (10R4/2), weathered light brown (5YR6/4), medium to thinly bedded, limonitic specks, grayish red and greenish gray shale chips.	20 (6.1)	272 (82.9)
Lower beds not exposed.		

LOCALITY 15 - ROY GAP

Section measured in stream bed through Roy Gap between River Knobs and Seneca Rocks, approximately 5.6 miles east of Mouth of Seneca, W.Va.; Pendleton County, W.Va.; Upper Tract, W.Va. 7.5-minute quadrangle (WC); 38°50.0'N, 79°22.0'W. Section is nearly vertical.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 352 ft (107.4 m)		
Covered. sandstone float.	136 (41.5)	136 (41.5)
Sandstone (quartzarenite), fine to very coarse, light gray (N7) to medium light gray (N6), cross-bedded, conglomeratic, quartz pebbles, 1.5 cm maximum diameter; rare interbeds of very fine, medium gray (N5) sublitharenite.	216 (65.9)	352 (107.4)
Juniata Formation: 755 ft (230.1 m). Sandstone grades upward from litharenite to sublitharenite.		
Covered.	146 (44.5)	498 (151.9)
Sandstone, fine, to siltstone, bedded, grayish red (5R4/2) grading upward to grayish red and medium dark gray (N4), cross-bedded, rare carbonaceous (?) clasts.	75 (22.9)	573 (174.8)
Mostly covered, some ledges of gray and grayish red sandstone.	23 (7.0)	596 (181.8)
Covered.	16 (4.9)	612 (186.7)
Interbedded sandstone and silt-shale; sandstone, fine to very fine, light olive gray (5Y6/1) and grayish red (10R4/2); silt-shale, grayish red, platy.	130 (39.6)	742 (226.3)
Covered.	113 (34.4)	855 (260.7)
Sandstone and mudstone. Sandstone, fine to very fine, medium dark gray (N4) and grayish red (5R4/2), cross-bedded; mudstone, grayish red, bedded to crumbly, Skolithos.	66 (20.1)	921 (280.8)
Covered.	45 (13.7)	966 (294.5)
Sandstone, fine to very fine, dark gray (N3) and grayish red (5R4/2), rare black carbonaceous clasts.	67 (20.4)	1033 (314.9)
Covered.	74 (22.6)	1107 (337.5)
Oswego Sandstone: 148 ft (45.1 m). Sandstone is litharenite.		
Sandstone, fine to very fine, medium dark gray (N4) to brownish gray (5YR4/1), Skolithos at base.	42 (12.8)	1149 (350.3)
Sandstone, very fine, feldspathic, dark gray (N3).	106 (32.3)	1255 (382.6)
Reedsville Formation: 202+ ft (61.6+ m)		
Siltstone, dark gray (N3), fossiliferous, bedded to massive, Lingula, Orthorhynchula (?).	107 (32.6)	1362 (415.2)
Interbedded fossiliferous siltstone and fossiliferous limestone, Lingula, Ambonychia.	95 (29.0)	1457 (444.2)
Lower beds are not exposed.		

LOCALITY 16 - HARPER GAP

Section measured along road and in stream bed in Harper Gap through River Knobs, approximately 2.0 miles south of Mouth of Seneca, W.Va.; Pendleton County, W.Va.; Onego, W.Va. 7.5-minute quadrangle (EC); 38°48.3'N, 79°22.8'W. Section is overturned.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 113 ft (34.4 m)		
Sandstone (quartzarenite), cross-bedded, conglomeratic zone 1.5 m above base of interval.	113 (34.4)	113 (34.5)
Juniata Formation: 720 ft (219.5 m)		
Covered, thickness approximate.	200 (61.0)	313 (95.4)
Interbedded sandstone and silt-shale. Sandstone, medium gray (N5) to grayish red (5R4/2); silt-shale, grayish red.	70 (21.3)	383 (116.8)
Mostly covered. Exposures of grayish red (5R4/2) sandstone and silt-shale in stream. Amount of sandstone increases in upper and lower portions of interval, thickness approximate.	450 (137.2)	833 (254.0)
Oswego Sandstone: 71 ft (21.6 m)		
Sandstone (litharenite), fine to very fine, dark gray (N3), interbedded olive gray (5Y4/1) shale, bedding plane trails on shaly partings and at base.	71 (21.6)	904 (275.6)
Reedsville Formation: 10+ ft (3.0+ m)		
Siltstone, medium dark gray (N4), massive, fossiliferous, Lingula.	10 (3.0)	914 (278.7)
Lower beds not measured.		

LOCALITY 17 - NORTH FORK MOUNTAIN/U. S. HIGHWAY 33

Section measured along U. S. Highway 33 on both sides of crest of North Fork Mountain (Harmon Rocks), approximately 5.3 miles northwest of Franklin, W. Va.; Pendleton County, W. Va.; Circleville, W. Va. 7.5-minute quadrangle (NE, EC); 38°42.0' to 38°42.7'N, 79°24.0' to 79°24.5'W (Woodward, 1951, p. 359-360).

	thickness ft (m)	total ft (m)
Tuscarora Formation: 170 ft (51.8 m). Top of interval goes to cover, assumed to be top of Tuscarora. Sandstone is quartzarenite.		
Sandstone, medium to fine, very light gray (N8), weathers light brown (5YR5/6), thinly to thickly bedded, cross-bedded.	17.5 (5.3)	17.5 (5.3)
Sandstone with shale interbeds. Sandstone, same as above; shale, light gray (N7), very thinly bedded.	6.5 (2.0)	24 (7.3)
Sandstone with shale interbeds. Sandstone, medium to fine, very light gray, (N8), weathers dark yellowish orange (10YR6/6), medium to thickly bedded, Skolithos; silt-shale, light gray (N7), thinly bedded.	8 (2.4)	32 (9.8)

Sandstone, medium to fine, very light gray (N8), weathers dark yellowish orange (10YR6/6), thinly to very thinly bedded, cross-bedded.	5 (1.5)	37 (11.3)
Sandstone, same as above, but thickly bedded.	3 (0.9)	40 (12.2)
Covered.	12 (3.7)	52 (15.8)
Sandstone, medium to fine, very light gray (N8), weathers dark yellowish orange (10YR6/6), thickly bedded, cross-bedded.	11 (3.4)	63 (19.2)
Sandstone, medium to fine, very light gray (N8), medium to very thinly bedded, cross-bedded, interbedded dark gray (N3) shale, Arthrophycus	4 (1.2)	67 (20.4)
Sandstone, fine to very fine, white (N9), weathers yellowish gray (5Y7/2), thinly to thickly bedded.	19 (5.8)	86 (26.2)
Sandstone, very fine, very light gray (N8), weathers light olive gray (5Y6/1)	1 (0.3)	87 (26.5)
Sandstone, fine, very light gray (N8), weathers yellowish gray (5YR5/2), thickly bedded, red-stained vertical, diagonal and horizontal burrows.	10.5 (3.2)	97.5 (29.7)
Sandstone, medium to very coarse, very light gray (N8), weathers light olive gray (5Y6/1), massive, cross-bedded, friable (clayey ?) zones at base and top of interval and at 2.4 m above base, friable zone at top is dark yellowish orange (10YR6/6).	34.5 (10.5)	132 (40.2)
Sandstone, medium to very coarse, very light gray (N8), weathers light brown (5YR6/4), thinly to thickly bedded, cross-bedded.	29 (8.9)	161 (49.2)
Sandstone, very fine, moderate red (5R5/4), Skolithos.	1 (0.3)	162 (49.4)
Sandstone, fine to very fine, light olive gray (N8), weathers moderate brown (5YR4/4), thickly to thinly bedded.	8 (2.4)	170 (51.8)
Paraconformity		
Juniata Formation: 736 ft (224.4 m)		
Interbedded mudstone and sandstone. Mudstone, grayish red (5R4/2), crumbly, grades upward into chippy silt-shale; sandstone, fine to very fine, light olive gray (5Y6/1).	13 (4.0)	183 (55.8)
Interbedded sandstone and mudstone. Sandstone, very fine to siltstone, grayish red (5R4/2); mudstone, grayish red, crumbly.	15 (4.6)	198 (60.4)
In the cycles below, the sandstone is quartzarenite to sublitharenite, very fine to siltstone, grayish red (5R4/2); mudstone is grayish red and crumbly; silt-shale is grayish red and chippy.		
Cycle. Lower 1.5 m sandstone; grades upward into mudstone.	12 (3.7)	210 (64.0)
Cycle. Lower 1.2 m sandstone; grades upward into mudstone.	8 (2.4)	218 (66.4)
Cycle. Lower 0.3 m sandstone; grades upward into mudstone.	9 (2.7)	227 (69.2)
Cycle. Lower 0.3 m sandstone; grades upward into mudstone.	6 (1.8)	233 (71.0)
Cycle. Lower 0.4 m sandstone; grades upward into mudstone.	4 (1.2)	237 (72.2)
Cycle. Lower 0.3 m sandstone; grades upward into mudstone.	4 (1.2)	241 (73.5)
Cycle. Lower 1.8 m sandstone; grades upward into 1.5 m interbedded sandstone and mudstone; grades upward into mudstone.	11 (3.4)	252 (76.8)
Cycle. Lower 0.3 m sandstone; grades upward into mudstone.	5 (1.5)	257 (78.3)
Interbedded mudstone and sandstone. Mudstone to silt-shale, grayish red (5R4/2), crumbly to chippy; sandstone, very fine, grayish red, cross-bedded. Interval probably comprises 5 cycles.	13 (4.0)	270 (82.3)
Cycle. Lower 0.9 m interbedded sandstone and silt-shale; grades upward into silt-shale to mudstone.	9 (2.7)	279 (85.0)
Cycle. Lower 1.5 m sandstone; grades upward into mudstone.	13 (4.0)	292 (89.0)
Cycle. Lower 1.8 m sandstone; grades upward into 1.8 m interbedded sandstone and silt-shale; grades upward into mudstone.	17 (5.2)	309 (94.2)
Mudstone, grayish red (5R4/2), crumbly, (probably top of a cycle).	18 (5.5)	327 (99.7)
Covered.	43 (13.1)	370 (112.8)
Interbedded grayish red (5R4/2) silt-shale and mudstone.	9 (2.7)	379 (115.5)
Sandstone below grades upward from sublitharenite to quartzarenite.		
Interbedded silt-shale and sandstone. Siltshale, grayish red (5R4/2), chippy to crumbly, increases in abundance downward (60%); sandstone, fine, light olive gray (5Y4/1) to grayish red (5R4/2), cross-bedded, limonitic specks (40%).	32 (9.8)	411 (125.3)
Sandstone, fine, light olive gray (5Y5/2), cross-bedded, limonitic specks.	9 (2.7)	420 (128.0)
Interbedded sandstone and silt-shale. Sandstone, medium to fine, olive gray (5Y4/1), weathers light olive gray (5Y5/2), cross-bedded; silt-shale, light olive gray, chippy to platy.	14 (4.3)	434 (132.3)
Interbedded silt-shale and sandstone. Siltstone, grayish red (5R4/2), chippy (85%); sandstone, fine to very fine, grayish red (15%).	27 (8.2)	461 (140.5)
Interbedded sandstone and silt-shale. Sandstone, medium to fine, olive gray (5Y4/1), weathers light olive gray (5Y5/2); silt-shale, light olive gray, chippy to platy.	19 (5.8)	480 (146.3)
Sandstone, medium to fine, olive gray (5Y4/1), weathers light olive gray (5Y5/2), medium bedded, cross-bedded, clay balls.	7 (2.1)	487 (148.4)
Covered.	23 (7.0)	510 (155.4)
Sandstone, fine to very fine, medium dark gray (N4) to light olive gray (5Y6/1), weathers light olive gray (5Y5/2) to very pale orange (10YR8/2), cross-bedded, clay balls.	7 (2.1)	517 (157.6)
Covered.	14 (4.3)	531 (161.8)
Sandstone, fine, medium dark gray (N4) to olive gray (5Y4/1), thickly to very thinly bedded, cross-bedded, concealed intervals are probably shale interbeds.	25 (7.6)	556 (169.5)
Covered.	42 (12.8)	598 (182.3)
Sandstone, medium to very fine, grayish red (5R4/2), cross-bedded (80%); interbedded grayish red silt-shale to mudstone (20%).	37 (11.3)	635 (193.5)
In the cycles below, the sandstone is fine to very fine, grayish red (5R4/2) sublitharenite; mudstone is grayish red and crumbly; silt-shale is grayish red and chippy.		
Cycle. Lower 0.3 m cross-bedded sandstone; grades upward into 0.7 m sandstone with Skolithos; grades upward into mudstone to silt-shale.	7.5 (2.3)	642.5 (195.8)
Cycle. Lower 1.4 m cross-bedded sandstone with greenish gray (5GY6/1) splotches; grades upward into 0.7 m interbedded sandstone with Skolithos; grades upward into silt-shale.	7.5 (2.3)	650 (198.1)
Cycle. Lower 0.4 m sandstone; grades upward into 0.3 m sandstone with Skolithos; grades upward into mudstone.	5.5 (1.7)	655.5 (199.8)

Cycle. Lower 1.8 m cross-bedded sandstone with clay balls; grades upward into 0.6 m sandstone with Skolithos; grades upward into 0.3 m interbedded sandstone and mudstone; grades upward into mudstone.	12.5 (3.8)	668 (203.6)
Cycle (base of cycle not exposed). Lower 0.3 m sandstone; grades upward into mudstone.	8 (2.5)	676 (206.1)
Covered.	134 (40.8)	810 (246.9)
Sandstone, fine to very fine, grayish red (5R4/2).	17 (5.2)	827 (252.1)
In the cycles below, the sandstone is fine to very fine sublitharenite, occasionally feldspathic, grayish red (5R4/2), occasionally with limonitic specks and light olive gray (5Y6/1) splotches in basal portions of cycle; silt-shale is grayish red and chippy; mudstone is grayish red and crumbly. Bottoms of cycles are bioturbated.		
Cycle. Lower 0.3 m cross-bedded sandstone; grades upward into 0.7 m sandstone with Skolithos; grades upward into mudstone.	14 (4.3)	841 (256.3)
Cycle. Lower 0.6 m cross-bedded sandstone with limonitic specks; grades upward into 0.4 m sandstone with Skolithos; grades upward into mudstone.	7 (2.1)	848 (258.5)
Cycle. Lower 0.4 m cross-bedded sandstone; grades upward into 0.6 m sandstone with Skolithos; grades upward into mudstone.	9 (2.7)	857 (261.2)
Cycle. Lower 0.7 m cross-bedded sandstone with limonitic specks and clay balls; grades upward into 0.6 m sandstone with Skolithos; grades upward into mudstone.	10 (3.0)	867 (264.3)
Cycle. Lower 0.6 m interbedded sandstone and mudstone; grades upward into mudstone.	8.5 (2.6)	875.5 (266.9)
Cycle. Lower 0.2 m cross-bedded sandstone with clay balls; grades upward into 0.4 m sandstone with Skolithos; grades upward into mudstone to silt-shale.	5 (1.5)	880.5 (268.4)
Cycle. Lower 0.2 m sandstone with SKolithos; grades upward into mudstone.	5.5 (1.7)	886 (270.1)
Cycle. Lower 0.9 m cross-bedded sandstone with Skolithos; limonitic specks; grades upward into silt-shale to mudstone.	7 (2.1)	893 (272.2)
Cycle. Lower 0.9 m cross-bedded sandstone, greenish gray (5GY6/1) to light brownish gray (5YR6/1), Skolithos, limonitic specks; grades upward into mottled mudstone with Skolithos.	8.5 (2.6)	901.5 (274.8)
Silt-shale, grayish red (5R4/2) to greenish gray (5GY6/1).	1.5 (0.5)	903 (274.8)
Mudstone, grayish red (5R4/2), crumbly, mottled with greenish gray (5GY6/1).	3 (0.9)	906 (276.1)
Oswego Sandstone: 182 ft. (55.5 m). Sandstone is sublitharenite to quartzarenite. Juniata/Oswego contact is uncertain due to large covered interval near top of Oswego.		
Interbedded sandstone and mudstone. Sandstone, fine to very fine, olive gray (5Y4/1), weathers grayish brown (5YR3/2), medium bedded, cross-bedded, limonitic specks, Skolithos; mudstone, light olive gray (5Y5/2), weathers moderate brown (5YR3/4), crumbly, Skolithos; some channeling.	10 (3.0)	916 (179.2)
Covered.	110 (33.5)	1026 (312.7)
Sandstone, fine to very fine, light olive gray (5Y6/1), medium to thinly bedded, cross-bedded; interbedded silt-shale, grayish olive (10Y4/2), chippy; rarely fossiliferous.	30 (9.1)	1056 (321.9)
Siltstone, grayish olive (10Y4/2), weathers dusky brown (5YR2/2), massive, fossiliferous, Lingula.	6 (1.8)	1062 (323.7)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, light olive gray (5Y6/1), medium to thinly bedded, cross-bedded; silt-shale, grayish olive (10Y4/2), weathers dusky brown (5YR2/2), platy, fossiliferous, Lingula.	12 (3.7)	1074 (327.4)
Siltstone to very fine sandstone, olive gray (5Y4/1), weathers light olive gray (5Y5/2), massive, fossiliferous, Lingula throughout, Orthorhynchula and gastropods near center of interval.	10 (3.0)	1084 (330.4)
Sandstone, fine to very fine, olive gray (5Y4/1), weathers light olive gray (5Y6/1), medium to thinly bedded, cross-bedded, limonitic specks.	4 (1.2)	1088 (331.6)
Reedsville Formation: 46+ ft (14.0+ m)		
Mudstone to siltstone, medium gray (N5) to greenish gray (5GY6/1), crumbly at base to somewhat more consolidated at top, occasional calcareous layers that weather moderate brown (5YR4/4), fossiliferous, Lingula, very rare Orthorhynchula, phosphate nodules.	33 (10.1)	1121 (341.7)
Mudstone to siltstone, light olive gray (5Y5/2), weathers dark yellowish brown (10YR4/2), crumbly to occasionally massive, very calcareous, fossiliferous, Orthorhynchula, occasional sandy layers.	7 (2.1)	1128 (343.8)
Mudstone with interbedded sandstone. Mudstone, light olive gray (5Y5/2), weathers dark yellowish brown (5YR5/6), crumbly, fossiliferous, Ambonychia (?), Orthorhynchula, rare Planolites (?); sandstone (litharenite), very fine, dusky brown (5YR2/2) to dark yellowish orange (10YR6/6), weathers dark yellowish brown (10YR4/2), thinly bedded, micaceous.	6 (1.8)	1134 (345.6)
Lower beds not measured.		

LOCALITY 18 - HARDSCRABBLE

Section measured along State Road 644 on Lantz Mountain, approximately 0.7 mile southeast of Hardscrabble, Va. and just south of W.Va. state line; Highland County, Va.; Snowy Mountain, W.Va.-Va. 7.5-minute quadrangle (C); 38°33.3'N, 79°33.7'W. Section is overturned.

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured		
Sandstone, grayish red (5R4/2), hematitic; shale, olive gray (5Y4/1).	--	--
Tuscarora Sandstone: 108 ft (33.0 m). Sandstone is quartzarenite.		
Sandstone, fine to very fine, light gray (N7), massive.	11 (3.4)	11 (3.4)
Sandstone, fine to very fine, light gray (N7), medium to very thinly bedded, wavy bedded, black shaly partings.	17 (5.2)	28 (8.6)
Covered.	26 (7.9)	54 (16.5)
Sandstone, fine to coarse, light gray (N7), massive, locally friable.	54 (16.5)	108 (33.0)
Paraconformity		
Juniata Formation: 629 ft (191.7 m). Sandstone is litharenite to sublitharenite.		
Covered.	26 (7.9)	134 (40.9)
Sandstone and mudstone. Sandstone, very fine, grayish red (5R4/2); mudstone, grayish red (5R4/2), crumbly.	16 (4.9)	150 (45.8)
Mostly covered, some exposure of sandstone and mudstone, same as above.	252 (76.8)	402 (122.6)

Interbedded mudstone and sandstone. Mudstone, grayish red (5R4/2), crumbly; sandstone, fine, to siltstone, grayish red (5R4/2), thinly to very thinly bedded, light olive gray (5Y5/2) where not stained red, bedding plane trails.	32 (9.7)	434 (132.3)
Covered, some exposure of grayish red (5R4/2) crumbly mudstone	179 (54.6)	613 (186.9)
Mostly covered, some exposure of sandstone and crumbly mudstone, both grayish red (5R4/2).	65 (19.8)	678 (206.7)
Interbedded grayish red (5R4/2) mudstone, and light olive gray (5Y5/2) mudstone, both crumbly.	3 (0.9)	681 (207.6)
Interbedded sandstone and mudstone. Sandstone, very fine to siltstone, medium gray (N5), weathers light olive gray (5Y5/2), thinly bedded; mudstone, grayish red (5R4/2), crumbly.	16 (4.9)	697 (212.5)
Interbedded sandstone and shale. Sandstone, very fine, to siltstone, light olive gray (5Y5/2) to brownish gray (5YR4/1), to medium gray (N5), weathers light olive gray, medium to very thinly bedded, limonitic specks, occasionally cross-bedded silt-shale to clay-shale, light olive gray to brownish gray, platy to chippy.	40 (12.2)	737 (224.7)
Oswego Sandstone: 48 ft (14.6 m). Sandstone is litharenite, unless otherwise specified.		
Sandstone, fine to siltstone, feldspathic, olive gray (5Y4/1) to light olive gray (5Y6/1), medium to thinly bedded, occasional interbeds of olive gray shale.	33 (10.1)	770 (234.8)
Siltstone to silt-shale, brownish gray (5YR4/1), very thinly bedded, limonitic mottles (may be burrows).	4 (1.2)	774 (236.0)
Sandstone (sublitharenite), very fine to siltstone, olive gray (5Y4/1), medium to thinly bedded.	3 (0.9)	777 (236.9)
Interbedded siltstone and silt-shale, very thinly bedded and thinly laminated, respectively, both olive gray (5Y4/1)	4 (1.2)	781 (239.3)
Sandstone, very fine to siltstone, light olive gray (5Y6/1), weathers moderate olive brown (5Y4/4), medium to thinly bedded, evenly bedded.	4 (1.2)	785 (239.3)
Reesville Formation: 115+ ft (35.0+ m)		
Fossiliferous siltstone, olive gray (5Y4/1), weathers light olive gray (5Y4/2), to moderate yellowish brown (10YR5/4), poorly bedded to massive, abundant fossil molds, Lingula, Orthorhynchula, Tancrediopsis, Plectonotus? upper 11.5 m mostly covered.	84 (25.6)	869 (264.9)
Interbedded siltstone and shale. Siltstone, olive gray (5Y4/1), limonitic specks, weathers brownish gray (5YR4/1), thinly to very thinly bedded, poorly bedded, rarely fossiliferous; clay-shale to silt-shale, olive gray (5Y4/1), chippy to platy, rarely fossiliferous; occasional olive gray sandstone bed with limonitic specks.	31 (9.4)	900 (274.3)
Lower beds of Reedsville not measured.		

LOCALITY 19 - LANTZ MOUNTAIN/ROUTE 250

Section measured along U. S. Highway 250 just east of crest of Lantz Mountain, approximately 0.9 mile west-northwest of Hightown, Va.; Highland County, Va.; Hightown, Va. 7.5-minute quadrangle (EC); 38°26.0'N, 79°38.9'W (Butts, 1940, p. 223; Hall, 1969, p. 48-49). Section is steeply dipping to overturned. Oswego/Juniata contact is repeated along road; reported section is a composite at this general interval.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 158 ft (48.2 m). Sandstone is quartzarenite.		
Sandstone, fine to very fine, occasionally coarse to conglomeratic, very light gray (N8), occasionally stained moderate red (5R5/4), weathers dark yellowish orange (10YR6/6). Section is covered above this interval. Top of exposure is assumed top of Tuscarora.	73 (22.3)	73 (22.3)
Clay-shale, olive black (5Y2/1), chippy to platy.	4 (1.2)	77 (23.5)
Sandstone, fine to very fine, white (N9) to medium gray (N5), cross-bedded.	5 (1.5)	82 (25.0)
Covered.	14 (4.3)	96 (29.3)
Sandstone, fine to very fine, white (N9) to medium gray (N5), cross-bedded.	57 (17.4)	153 (46.6)
Sandstone, fine to very fine, very light gray (N8), cross-bedded, conglomeratic, rounded quartz pebbles, 2 cm maximum diameter.	5 (1.5)	158 (48.2)
Juniata Formation: 659 ft (200.8 m)		
Mostly covered. Scattered outcrops of grayish red (5R4/2) sandstone and mudstone.	565 (172.2)	723 (220.4)
Interbedded sandstone and mudstone. Sandstone, fine to very fine, grayish red (5R4/2); mudstone, grayish red.	70 (21.3)	793 (241.7)
Sandstone, fine to very fine, brownish gray (5YR4/1) to grayish red (10R4/2), laminated to thickly bedded, cross-bedded.	9 (2.7)	802 (244.4)
Covered.	15 (4.6)	817 (249.0)
Oswego Sandstone: 78 ft (23.8 m)		
Sandstone (sublitharenite), very fine to siltstone, olive gray (5Y4/1), weathers light olive gray (5Y6/1), thinly to thickly bedded, cross-bedded, some channeling; interbedded silt-shale, greenish gray (5GY6/1), chippy. Upper third of interval is partially covered.	78 (23.8)	895 (272.8)
Reedsville Formation: 128+ ft (39.0 m)		
Siltstone, olive gray (5Y4/1), weathers brownish gray (5YR4/1), medium to very thinly bedded, sparsely fossiliferous, interbedded silt-shale, rare sandstone interbeds in upper 1.5 m.	32 (9.8)	927 (282.5)
Siltstone, olive gray (5Y4/1), massive, fossiliferous, Lingula, Orthorhynchula, gastropods, phosphatic nodules, shale interbeds in lower 3 m.	53 (16.2)	980 (298.7)
Interbedded shale, siltstone and limestone. Shale, medium gray (N5), platy; siltstone, medium gray (N5), weathers brownish gray (5YR4/1), calcareous, medium to very thinly bedded; limestone, silty, medium gray, weathers light olive gray (5Y6/1), fossiliferous (shell hash), thinly bedded.	43 (13.1)	1023 (311.8)
Lower beds not measured.		

LOCALITY 20 - MONTEREY MOUNTAIN/U. S. HIGHWAY 250

Section measured along U. S. Highway 250 just west of crest of Monterey Mountain, approximately 1.5 miles northwest of Monterey, Va.; Highland County, Va.; Monterey, Va.-W. Va. 7.5-minute quadrangle (WC); 38°26.1'N, 79°35.8'W (Hall, 1969, p. 50-51).

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured.		
Juniata Formation: 733 ft (223.4 m). Upper sandstone beds are quartzarenite to sublitharenite.		
Covered.	190 (57.9)	190 (57.9)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (5R4/2), chippy (65%);	22 (6.7)	212 (64.6)

sandstone, very fine, grayish red, medium bedded (35%); sandstone abundance increases downward.		
Covered.	63 (19.2)	275 (83.8)
Sandstone, fine to very fine, grayish red (5R4/2) to pale red (10R6/2), rarely yellowish gray (5Y8/1), very thinly to thickly bedded, undulatory bedding, somewhat friable, clay balls, Skolithos, cross-beds, herringbone cross-beds at base; interbedded grayish red silt-shale, chippy to crumbly, thinly to thickly bedded.	69 (21.0)	344 (104.8)
Partly covered. Some exposure of sandstone, grayish red (5R4/2), cross-bedded.	28 (8.5)	372 (113.4)
Interbedded sandstone and silt-shale. Sandstone, very fine, pale red (10R6/2), thinly to thickly bedded, faint cross-beds; silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly.	6.5 (2.0)	378.5 (115.4)
Sandstone below is litharenite to sublitharenite.		
Cycle. Sandstone, very fine, grayish red (5R4/2) with light olive gray (5Y6/1) splotches, thinly to thickly bedded, cross-bedded, hints of vertical burrows with limonitic stains in burrows, faint channeling; grades upward into silt-shale to mudstone, grayish red, chippy to crumbly.	12.5 (3.8)	391 (119.2)
Cycle. Same as above, basal contact is a channel cut into lower interval.	13 (4.0)	404 (123.1)
Siltstone to mudstone, grayish red (5R4/2), well bedded to crumbly.	6 (1.8)	410 (125.0)
Covered.	37 (11.3)	447 (136.2)
Siltstone to mudstone, grayish red (5R4/2), well bedded to crumbly; 0.2 m interbed of very fine, grayish red sandstone.	4 (1.2)	451 (136.5)
Covered.	84 (25.6)	535 (163.1)
Cycle. Lower 1.2 m sandstone, very fine, grayish red (5R4/2), medium bedded, Skolithos; grades upward into mudstone, grayish red, crumbly.	13 (4.0)	548 (167.0)
Cycle. Lower 1.8 m sandstone, very fine, grayish red (5R4/2) to light olive gray (5Y6/1), weathers brownish gray (5YR4/1), medium to thickly bedded, cross-bedded near base, Skolithos near top; grades upward into mudstone, grayish red, crumbly.	35 (10.7)	583 (177.7)
Interbedded sandstone and mudstone. Possibly two, or maybe more cycles, same as above.	15 (4.6)	598 (182.3)
Cycle. Sandstone, very fine, grayish red (5R4/2) to light olive gray (5Y6/1), weathers brownish gray (5YR4/1), medium to thickly bedded; grades upward into mudstone, grayish red, crumbly to chippy.	4 (1.2)	602 (183.5)
Cycle. Sandstone, same as above, cross-bedded near base, Skolithos near top; grading upward into mudstone, same as above.	8 (2.4)	610 (185.9)
Silt-shale to mudstone, grayish red (5R4/2) with streaks of light olive gray (5Y5/2), chippy to crumbly.	17 (5.2)	627 (191.1)
Interbedded silt-shale and sandstone. Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly, very thinly to thickly bedded; sandstone, fine to very fine, pale brown (5YR5/2) to olive gray (5Y4/1), medium to thinly bedded, evenly bedded.	11 (3.4)	638 (194.5)
Silt-shale, grayish red (5R4/2), chippy.	3 (0.9)	641 (195.4)
Silt-shale to clay-shale, light olive gray (5Y5/2), chippy.	8 (2.4)	649 (197.8)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, dusky yellow (5Y6/4) to greenish gray (5GY6/1), weathers light brown (5YR5/6) to grayish brown (5YR3/2), thinly to thickly bedded, planar cross-beds, some channeling, somewhat flaggy (75%); silt-shale, light olive gray (5Y5/2), platy to chippy, medium to thinly bedded (25%); Rusophycus.	37 (11.3)	686 (209.1)
Covered.	47 (14.3)	733 (223.4)
Oswego Sandstone: 43 ft (13.1 m)		
Sandstone (litharenite to sublitharenite), fine to very fine, light olive gray (5Y6/1), weathers moderate brown (5YR4/4) to grayish brown (5YR3/2), thickly to very thinly bedded, evenly bedded, flaggy to somewhat crumbly, planar cross-beds; interbeds of silt-shale and clay-shale, light olive gray, especially in lower 3.5 m and upper 5.5 m; hints of bedding plane trace fossils on some shale beds; medium bed of grayish red (5R4/2) siltstone at 7.5 m below top of interval.	43 (13.1)	776 (236.5)
Reedsville Formation: 42+ ft (12.8+ m)		
Siltstone and interbedded sandstone. Siltstone, dark greenish gray (5G4/1), weathers olive gray (5Y4/1), medium to thinly bedded, massive to somewhat crumbly, slightly fossiliferous, Lingula; sandstone, very fine, olive gray to greenish gray (5GY6/1), weathers moderate brown (5YR4/4), thinly bedded, somewhat undulatory.	5 (1.5)	781 (238.0)
Siltstone, dark greenish gray (5G4/1), weathers olive gray (5Y4/1), very thinly to very thickly bedded, massive to slightly crumbly, fossiliferous, slightly calcareous, fossils seem to be concentrated in 5 cm thick zones of moderate brown (5YR4/4) crumbly siltstone as voids, Lingula, Orthorhynchula (?), gastropods.	37 (11.3)	818 (238.0)
Lower beds of Reedsville not measured.		

LOCALITY 21 - TRIMBLE

Section measured along State Road 606 at gap in Little Mountain, approximately 0.1 mile west of Trimble, Va.; Highland County, Va.; Monterey SE, Va. 7.5-minute quadrangle (WC); 38°18.3'N, 79°37.3'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured		
Sandstone (quartzarenite), light gray (N7) to very light gray (N8).	---	---
Juniata Formation: 447 ft (136.2 m)		
Covered, with sandstone boulders in upper 15 m.	409 (124.6)	409 (124.6)
Partially covered, with some exposed sandstone beds, (quartzarenite to sublitharenite), very fine, greenish gray (5GY6/1).	38 (11.6)	447 (136.2)
Oswego Sandstone: 27 ft (8.2 m). Sandstone is feldspathic sublitharenite.		
Sandstone, very fine, greenish gray (5GY6/1) to dark greenish gray (5GY4/1), weathers light brown (5YR5/6) to moderate brown (5YR3/4), very thinly to thickly bedded; grayish red (5R4/2) silt-shale bed at base.	7 (2.1)	454 (138.3)
Sandstone, same as above; interbedded silt-shale, greenish gray, occasionally fossiliferous.	12 (3.7)	466 (142.0)

	thickness ft (m)	total ft (m)
Siltstone, medium dark gray (N4), weathers brownish gray (5YR4/1), medium to very thinly bedded, fossiliferous, interbedded sandstone (same as above), silt-shale partings, Lingula.	8 (2.4)	474 (144.4)
Reedsville Formation: 23+ ft (7.0+ m)		
Siltstone, medium dark gray (N4), weathers brownish gray (5YR4/1), massive, calcareous, fossiliferous, Lingula, Orthorhynchula, some calcareous beds, black phosphatic nodules.	23 (7.0)	497 (151.4)

LOCALITY 22 - BUFFALO GAP

Section measured along Chesapeake and Ohio Railroad tracks parallel to State Highway 42, at gap in Little North Mountain, approximately 4.6 miles southwest of Churchville, Va.; Augusta County, Va.; Churchville, Va. 7.5-minute quadrangle (WC); 38°11.1'N, 79°14.3'W (Hall, 1969, p. 38-39). Section is overturned and occasionally offset slightly by faulting.

	thickness ft (m)	total ft (m)
Rose Hill Formation: 127+ ft (38.7+ m), top not measured.		
Interbedded hematitic sandstone and light olive gray silt-shale (not measured).	--	--
Covered.	127 (38.7)	127 (38.7)
Tuscarora Formation: 37 ft (11.3 m)		
Sandstone (quarzarenite), coarse to fine, light gray (N7) to very light gray (N8), rarely stained grayish red (5R4/2), thickly to very thinly bedded, some pinch and swell bedding, cross-bedded, somewhat massive, locally conglomeratic, quartz pebbles.	37 (11.3)	164 (50.0)
Juniata Formation: 74 ft (22.6 m). Upper 14.6 m transitional to Tuscarora. Sandstone is quartzarenite.		
Sandstone, coarse to fine, light gray (N7) to very light gray (N8), grades downward to light olive gray (5Y6/1) in lower 1.5 m, rarely stained grayish red (5R4/2), thickly to very thinly bedded, cross-bedded, somewhat massive, rare mud balls; rare interbeds of silt-shale, medium gray (N5), light olive gray (5Y6/1), pale red (5R6/2) and moderate yellowish brown (10YR5/4), partings to medium bedded, discontinuous laterally.	48 (14.6)	212 (64.6)
Sandstone (grades downward to sublitharenite), coarse to very fine, pinkish gray (5YR8/1) to light olive gray (5Y6/1), stained dark yellowish orange (10YR6/6), weathers dark yellowish brown (10YR4/2) to moderate brown (5YR4/4), medium to thickly bedded, evenly bedded, shaly partings, obscure bedding plane trails, interbeds of grayish red (5R4/2) and light olive gray (5Y6/1) silt-shale, medium to thinly bedded.	26 (7.9)	238 (72.6)
Oswego Sandstone: true thickness uncertain.		
Sandstone, coarse to fine, pinkish gray (5YR8/1) to light olive gray (5Y6/1), stained dark yellowish orange (10YR6/6), weathers dark yellowish brown (10YR4/2) to moderate brown (5YR4/4), medium to thickly bedded, evenly bedded, shaly partings, obscure bedding plane trails, Cruziana.	39 (11.9)	277 (84.5)
Covered, true stratigraphic thickness unreliable, possibly fault controlled.	85 (25.9)	362 (110.4)
Sandstone (litharenite), fine to very fine, olive gray (5Y4/1) to medium dark gray (N4), weathers light olive gray (5Y6/1) to grayish orange (10YR7/4), medium to very thinly bedded, slight undulatory bedding, mud balls, limonitic specks, interbedded light olive gray (5Y6/1) shale.	12 (3.7)	374 (114.0)
Lower beds not exposed.		

LOCALITY 23 - WARM SPRINGS

Section measured along State Highway 39 at gap in Little Mountain, approximately 0.3 mile west of town of Warm Springs, Va.; Bath County, Va.; Warm Springs, Va. 7.5-minute quadrangle (C); 38°02.9'N, 79°47.7'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 46+ ft (14.0+ m)		
Sandstone (quartzarenite), coarse to fine, very light gray (N8) to light pinkish gray (5YR8/1), weathers dark yellowish orange (10YR6/6), massive, cross-bedded, lower 3.0 m conglomeratic, rounded quartz pebbles, 1 cm maximum diameter.	46 (14.0)	46 (14.0)
Paraconformity		
Juniata Formation: 413 ft (125.9 m). Sandstone is sublitharenite.		
Cycle. Sandstone, fine to very fine, greenish gray (5GY6/1) to light brownish gray (5YR6/1), weathers light brown (5YR5/6), medium to very thinly bedded, slight pinch and swell bedding, limonitic specks, Skolithos; grades upward into mudstone, greenish gray, crumbly.	14 (4.3)	60 (18.3)
Cycle. Sandstone, fine to very fine, greenish gray (5GY6/1) to light brownish gray (5YR6/1), weathers light brown (5YR5/6), medium to very thinly bedded, slight pinch and swell bedding, limonitic specks, cross-bedded; grades upward into interbedded sandstone and chippy, greenish gray to grayish red (5R4/2) silt-shale.	15 (4.6)	75 (22.9)
In the following cycles, the sandstone is sublitharenite, fine to very fine, light bluish gray (5B7/1) to light olive gray (5Y6/1), often to grayish red (5R4/2), weathers moderate yellowish brown (10YR5/4), very thinly to thickly bedded, occasional pinch and swell, occasional grayish red clay balls; the silt-shale is grayish red and chippy; the mudstone is grayish red and crumbly. The sandstone with Skolithos is somewhat muddy.		
Cycle. Sandstone, cross-bedded; grading upward into sandstone with Skolithos: grading upward into mudstone.	15 (4.6)	90 (27.4)
Cycle. Cross-bedded sandstone; grading upward into interbedded sandstone and silt-shale; bedding plane trails.	7.5 (2.3)	97.5 (29.7)
Cycle. Sandstone with Skolithos; grading upward into mudstone.	3 (0.9)	100.5 (30.6)
Cycle. Sandstone with Skolithos; grading upward into mudstone; bedding plane trails.	3.5 (1.1)	104 (31.7)
Cycle. Cross-bedded sandstone; grading upward into sandstone with Skolithos; grading upward into silt-shale; bedding plane trails, Rusophycus, Dimorphichnus.	7.5 (2.3)	111.5 (34.0)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	1.5 (0.5)	113 (34.4)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	1 (0.3)	114 (34.7)
Cycle. Cross-bedded sandstone with trough cross-beds; grading upward into mudstone; bedding plane trails, tool marks at top.	8 (2.4)	122 (37.2)

Cycle. Cross-bedded sandstone; grading upward into mudstone; clay balls, bedding	10 (3.0)	132 (40.2)
Cycle. Cross-bedded sandstone; grading upward into sandstone with Skolithos; grading upward into interbedded sandstone and mudstone; bedding plane trails.	6 (1.8)	138 (42.1)
Cycle. Cross-bedded sandstone; grading upward into sandstone with Skolithos; grading upward into mudstone.	19 (5.8)	157 (47.9)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	2 (0.6)	159 (48.5)
Cycle. Massive sandstone with Skolithos; grading upward into mudstone.	5 (1.5)	164 (50.0)
Cycle. Cross-bedded sandstone; grading upward into mudstone; Rusophycus.	6 (1.8)	170 (51.8)
Cycle. Cross-bedded sandstone; grading upward into mudstone; bedding plane trails at base.	5 (1.5)	175 (53.3)
Cycle. Cross-bedded sandstone; grading upward into sandstone with Skolithos; grading upward into interbedded sandstone and mudstone; bedding plane trails at base.	5 (1.5)	180 (54.9)
Cycle. Cross-bedded sandstone; grading upward into mudstone; bedding plane trails at base.	13 (3.9)	193 (58.8)
Cycle. Cross-bedded sandstone; grading upward into interbedded sandstone and mudstone; clay balls.	5 (1.5)	198 (60.3)
In the following cycles, the sandstone is litharenite to sublitharenite, fine to very fine, somewhat feldspathic, grayish red (5R4/2), with greenish gray (5GY6/1) splotches, thinly to thickly bedded, pinch and swell bedding, some limonitic specks; the mudstone is grayish red and crumbly.		
Cycle. Lower 5.2 m cross-bedded sandstone; grading upward into 0.3 m of mudstone.	18 (5.5)	216 (65.8)
Cycle. Cross-bedded sandstone; grading upward into mudstone; bedding plane trails, clay balls.	14 (4.3)	230 (70.1)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	7 (2.1)	237 (72.2)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	5.5 (1.7)	242.5 (73.9)
Cycle. Cross-bedded sandstone; grading upward into mudstone.	10.5 (3.2)	253 (77.1)
Mudstone, grayish red (5R4/2), crumbly.	3 (0.9)	256 (78.0)
Covered.	203 (61.9)	459 (139.9)
Oswego Sandstone: 54 ft (16.5 m). Sandstone is sublitharenite.		
Sandstone. fine to very fine, feldspathic, medium gray (N5) to greenish gray (5GY6/1), occasionally with red tint, weathers light brown (5YR5/6), very thinly to thickly bedded, cross-bedded, occasional limonitic specks; interbedded silt-shale, greenish gray (5G6/1 to 5GY6/1), chippy.	10 (3.0)	469 (142.9)
Sandstone with interbedded silt-shale, same as above, but sandstone is not tinted red, rare herringbone cross-beds, bedding plane trails, Cruziana, clay balls.	33 (10.1)	502 (153.0)
Interbedded siltstone and sandstone. Siltstone to silt-shale, grayish red (5R4/2), very thinly to thickly bedded, thinner beds are chippy; sandstone, very fine, medium gray (N5) to grayish red (5R4/2), weathers light brown (5YR5/6), medium to very thinly bedded, evenly bedded, planar cross-beds, calcareous when not stained red, bedding plane trails.	11 (3.4)	513 (156.4)
Reedsville Formation: 103+ ft (31.4+ m)		
Sandstone, very fine to siltstone, grayish red (5R4/2), weathers grayish brown (5YR3/2), thinly to thickly bedded, massive, slightly fossiliferous, very rare Lingula, grayish red silt-shale partings, bedding plane trails, groove casts.	8 (2.4)	521 (158.8)
Sandstone, same as above, but without grayish red silt-shale partings.	3 (0.9)	524 (159.7)
Siltstone, grayish red (5R4/2), weathers grayish brown (5YR3/2), massive, thinly to thickly bedded, fossilferous, Lingula, bryozoa.	3 (0.9)	527 (160.6)
Siltstone, medium dark gray (N4) to grayish red (5R4/2), weathers moderate yellowish brown (10YR5/4) to brownish black (5YR2/1), massive, medium to thickly bedded, fossiliferous, Lingula, bryozoa, rare interbeds of grayish red silt-shale.	12 (3.7)	539 (164.3)
Siltstone, medium dark gray (N4), weathers moderate yellowish brown (10YR5/4) to brownish black (5YR2/1), medium to thickly bedded, massive, fossiliferous, Lingula.	12 (3.7)	551 (167.9)
Sandstone (sublitharenite), very fine, to mudstone, medium gray (N5), weathers light brown (5YR5/6), medium to thinly bedded, cross-bedded.	3 (0.9)	554 (168.9)
Siltstone, medium dark gray (N4), weathers moderate yellowish brown (10YR5/4) to brownish black (5YR2/1), massive, medium to thickly bedded, fossiliferous, non-calcareous to slightly calcareous, Lingula, Orthorhynchula, Ambonychia (?), bryozoa.	26 (7.9)	580 (176.8)
Interbedded siltstone, sandstone and shale. Siltstone, medium dark gray (N4), weathers dusky brown (5YR2/2), massive to crumbly, thinly to thickly bedded, fossiliferous; sandstone (litharenite), very fine, medium dark gray, weathers moderate brown (5YR3/4), medium to very thinly bedded, cross-bedded, limonitic specks, calcareous, Skolithos at top of interval, rare beds with pyritic fossils; clay-shale, olive gray (5Y4/1), chippy, thinly to very thinly bedded; Orthorhynchula (?), Ambonychia (?), bedding plane trails.	36 (11.0)	616 (187.7)
Lower beds not exposed.		

LOCALITY 24 - HOT SPRINGS

Section measured along State Road 615 and subsidiary road that joins State Road 615 from the northeast, at gap in Little Mountain, at northwest edge of the town of Hot Springs, Va.; Bath County, Va.; Warm Springs, Va. 7.5-minute quadrangle (SW); 38°00.1'N, 79°50.1'W. Section is near vertical.

	thickness ft (m)	total ft (m)
Covered. Probably Rose Hill Formation. Not measured.	---	---
Tuscarora Formation: 79 ft (24.1 m). Sandstone is quartzarenite.		
Sandstone, fine to coarse, light gray (N7) to dark gray (N3) to pale red (5R6/2), weathers grayish orange (10YR7/4) and grayish brown (5YR3/2), thinly to very thickly bedded, somewhat massive, some undulatory bedding, cross-bedded.	25 (7.6)	25 (7.6)
Sandstone with shale interbeds. Sandstone, medium to fine, light gray (N7) to dark gray (N3), thinly to very thinly bedded; silt-shale, medium gray (N5), partings to very thinly bedded.	4 (1.2)	29 (8.8)
Sandstone, fine to coarse, light gray (N7) to dark gray (N3), weathers grayish orange (10YR7/4) and grayish brown (5YR3/2), thinly to very thickly bedded, somewhat	14.5 (4.4)	43.5 (13.3)

massive, some undulatory bedding, cross-bedded.		
Sandstone with shale interbeds. Sandstone, medium to fine, light gray (N7) to dark gray (N3), thinly to very thinly bedded; shale, dark gray, thinly bedded.	1.5 (.5)	45 (13.7)
Sandstone, fine to coarse, light gray (N7) to dark gray (N3), weathers grayish orange (10YR7/4) and grayish brown (5YR3/2), thinly to very thickly bedded, somewhat massive, some undulatory bedding, cross-bedded.	28 (8.5)	73 (22.3)
Sandstone, same as above, but conglomeratic, quartz pebbles, 1 cm maximum diameter.	6 (1.8)	79 (24.1)
Juniata Formation: 339 ft (103.3 m). Sandstone is litharenite to sublitharenite.		
Partially covered. Occasional exposures of sandstone, fine, light olive gray (5Y6/1), medium to very thinly bedded; interbedded silt-shale, grayish red (10R4/2), chippy.	64 (19.5)	143 (43.6)
Interbedded sandstone and silt-shale to mudstone. Sandstone, medium to very fine, light olive gray (5Y5/2) to grayish orange (10YR7/4), stained grayish red (5R4/2) especially near the top, weathers dark yellowish brown (10YR4/2), thickly to thinly bedded, undulatory bedding, graded beds in thin-section; silt-shale to mudstone, grayish red and dusky yellow (5Y6/4), medium to very thinly bedded, chippy to crumbly; rare interbeds of medium dark gray (N4) clay-shale; cross-bedded, clay balls, rare Skolithos, rare bedding plane trails.	54 (16.5)	197 (60.1)
Covered. Grayish red sandstone and silt-shale float.	114 (34.7)	311 (94.8)
Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly, some dusky yellow (5Y6/4) splotches.	20 (6.1)	331 (100.9)
Sandstone, very fine, pale brown (5YR5/2), limonitic specks.	1 (0.3)	332 (101.2)
Covered.	44 (13.4)	376 (114.6)
Clay-shale, light olive gray (5Y5/2), chippy.	1 (0.3)	377 (114.9)
Sandstone, very fine, greenish gray (5GY6/1) to brownish gray (5YR4/1), medium to thickly bedded, interbeds of moderate yellowish brown (10YR5/4) silt-shale and light olive gray clay-shale.	36 (11.0)	413 (125.9)
Mudstone, moderate yellowish brown (10YR5/4), weathers pale brown (5R5/2), thickly bedded, crumbly; thin interbeds of sandstone, very fine, olive gray (5Y4/1).	5 (1.5)	418 (127.4)
Oswego Sandstone: 62 ft (18.8 m). Sandstone is litharenite.		
Sandstone, very fine, to siltstone, light olive gray (5Y5/2) to olive gray (5Y4/1), weathers light brown (5YR5/6), medium to thickly bedded, evenly bedded, cross-bedded, micaceous, clay balls in lower part, very fine, limonitic specks; occasional light olive gray shale beds.	53 (16.1)	471 (143.5)
Interbedded sandstone and silt-shale. Sandstone, very fine, to siltstone, dusky yellow (5Y6/4), weathers olive gray (5Y4/1) to light brown (5YR5/6), thinly to thickly bedded, fairly evenly bedded, micaceous; silt-shale, moderate yellowish brown (10YR5/4), medium bedded, chippy to lath-shaped, clay balls.	3 (0.9)	474 (144.4)
Sandstone to mudstone, light olive gray (5Y5/2) to grayish red (5R4/2), thinly to thickly bedded, crumbly; interbedded sandstone, very fine, greenish gray (5GY6/1), weathers light brown (5YR5/6), medium bedded; occasional grayish red shale partings.	6 (1.8)	480 (146.2)
Reedsville Formation: 37+ ft (11.4+ m)		
Siltstone, dusky yellow (5Y6/4), weathers light olive gray (5Y5/2) to olive gray (5Y3/2), very thinly to thickly bedded, massive.	5.5 (1.7)	485.5 (147.9)
Siltstone, grayish red (5R4/2).	0.5 (0.2)	486 (148.1)
Siltstone, dusky yellow (5Y6/4), weathers light olive gray (5Y5/2) to olive gray (5Y3/2), very thinly to thickly bedded, massive, fossiliferous, Lingula (bleached shells), Orthrhynchula, poorly exposed.	31 (9.5)	517 (157.6)
Lower beds of Reedsville not measured.		

LOCALITY 25 - MINNEHAHA SPRINGS

Section measured along W.Va. Highway 39 just west of junction with W.Va. Highway 28, at Brushy Mountain, on northeast side of Knapp Creek, approximately 0.4 mile northwest of town of Minnehaha Springs, W.Va.; Pocahontas County, W.Va.; Minnehaha Springs, W.V.-Va. 7.5-minute quadrangle (SW, WC); 38°10.0'N, 79°59.2'W (Price, 1929, p. 107).

	thickness ft (m)	total ft (m)
Rose Hill Formation: 36 ft (11.0 m)		
Sandstone, medium to fine, light brownish gray (10YR6/1) to pale red (5R6/2), weathers dark yellowish brown (10YR4/2) to dusky yellow (5Y6/4), thinly to very thinly bedded, shaly partings that weather very light gray (N8).	36 (11.0)	36 (11.0)
Tuscarora Formation: 134 ft (40.8). Sandstone is quartzarenite.		
Sandstone, very fine, to bedded siltstone. light gray (N7) to medium gray (N5), friable, mud balls, bedding plane trails.	33 (10.1)	69 (21.0)
Sandstone, fine to very fine, medium light gray (N6) to light gray (N7), weathers light brown (5YR5/6) to dusky yellow (5Y6/4), fossil voids at base.	5 (1.5)	74 (22.6)
Sandstone, medium to fine, medium light gray (N6), interbedded shale, mud balls and mud ball voids, Skolithos, bedding plane trails, dark gray partings, friable.	20 (6.1)	94 (28.6)
Sandstone, medium to very fine, very rarely coarse, medium gray (N5) to medium light gray (N6), weathers moderate reddish brown (10R4/6) to dusky yellow (5Y6/4), thinly to very thickly bedded.	26 (7.9)	120 (36.6)
Sandstone, very fine, to bedded siltstone, medium gray (N5) to dark gray (N3), weathers yellowish gray (5Y8/1) to light olive brown (5YR5/6), black partings, Skolithos, friable.	7 (2.1)	127 (38.7)
Sandstone, fine to very fine, interbedded with medium to fine. Sandstone, fine to very fine, medium gray (N5) weathers moderate brown (5YR3/4) to dusky yellow (5Y6/4), thinly to very thickly bedded; interbedded medium to fine sandstone, medium light gray (N6), weathers light brown (5YR6/4), thinly to thickly bedded, friable, Skolithos, black partings.	4 (1.2)	131 (39.9)
Sandstone, medium to fine, rarely coarse to very coarse, light gray (N7) to medium light gray (N6), weathers yellowish gray (5Y8/1) to light brown (5YR6/4), thinly to thickly bedded, somewhat massive, Skolithos, low angle planar cross-beds.	38 (11.6)	169 (51.5)
Conglomeratic sandstone, medium light gray (N6), quartz pebbles, 2 cm maximum diameter.	1 (0.3)	170 (51.8)

Paraconformity

Juniata Formation: 497+ ft (151.5+ m). Sandstone grades upward from sublitharenite at base to quartzarenite at top.		
Mostly covered. Interbedded light gray (N7) sandstone and shale.	10 (3.0)	180 (54.9)
Interbedded sandstone and siltstone. Sandstone, medium to fine, grayish red (5R4/2) with light olive gray (5Y6/1) clay-shale chips; silt-shale, grayish red. Partly covered.	31 (9.4)	211 (64.3)
Sandstone, fine to very fine, light gray (N7) to grayish red (5R4/2), medium to thinly bedded, Skolithos, mud balls.	3 (0.9)	214 (65.2)
Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly, light green streaks.	8 (2.4)	222 (67.7)
Sandstone, fine to very fine, to bedded siltstone, grayish red (5R4/2), weathers light brown (5YR5/6), thinly to thickly beddd, rare silt-shale partings, bedding plane trails, mud balls.	15 (4.6)	237 (72.2)
Interbedded sandstone and silt-shale. Sandstone, very fine at base to fine at top, grayish red (5R4/2), weathers light brown (5YR5/6), medium to thinly bedded, low angle cross-beds, Skolithos; silt-shale to siltstone, grayish red, chippy to bedded, laminated to medium bedded, Skolithos.	36 (11.0)	273 (83.2)
Siltstone to silt-shale, grayish red (5R4/2), bedded to platy, Skolithos.	14 (4.3)	287 (87.5)
Sandstone, very fine, grayish red (5R4/2) with light olive gray (5Y6/1) splotches, planar cross-beds; interbedded silt-shale, grayish red, platy, bioturbation.	7 (2.1)	294 (89.6)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (5R4/2), medium to thinly bedded, chippy to platy (70%); sandstone, very fine, grayish red, weathers light brown (5YR5/6), thinly bedded (30%); bedding plane trails and bioturbation throughout.	6 (1.8)	300 (91.4)
Sandstone, fine to very fine, grayish red (5R4/2), with greenish gray (5GY6/1) splotches, weathers light brown (5YR5/6), medium to thinly bedded, shaly partings and silt-shale interbeds, bioturbation on shaly beds.	9 (2.7)	309 (94.2)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (5R4/2), chippy to platy, thinly bedded; sandstone, fine to very fine, grayish red, weathers light brown (5YR5/6), thinly bedded; bedding plane trails throughout.	17 (5.2)	326 (99.4)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, grayish red (5R4/2) to light olive gray (5Y6/1), weathers light brown (5YR5/6), thickly to very thinly bedded, somewhat, flaggy, planar cross-beds; silt-shale grayish red, chippy, occasionally crumbly, medium to very thinly bedded.	14 (4.3)	340 (103.6)
Cycle. Lower 0.45 m sandstone, fine to very fine, grayish red (5R4/2) to light olive gray, planar cross-beds, bioturbation, bedding plane trails; grades upward into silt-shale, grayish red, rarely mottled light olive gray, chippy.	13.5 (4.1)	353.5 (107.7)
Interbedded sandstone (75%) and silt-shale (25%) same as above, but not arranged into discrete cycles.	14.5 (4.5)	368 (112.2)
Siltstone and interbedded sandstone. Siltstone to mudstone, grayish red (5R4/2), chippy to crumbly (80%); sandstone, fine to very fine, grayish red to light olive gray (5Y6/1), thinly to very thinly bedded (20%).	5 (1.5)	373 (113.7)
Sandstone and interbedded silt-shale. Sandstone, fine to very fine, grayish red (5R4/2) to light olive gray (5Y6/1), very thinly to thickly bedded, planar cross-beds, bedding plane trails, Cruziana, Rusophycus, Skolithos (75%); silt-shale, grayish red, chippy to platy, medium to very thinly bedded.	30 (9.1)	403 (122.8)
Cycle. Lower 0.3 m sandstone, very fine, grayish red (5R4/2), medium bedded; grades upward into mudstone, grayish red, crumbly, bioturbated.	5 (1.5)	408 (124.4)
Cycle. Lower 1.0 m sandstone, very fine, grayish red (5R4/2) to light olive gray (5Y6/1), medium to thinly bedded; grades upward into mudstone, grayish red, crumbly, bioturbated.	6.5 (2.0)	414.5 (126.3)
Mudstone to silt-shale, grayish red (5R4/2) with greenish gray (5GY6/1) splotches, crumbly to chippy, bioturbated, bedding plane trails.	5.5 (1.7)	420 (128.0)
Interbedded sandstone and mudstone. Sand stone, very fine, to siltstone, grayish red (5R4/2) with greenish gray (5GY6/1) splotches, medium to thinly bedded; mudstone to silt-stone, grayish red with greenish gray mottles, crumbly to chippy, bedding plane trails, Skolithos.	29 (8.8)	449 (136.8)
Covered. Thickness may be unreliable due to variance in dip at either end of covered interval.	78 (23.8)	527 (160.6)
Sandstone, very fine, grayish red (5R4/2), with interbedded grayish red mudstone (probably the base of a cycle.)	4 (1.2)	531 (161.8)
Cycle. Lower 1.5 m sandstone, very fine, grayish red (5R4/2), weathers grayish black (N2) to light brown (5YR6/4), planar cross-beds; grades upward into mudstone, grayish red, crumbly to chippy.	8 (2.4)	539 (164.3)
Cycle (?). Lower 2.8 m sandstone, fine, to siltstone, grayish red (5R4/2), interbeds of grayish red platy silt-shale; grades upward into silt-shale, grayish red, chippy, interbeds of sandstone, Skolithos, flute casts.	19 (5.8)	558 (170.1)
Cycle. Lower 0.9 m interbedded grayish red (5R4/2) mudstone, silt-shale and very fine sandstone; grades upward into mudstone, grayish red with rare greenish gray (5GY6/1) mottles.	8.5 (2.6)	566.5 (172.7)
Cycle. Lower 0.3 m sandstone, very fine, grayish red (5R4/2); grades upward into mudstone, grayish red, with greenish gray (5GY6/1) mottles, crumbly.	5.5 (1.7)	572 (174.3)
Silt-shale to mudstone, grayish red (5R4/2), greenish gray (5GY6/1) mottles, chippy to crumbly, bioturbated, Skolithos.	17 (5.2)	589 (179.5)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (5R4/2), chippy; sandstone grayish red, weathers light brown (5YR5/6) to black (N1), medium to very thinly bedded.	3.5 (1.1)	592.5 (180.6)
Sandstone, fine to very fine, grayish red (5R4/2), weathers light brown (YR65/6), medium bedded, planar cross-beds, bedding plane trails.	1.5 (0.5)	594 (181.6)
Mudstone, grayish red (5R4/2), crumbly, slightly micaceous, Skolithos, rare streaks of greenish gray (5GY6/1), rare beds of silt-shale, grayish red, weathers light brown (5YR5/6).	23 (7.0)	617 (188.1)
Sandstone and mudstone to silt-shale, grayish red (5R4/2), very poorly exposed, thickness not reliable due to poor exposure and variable dips.	50 (15.2)	667 (203.3)
Lower portion of section not exposed at road level. Outcrops of Reedsville Formation have been reported in stream bed.		

LOCALITY 26 - FALLING SPRING FALLS

Section measured along U. S. Highway 220 just north of its junction with State Road 640, at south end of Little Mountain, approximately 4.7 miles north-northeast of Covington, Va.; Alleghany County, Va.; Covington, Va. 7.5-minute quadrangle (NC); 37°52.3'N, 79°56.5'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured.		
Sandstone (quartzarenite), coarse to very coarse.	--	--
Juniata Formation: 504 ft (153.6 m) total thickness not certain.		
Covered. (possible structural complication)	313 (95.4)	313 (95.4)
Interbedded sandstone and silt-shale. Sandstone (sublitharenite to almost quartzarenite), fine to very fine, grayish red (5R4/2) to light olive gray (5Y6/1), medium to thinly bedded, cross-bedded; silt-shale to mudstone, grayish red, thickly to thinly bedded, chippy to crumbly.	25 (7.6)	338 (102.0)
In the cycles below, the sandstone is sublitharenite to litharenite, fine to very fine, grayish red (5R4/2) to light olive gray (5Y6/1), thinly to thickly bedded; the silt-shale is grayish red and chippy; the mudstone is grayish red and crumbly.		
Cycle. Cross-bedded sandstone grading upward into mudstone.	7 (2.1)	345 (105.2)
Cycle. Same as above.	13 (4.0)	358 (109.1)
Cycle. Cross-bedded sandstone grading upward into interbedded sandstone and silt-shale.	3 (0.9)	361 (110.0)
Cycle. Sandstone with Skolithos grading upward into mudstone.	2 (0.6)	363 (110.6)
Cycle. Cross-bedded sandstone grading upward into interbedded sandstone and silt-shale.	9 (2.7)	372 (113.4)
Cycle. Cross-bedded sandstone grading upward into mudstone, bedding plane trails, Cruziana, Rusophycus.	7 (2.1)	379 (115.5)
Cycle. Cross-bedded sandstone grading upward into mudstone, bedding plane trails.	9 (2.7)	388 (118.3)
Cycle. Cross-bedded sandstone grading upward into interbedded sandstone and silt-shale, bedding plane trails, Cruziana.	22.5 (6.9)	410.5 (125.1)
Cycle. Cross-bedded sandstone grading upward into interbedded sandstone and silt-shale, ripple marks at base.	9 (2.7)	419.5 (127.9)
Cycle. Cross-bedded sandstone grading upward into interbedded sandstone and silt-shale.	5.5 (1.6)	425 (129.5)
Interbedded, silt-shale and sandstone. Siltshale to mudstone, grayish red (5R4/2), chippy to crumbly, medium to thickly bedded (80%); sandstone (litharenite), fine to very fine, light olive gray (5Y6/1) and grayish red, weathers olive gray (5Y4/1), medium to thinly bedded (20%).	23 (7.0)	448 (136.5)
Sandstone (litharenite), fine to very fine, light olive gray (5Y6/1), becoming grayish red (5R4/2) toward the top, weathers light brown (5YR5/6) to medium dark gray (N4), very thinly to thickly bedded, undulatory bedding, planar cross-beds, some mud balls; interbedded grayish red silt-shale in lower 4 m.	40 (12.2)	488 (148.7)
Cycle. Sandstone (litharenite), fine to very fine, dusky yellow (5Y6/4) to light olive gray (5Y6/1), medium to very thinly bedded; grades upward into mudstone, grayish red (5R4/2), crumbly.	7 (2.1)	495 (150.9)
Cycle. Same as above.	9 (2.7)	504 (153.6)
Reedsville Formation: 41+ ft (12.5+ m)		
Siltstone, grayish red (5R4/2), massive, somewhat crumbly, sparsely fossiliferous, rare Lingula (very small individuals).	13 (4.0)	517 (157.6)
Siltstone, medium gray (N5), weathers light olive gray (5Y5/2) to moderate yellowish brown (10YR5/4), medium to thickly bedded, massive, slightly calcareous at base to non-calcareous upward, fossiliferous, Lingula.	28 (8.5)	545 (166.1)
Lower beds of Reedsville not measured.		

LOCALITY 27 - WARM SPRINGS MOUNTAIN/AIRPORT ROAD

Section measured along State Roads 606 and 703 at their junction atop Warm Springs Mountain, approximately 4.7 miles northwest of Clifton Forge, Va.; Alleghany County, Va.; Falling Spring, Va.-W.Va. 7.5-minute quadrangle (SE); 37°52.6'N, 79°53.3'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 52 ft (15.8 m). Thickness is approximate, top of exposure is assumed top of Tuscarora. Sandstone is quartzarenite.		
Sandstone, very thickly to thinly bedded, cross-bedded, not measured in detail, thickness approximate.	28 (8.5)	28 (8.5)
Sandstone, medium to fine, pale red (5R6/2) to yellowish gray (5Y8/1), weathers light brown (5YR5/6), medium to thinly bedded, cross-bedded, somewhat friable, interbeds of yellowish gray silt-shale, Skolithos at top.	24 (7.3)	52 (15.8)
Juniata Formation: 225 ft (68.6 m). Upper 6.4 m is transitional to Tuscarora. Sandstone in upper beds is sublitharenite to quartzarenite.		
Sandstone, medium to fine, pale red (5R6/2) to yellowish gray (5Y8/1), weathers light brown (5YR5/6), medium to thinly bedded, cross-bedded, somewhat friable, interbeds of grayish red (5R4/2) silt-shale.	15 (4.6)	67 (20.4)
Mudstone, grayish red (5R4/2), crumbly, yellowish gray (5Y7/2) splotches.	1 (0.3)	68 (20.7)
Sandstone, medium to fine, pale red (5R6/2) to grayish orange (10YR7/4), weathers light brown (5YR5/6), medium to thinly bedded, evenly bedded, planar cross-beds, Skolithos near top, some interbeds of yellowish gray (5Y7/2) silt-shale, rare interbeds of grayish red (5R4/2) silt-shale.	24 (7.3)	92 (28.0)
Interbedded sandstone and mudstone. Sandstone, fine to very fine, pale red (5R6/2) to grayish orange (10YR7/4), weathers light brown (5YR5/6), very thinly to thickly bedded, bed thickness increases upward, redness decreases upward, coarser beds are cross-bedded, finer beds are redder; mudstone, grayish red (5R4/2), medium to thinly bedded, bed thickness and abundance decrease upward.	38 (11.6)	130 (39.6)
In the following cycles, the sandstone is litharenite to sublitharenite, fine to very fine, grayish red (5R4/2) with splotches of yellowish gray (5Y7/2), thinly to thickly bedded, evenly bedded; the mudstone is grayish red, crumbly.		
Cycle. Cross-bedded sandstone grading upward into mudstone.	8 (2.4)	138 (42.0)
Cycle. Same as above.	3 (0.9)	141 (42.9)
Cycle. Sandstone with Skolithos, grading upward into mudstone.	7 (2.1)	148 (45.1)

Cycle. Cross-bedded sandstone grading upward into mudstone.	8 (2.4)	156 (47.5
Cycle. Same as above.	3 (0.9)	159 (48.4)
Cycle. Same as above.	3 (0.9)	162 (49.3)
Cycle. Sandstone with Skolithos, grading upward into mudstone.	3 (0.9)	165 (50.3)
Cycle. Cross-bedded sandstone grading upward into mudstone.	5 (1.5)	170 (51.8)
Cycle. Sandstone with Skolithos, grading upward into mudstone.	2 (0.6)	172 (52.4)
Cycle. Cross-bedded sandstone grading upward into mudstone.	7.5 (2.3)	179.5 (54.7)
Cycle. Sandstone grading upward into mudstone.	1.5 (0.5)	181 (55.1)
Cycle. Cross-bedded sandstone grading upward into mudstone.	1 (0.3)	182 (55.4)
Cycle. Cross-bedded sandstone grading upward into sandstone with Skolithos, grading upward into mudstone with yellowish gray splotches.	18 (5.5)	200 (60.9)
Mudstone, grayish red (5R4/2), crumbly, yellowish gray splotches; interbedded sandstone, very fine, grayish red.	6 (1.8)	206 (62.8)
Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly, mostly covered.	12 (3.7)	218 (66.4)
Interbedded silt-shale and sandstone. Silt-shale, grayish red (5R4/2), platy to chippy, mostly covered; sandstone, fine to very fine, grayish red and rarely yellowish gray (5Y7/2), medium to thinly bedded, planar bedded, planar cross-beds. Probably cyclical, but poorly exposed.	28 (8.5)	246 (74.9)
Covered.	3 (0.9)	249 (75.9)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, feldspathic, yellowish gray (5Y7/2) and locally stained grayish red (5R4/2), weathers light brown (5R5/6), medium to very thinly bedded, cross-bedded, flaggy; silt-shale, grayish red, platy, medium bedded.	6 (1.8)	255 (77.7)
Covered, probably grayish red, platy siltshale.	22 (6.7)	277 (84.4)
Oswego Sandstone: 42 ft (12.8 m). Sandstone is litharenite to sublitharenite.		
Sandstone, fine to very fine, feldspathic, yellowish gray (5Y7/2) to medium gray (N5), weathers light brown (5YR5/6), medium to very thinly bedded, planar cross-beds, some channeling; interbedded silt-shale, grayish red (5R4/2), especially in lower 3 m.	37 (11.3)	314 (95.7)
Interbedded mudstone and sandstone. Mudstone to siltstone, grayish red (5R4/2), crumbly to massive, very thinly to thickly bedded; sandstone, fine to very fine, yellowish gray (5Y7/2), weathers moderate yellowish brown (10YR5/4), medium to thinly bedded, evenly bedded.	5 (1.5)	319 (97.2)
Reedsville Formation: 66+ ft (20.1+ m)		
Siltstone to mudstone, grayish red (5R4/2), crumbly but somewhat massive, fossiliferous, Lingula.	13 (4.0)	332 (101.2)
Interbedded mudstone and siltstone. Mudstone, grayish red (5R4/2), medium bedded, crumbly, fossiliferous; siltstone, dusky yellow (5Y6/4), weathers grayish brown (5YR3/2), medium to thickly bedded, massive, occasionally coarsening to very fine, cross-bedded sandstone; Lingula throughout.	9 (2.7)	341 (103.9)
Siltstone, grayish olive (10Y4/2) to dusky yellow (5Y6/4), weathers pale yellowish brown (5Y6/4), medium to thickly bedded, massive, fossiliferous; interbeds of greenish gray (5GY6/1) calcareous, fossiliferous siltstone, weathers moderate brown (5YR4/4), in lower 1.0 m; Lingula throughout.	7 (2.1)	348 (106.0)
Siltstone to silt-shale, medium dark gray (N4), weathers light olive gray (5Y5/2) to moderate yellowish brown (10YR5/4), thinly to thickly bedded, massive with some shaly interbeds, mostly at base, fossiliferous, Lingula, Oniella (?), Orthorhynchula (?), bryozoa; interbeds of greenish gray (5GY6/1), calcareous, fossiliferous siltstone, weathers moderate brown (5YR4/4) in upper 0.6 m.	18 (5.5)	366 (111.5)
Interbedded silt-shale, sandstone and clay-shale. Silt-shale to siltstone, medium gray (N5), weathers moderate brown (5YR4/4) to olive gray (5Y4/1), medium to very thinly bedded, undulatory, calcareous, fossiliferous, rare beds of fossil hash; sandstone (litharenite), very fine, grayish olive (10Y4/2) to dark yellowish brown (10YR5/4), weathers brownish gray (5YR4/1), medium to thinly bedded, undulatory, calcareous; clay-shale, olive black (5Y2/1), very thinly bedded, undultory, chippy to lath-shaped; phosphatic nodules.	19 (5.8)	385 (117.3)

LOCALITY 28 - NORTH MOUNTAIN/STATE ROAD 770

Section measured along State Road 770 on southeast slope of North Mountain, approximately 300 ft (elevation) below crest of mountain, approximately 2.8 miles east-northeast of Longdale Furnace, Va.; Rockbridge County, Va.; Longdale Furnace, Va. 7.5-minute quadrangle (EC); 37°49.1'N, 79°37.9'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: approximately 30 ft (9.1 m)		
Sandstone (quartzarenite), coarse to fine, pinkish gray (5YR8/1) to very light gray (N8), occasionally stained moderate red (5R5/4), cross-bedded, greenish gray (5G6/1) shale at base.	30 (9.1)	30 (9.1)
Juniata Formation: 153.5 ft (46.8 m). Sandstone is quartzarenite.		
Cycles of mudstone and sandstone. Mudstone, grayish red (5R4/2), crumbly; sandstone, medium to fine, light olive gray (5Y6/1). Cycles consist of sandstone grading upward into mudstone.	92 (28.0)	122 (37.1)
Sandstone, fine to very fine, light olive gray (5Y6/1), cross-bedded, shale chips.	2 (0.6)	124 (37.7)
Cycle. Lower 0.6 m sandstone, fine to very fine, yellowish gray (5Y7/2), cross-bedded; grades upward into mudstone, pale yellowish brown (10YR6/2) to pale red (5R6/2), crumbly.	14 (4.3)	138 (42.0)
Mudstone, grayish red (10R4/2) to pale yellowish brown (10YR6/2), crumbly, Skolithos.	2 (0.6)	140 (42.6)
Covered.	10 (3.0)	150 (45.6)
Sandstone, fine, greenish gray (5GY6/1), weathers moderate yellowish brown (10YR5/4), cross-bedded.	12 (3.7)	162 (49.3)
Mudstone, grayish red (5R4/2) to pale olive (10Y6/2), crumbly, Skolithos.	1.5 (0.5)	163.5 (49.8)
Covered.	11 (3.4)	174.5 (53.2)

Sandstone (sublitharenite), very fine, olive gray (5Y4/1) to pale yellowish brown (10YR6/2), thinly to thickly bedded, cross-bedded, dark greenish gray (5GY4/1) shale chips.	7 (2.2)	181.5 (55.4)
Mudstone, pale yellowish brown (10YR6/2), crumbly, Skolithos.	2 (0.6)	183.5 (56.0)
Oswego Sandstone: 95 ft (28.9 m). Sandstone is litharenite to sublitharenite.		
Sandstone, very fine, olive gray (5Y4/1) to pale yellowish brown (10YR6/2), thinly to thickly bedded, cross-bedded, dark greenish gray (5GY4/1) shale chips.	55 (16.8)	238.5 (72.8)
Sandstone, very fine, light brown (5YR6/4) to pinkish gray (5YR8/1) with moderate red (5R4/6) specks, cross-bedded, channeled; interbedded dusky yellow (5Y6/4) to light brown (5YR5/6) shale.	10 (3.0)	248.5 (75.8)
Sandstone, very fine, light olive gray (5Y6/1) to medium gray (N5), medium to thinly bedded, interbedded dusky yellow (5Y6/4) silt-shale, rare dark greenish gray (5GY4/1) shale chips.	30 (9.1)	278.5 (84.9)
Reedsville Formation: 128+ ft (39.0+ m)		
Siltstone, light olive gray (5Y5/2) to moderate yellowish brown (10YR5/4), massive, somewhat crumbly, fossiliferous; interbedded moderate yellowish brown (10YR5/4) chippy shale.	70 (21.3)	348.5 (106.2)
Interbedded clay-shale and silt-shale. Clay-shale, light olive gray (5Y6/1) to moderate yellowish brown (10YR5/4), chippy (50%); silt-shale, light olive gray, limonitic specks, fossiliferous, Ambonychia (?) (50%).	18 (5.5)	366.5 (111.7)
Interbedded clay-shale (75%) and silt-shale (25%). Same as above.	40 (12.2)	406.5 (123.9)
Lower beds not measured.		

LOCALITY 29 - EAGLE ROCK

Section measured along U.S. Highway 220 at southwest end of bridge of old U.S. Highway 220 over James River (at old junction of U.S. Highway 220 and State Road 685, according to 1962 topographic map), at northeast end of Crawford Mountain, approximately 0.2 mile west-northwest of town of Eagle Rock, Va.; Botetourt County, Va.; Eagle Rock, Va. 7.5-minute quadrangle (SC); 37°38.45' N, 79°48.4'W. Measured portion of section is overturned. Section is also exposed on northeast side of James River (Hall, 1969, p. 30-33; Appalachian Geological Society, 1970, p. 141-142), but more obscure. Slickensides are prevalent throughout outcrop, and some bedding plane slippage.

	thickness ft (m)	total ft (m)
"Keefer Sandstone": 74+ ft (22.6+m) only measured basal portion, unit is contorted above this interval.		
Sandstone (quartzarenite), medium light gray (N6) to very light gray (N8), with carbonaceous partings, bedding plane trails, and localized Skolithos and mudcracks.	74 (22.6)	74 (22.6)
Rose Hill Formation: 82.7 ft (25.2 m)		
Sandstone and clay-shale, medium light gray (N6), with some red staining.	21 (6.4)	95 (29.0)
Sandstone, fine to very fine, grayish red purple (5RP4/2), hematitic.	21 (6.4)	116 (35.4)
Interbedded sandstone and clay-shale. Sandstone, same as above; clay-shale, dark greenish gray (5GY4/1), fissile, bedding plane trails.	26.5 (8.1)	142.5 (43.5)
Clay-shale to silt-shale, dark greenish gray (5GY4/1), fissile; interbedded medium light gray (N6) sandstone, very thinly bedded.	7.5 (2.3)	150 (45.8)
Sandstone, medium to coarse, grayish red purple (5RP4/2), hematitic, upper 0.9 m is pebbly, carbonaceous partings, bedding plane trails; interbedded fine, medium light gray (N6) sandstone.	6.7 (2.0)	156.7 (47.8)
Tuscarora Formation: 139.8 ft (42.6 m). Sandstone is quartzarenite.		
Conglomerate, rounded to subrounded quartz pebbles, 0.5 cm maximum diameter, medium dark gray (N4), black (N1) (carbonaceous ?) matrix and partings.	0.3 (0.1)	157 (47.9)
Sandstone, medium to very fine, medium gray (N5), locally conglomeratic, subrounded quartz pebbles and black siltstone clasts, medium dark gray (N4) shaly partings.	3 (0.9)	160 (48.8)
Sandstone, fine to very fine, medium gray (N5) to light gray (N7), medium to thickly bedded, Skolithos.	7 (2.1)	167 (50.9)
Sandstone, medium to fine, light gray (N7) to light olive gray (5Y6/1), black (N1) specks throughout, blackened cross-beds, interbeds and partings of carbonaceous material.	6.5 (2.0)	173.5 (52.9)
Sandstone, medium to fine, medium dark gray (N4) to light olive gray (5Y6/1), massive, black stains along joints.	12.5 (3.8)	186 (56.7)
Sandstone, medium to fine, pinkish gray (5YR8/1).	2 (0.6)	188 (57.3)
Sandstone, fine to coarse, variegated medium light gray (N6), light gray (N7) and light brown (5YR6/4), cross-bedded.	2.5 (0.8)	190.5 (58.1)
Sandstone, fine to very fine, medium light gray (N6), massive.	15 (4.6)	205.5 (62.7)
Sandstone, fine to very fine, very light gray (N8), medium bedded.	2.5 (0.8)	208 (63.5)
Sandstone, fine to very fine, medium light gray (N6), massive.	5 (1.5)	213 (65.0)
Sandstone, fine to very fine, very light gray (N8), medium bedded.	2 (0.6)	215 (65.6)
Sandstone, fine to very fine, medium light gray (N6), massive.	6 (1.8)	221 (67.4)
Conglomeratic sandstone, medium to coarse, light gray (N7), weathers light brown (5YR6/4), quartz pebbles, 1 cm maximum diameter.	3 (0.9)	224 (68.3)
Carbonaceous silt-shale, black (N1).	1 (0.3)	225 (68.6)
Sandstone, very fine, grayish orange (10YR7/4), massive.	4 (1.2)	229 (69.8)
Sandstone, coarse to fine, light gray (N7), some medium dark gray (N4) beds in upper 1.2 m, cross-bedded, olive gray (5Y4/1) shale clasts.	26 (7.9)	255 (77.7)
Sandstone, medium to fine, medium light gray (N6), weathers very pale orange (10YR8/2) to light brown (5YR5/6), medium to very finly bedded, cross-bedded, rare olive gray (5Y4/1) shale clasts.	20 (6.1)	275 (83.8)
Sandstone, fine to very fine, light gray (N7), medium bedded, cross-bedded.	1.5 (0.5)	276.5 (84.3)
Sandstone, medium to fine, very light gray (N8), weathers light brown (5YR5/6), medium to very thinly bedded, cross-bedded.	2.5 (0.8)	279 (85.1)
Sandstone, fine to very fine, medium light gray (N6), cross-bedded, blackened joints, some yellowish gray (5Y8/1) 2 cm shale beds in upper 0.6 m.	7 (2.1)	286 (87.2)
Sandstone, fine to very fine, light gray (N7), weathers light brown (5YR5/6), medium to thickly bedded, cross-bedded, interbedded light olive gray (5Y6/1) silt-shale in upper 2.0 m.	10.5 (3.2)	296.5 (90.4)
Oswego Sandstone: 36 ft (11.0 m). Sandstone is quartzarenite to sublitharenite unless otherwise noted.		
Siltstone, light olive gray (5Y6/1), weathers light brown (5YR5/6), bedded, good cleavage; 5 cm bed of fine, light gray (N7) sandstone at 1.0 m above base of interval.	4.5 (1.4)	301 (91.8)

Interbedded sandstone and siltstone. Sandstone, fine to very fine, medium light gray (N6) to light brownish gray (5YR6/1) to light olive gray (5Y6/1), medium bedded, cross-bedded; siltstone, light olive gray (5Y6/1), weathers light brown (5YR5/6), bedded.	3 (0.9)	304 (92.7)
Sandstone, fine to very fine, light bluish gray (5B7/1), weathers light brown (5YR5/6), thickly to very thinly bedded, cross-bedded, occasional clasts and interbeds of light olive gray (5Y6/1) silt-shale, 1 cm maximum clast size.	4 (1.2)	308 (93.9)
Interbedded sandstone and siltstone. Sandstone (litharenite), fine to very fine, medium light gray (N6), weathers pale yellowish brown (10YR6/2) to pale brown (5YR5/2), thickly bedded, micaceous, cross-bedded, some siltstone clasts; siltstone, light olive gray (5Y5/2), weathers light brown (5YR5/6), bedded.	3 (0.9)	311 (94.8)
Sandstone, fine to very fine, light bluish gray (5B7/1), weathers light brown (5YR5/6), very thinly to thickly bedded, cross-bedded, interbeds and clasts of light olive gray (5Y6/1) silt-shale, 2 cm maximum clast size, carbonaceous partings, black (N1) silt-shale interbed at 1.2 m below top of interval.	11.5 (3.5)	322.5 (98.3)
Siltstone, medium gray (N5), weathers light olive gray (5Y5/2), medium bedded.	1.5 (0.5)	324 (98.8)
Sandstone (litharenite), fine to very fine, greenish gray (5G6/1), weathers light brown (5YR5/6), medium to very thinly bedded; interbeds of medium gray (N5) silt-shale, weathers light olive gray (5Y5/2), channeling.	8.5 (2.6)	332.5 (101.4)
Reedsville Formation: 52.5+ ft (16.0+ m)		
Siltstone, medium gray (N5), weathers light olive gray (5Y5/2), medium bedded, slightly micaceous, some medium light gray (N6) sandstone stringers, 2 cm bed of fossiliferous sandstone at middle of interval, Lingula, channeling.	2 (0.6)	334.5 (102.0)
Siltstone, fossiliferous, olive gray (5Y4/1), bedded, Lingula, gastropods, fossiliferous beds are phosphatic, some beds of Lingula coquina, occasional carbonaceous (?) partings; medium bedded brownish gray sandstone at 0.5 and 1.0 m above base.	13 (4.0)	347.5 (106.0)
Siltstone to sandstone (feldspathic sublitharenite), very fine, dark gray (N3) to brownish gray (5Y4/1) with white specks that weather light brown (5YR5/6), interbedded with olive gray (Y4/1), medium to thickly bedded.	7.5 (2.3)	355 (108.3)
Siltstone, fossiliferous, olive gray (5Y4/1), weathers brownish gray (YR4/1), bedded, Lingula.	3 (0.9)	358 (109.2)
Interbedded sandstone and shale. Sandstone, fine, to siltstone, medium gray (N5) to medium dark gray (N4), occasionally with white specks that weather grayish orange (10YR7/4), very thinly to thickly bedded; silt-shale to clay-shale, medium dark gray (N4), sandstone increases upward, shale decreases upward. Lower beds of Reedsville not measured.	27 (8.2)	385 (117.4)

LOCALITY 30 - JOHNSON-PORTER MOUNTAIN

Outcrop is exposed along State Road 616 between Johnson Mountain and Porter Mountain, approximately 1.3 miles north of junction of State Road 616 with Route 621 at Rich Patch; Alleghany County, Va.; Strom, Va. 7.5-minute quadrangle (NE); 37°44.5'N, 79°55.0'W.

Section was not measured. Outcrop exposes a 40 ft (12 m) thick stream channel (paleo-stream channel) that appears to be cut into the top of the Reedsville Formation. The Reedsville here is red and contains Lingula. The stream deposit is composed of litharenite, with conglomeratic lag deposits. The lag conglomerates are primarily phosphate pebbles and shale chips. The channel sand is probably Oswego. Palecurrent data were collected at this outcrop.

LOCALITY 31 - HOOKS MILL

Section measured along State Road 621 and in stream bed of Roaring Run at gap between Bearwallow Mountain and Shoemaker Knob, approximately 0.2 mile southeast of Hooks Mill; Alleghany County, Va. (just west of Botetourt County boundary); Strom, Va. 7.5-minute quadrangle (NE); 37°42.8'N, 79°54.7'W.

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured.		
Sandstone (quartzarenite) with interbedded light olive gray (5Y6/1) shale.	---	---
Tuscarora Formation: 30 ft (9.1 m). Sandstone is quartzarenite.		
Sandstone, medium to coarse, medium dark gray (N4), weathers dusky brown (5YR2/2), massive.	2 (0.6)	2 (0.6)
Sandstone, coarse to fine, white (N9) to medium orange pink (5YR8/4), weathers light brown (5YR5/6), thickly bedded.	28 (8.5)	30 (9.1)
Juniata Formation: 122 ft (37.2 m)		
Covered. Sandstone outcrop in stream: sublitharenite fine to very fine, grayish red (10R4/2) to light olive gray (5YR6/1) and dark gray (N3), cross-bedded.	122 (37.2)	152 (46.3)
Oswego Sandstone: 62 ft (18.9 m)		
Sandstone (sublitharenite), fine to very fine, feldspathic, olive gray (5Y4/1) to black olive (5Y2/1), weathers pale yellowish brown (10YR6/2), very thinly to thickly bedded, wavy bedded.	62 (18.9)	214 (62.5)
Reedsville Formation: 48+ ft (14.6+ m)		
Covered.	40 (12.2)	254 (74.7)
Siltstone, light olive gray (5Y5/2), massive, fossiliferous, light brown (5YR5/6) fossil voids, Lingula, Ambonychia, almost a coquina in places, phosphatic nodules.	8 (2.4)	262 (77.1)

LOCALITY 32 - CLIFF DALE CHAPEL

Section measured along State Road 615 and in Blue Spring Run, approximately 4.5 miles south-southwest of Covington, Va., 0.2 mile southwest of the Cliff Dale Chapel; Alleghany County, Va.; Jordan Mines, Va. 7.5-minute quadrangle (EC); 37°40.8'N, 80°01.1'W (Lesure, 1957, p. 31; Hall, 1969, p. 42-44).

	thickness ft (m)	total ft (m)
Tuscarora Formation: 32+ ft (9.7+ m). Hall reports 90 ft. Sandstone is quartzarenite.		
Sandstone, fine to very fine, grayish black (N2) interbedded with light gray (N7), thickly to very thinly bedded.	3 (0.9)	3 (0.9)
Sandstone, fine to very fine, grayish black (N2), thickly to very thinly bedded,	2 (0.6)	5 (1.5)
Sandstone, very fine to very coarse, very light gray (N8) to medium dark gray (N4), weathers light brown (5YR5/6), thickly to very thinly bedded, cross-bedded.	27 (8.2)	32 (9.7)

Paraconformity

Juniata Formation: 252 ft (75.4 m). All of the sandstone in the Juniata is quartzarenite to sublitharenite.		
Covered interval. Partial exposure in stream; sandstone, fine to very fine, grayish red (5R4/2) to greenish gray (5GY6/1), redder at base of interval, interbedded grayish red (5R4/2) silt-shale.	140 (42.7)	172 (52.4)
Interbedded mudstone and sandstone. Mudstone to silt-shale, grayish red (5R4/2), medium to very thinly bedded, crumbly to chippy (60%). Sandstone, fine to very fine, greenish gray (5GY6/1) to grayish red (5R4/2), weathers light brown (5YR5/6), medium to very thinly bedded, planar cross-beds (40%). Some bioturbation, Skolithos.	33 (10.1)	205 (62.5)
Cycle. Sandstone, very fine, grayish red (5R4/2), Skolithos; grades upward into mudstone, grayish red (5R4/2), crumbly, bedding plane trace fossils at top.	5 (1.5)	210 (64.0)
Cycle. Lower 0.75 m sandstone, very fine, grayish red (5R4/2), cross-bedded; grades upward into silt-shale, grayish red (5R4/2), chippy, sandstone interbeds, bioturbated.	11 (3.4)	221 (67.4)
Cycle. Lower 1.2 m sandstone, same as above; grades upward into silt-shale, grayish red (5R4/2), chippy, with interbedded sandstone in lower portion.	13 (4.0)	234 (71.4)
Sandstone, very fine, greenish gray (5GY6/1) to grayish red (5R4/2), weathers light brown (5YR5/6), medium to very thinly bedded, irregular bedding, planar cross-beds; interbedded mudstone, grayish red (5R4/2), medium to very thinly bedded, crumbly; clay-shale, grayish red (5R4/2), laminated to medium bedded, chippy. Bioturbated throughout, bilobed bedding plane trails, some channeling.	24 (7.3)	258 (78.7)
Cycle. Lower 1.2 m sandstone, very fine, grayish red (5R4/2) to greenish gray (5GY6/1), weathers light brown (5YR5/6), planar cross-beds; grades upward into mudstone, grayish red (5R4/2), crumbly, with interbedded sandstone and chippy clay-shale of same color. Bedding plane trails, Cruziana.	11 (3.4)	269 (82.1)
Cycle. Lower 2.3 m sandstone, very fine, greenish gray (5GY6/1) to grayish red (5R4/2), weathers light brown (5YR5/6), planar cross-beds, flaggy; grades upward into silt-shale, grayish red (5R4/2), chippy. Bedding plane trails, tool marks at top.	10 (3.0)	279 (85.1)
Reedsville Formation: 26+ ft (8.0+ m)		
Siltstone to mudstone, grayish red (5R4/2), medium to very thinly bedded, interbedded clay-shale of same color, localized bioturbation, somewhat massive.	13 (4.0)	292 (89.1)
Siltstone, calcareous, fossiliferous, olive gray (5Y4/1), weathers light olive gray (5Y5/2) to brownish gray (5YR4/1), thickly bedded, massive, Lingula, Ambonychia (?), bryozoa, bedding plane trails.	13 (4.0)	305 (93.1)
Lower beds are exposed, but not measured.		

LOCALITY 33 - READ MOUNTAIN

Section is mostly covered, but was observed by Mervin J. Bartholomew, Sharon Lewis, and Richard J. Diecchio, and thicknesses of units were approximated. Traverse was made on northwest slope of Read Mountain, east of State Road 605, approximately 2.0 mile north-northwest of Roanoke city limits; Roanoke County, Va.; Roanoke, Va. 7.5-minute quadrangle (NE); 37°20.0'N, 79°54.0'W.

Visual estimates are the basis for the generalized section that follows:

Shales and siltstones of the Reedsville Formation, containing Lingula, occur about 10 ft (3 m) below the lowest quartzarenite ledge, the intervening interval being covered. This lowest quartzarenite is the base of a 40 ft (12 m) interval of friable sandstone that is probably interbedded with mudstone, and if so, the unit is the Juniata Formation. This interval is overlain by 60 ft (19 m) of massive, resistant quartzarenite (Tuscarora Sandstone) which is in turn overlain by 80 ft (25 m) of Rose Hill Formation (based on the presence of red, hematitic sandstone float), and 200 ft (69 m) of "Keefer Sandstone."

LOCALITY 34 - CATAWBA MOUNTAIN/ROUTE 311

Section measured along State Highway 311 at crest of Catawba Mountain, approximately 1.0 miles of Catawba, Va.; Roanoke County, Va.; Catawba, Va. 7.5-minute quadrangle (SW); 37°22.8'N, 80°05.4'W (Woodward, 1932, 71-72; Nichol, 1959; Tillman, 1963, p. 63; Hall, 1969, p. 27-29; Appalachian Geological Society, 1970, p. 137; Plants, 1977, p. 193).

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured. 44 ft according to Tillman.		
Sandstone (quartzarenite), fine to coarse, light gray (N7) to very light gray (N8), cross bedded, conglomeratic, 3.5 cm maximum rounded quartz pebbles, clay balls.	---	---
Disconformity		
Reedsville Formation 77+ ft (23.4+ m)		
Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly, somewhat massive, fossiliferous, Lingula, gastropods at top, phosphatic nodules.	12 (3.7)	12 (3.7)
Interbedded siltstone and silt-shale, medium gray (N5), weathers olive gray (10Y4/2), phosphatic nodules.	5 (1.5)	17 (5.2)
Covered.	10 (3.0)	27 (8.2)
Interbedded siltstone to very fine sandstone and silt-shale, medium gray (N5) weathers olive gray (10YR4/2), mostly covered.	27 (8.2)	54 (16.4)
Sandstone, fine, greenish gray (5G6/1), weathers grayish olive (10Y4/2), very thinly to thickly bedded, wavy bedded; interbedded silt-shale to mudstone, grayish olive (10Y4/2), chippy to crumbly.	23 (7.0)	77 (23.4)
Lower beds of Reedsville not measured.		

LOCALITY 35 - MEADOW CREEK FALLS

Section measured along State Highway 42 at east end of Johns Creek Mountain where it joins Sinking Creek Mountain, at nose of Sinking Creek Anticline, approximately 0.7 mile southwest of New Castle, Va.; Craig County, Va.; Looney, Va. 7.5-minute quadrangle (NE); 37°36.6'N, 80°07.7'W (Tillman, 1963, p. 70; Bregman, 1967, p. 64-67).

	thickness ft (m)	total ft (m)
Rose Hill Formation: covered, not measured.		
Tuscarora Formation: 34 ft (10.4 m)		
Sandstone (quartzarenite), very fine to very coarse, very light gray (N8), weathers dark yellowish orange (10YR6/6) to moderate yellowish brown (10YR5/4), medium to thickly bedded, cross beeded, occasionally conglomeratic, quartz pebbles, 1.5 cm maximum diameter, clay balls.	34 (10.4)	34 (10.4)
Juniata Formation: 233 ft (71.0 m). Upper 22.6 m is transitional to Tuscarora. Sandstone appears to be quartzarenite. commonly argillaceous.		
Covered.	10 (3.0)	44 (13.4)

Sandstone, medium to fine, pale reddish brown (10R5/4) to bluish white (5B9/1), weathers light brown (10YR5/6) to very pale orange (10YR8/2), medium to thickly bedded, cross-bedded, rare clay balls; interbeds of grayish red (5R4/2) silt-shale.	10 (3.0)	54 (16.5)
Sandstone, medium to very fine, dusky yellow (5Y6/4) to light olive gray (5Y5/2), very thinly to thickly bedded, cross-bedded, clay balls, some channeling, interbeds of light olive gray and grayish red (5R4/2) silt-shale.	30 (9.1)	84 (25.6)
Covered.	7 (2.1)	91 (27.7)
Sandstone, fine, light olive gray (5Y5/2) to dusky yellow (5Y6/4), thickly bedded, planar cross-beds.	8 (2.4)	99 (30.2)
In the cycles below, the sandstone is quartzarenite, fine to very fine, grayish red (5R4/2) with pale olive (10Y6/2) splotches, very thinly to thickly bedded, occasionally with grayish olive (10Y4/2) clay balls; the mudstone is grayish red (5Y4/2), crumbly and occasionally chippy, very thinly to thickly bedded.		
Cycle. Lower 0.3 m cross-bedded; sandstone grading upward into mudstone.	5.5 (1.7)	104.5 (31.9)
Cycle. Lower 0.5 m cross-bedded sandstone; grading upward into mudstone.	4.5 (1.4)	109 (33.2)
Cycle. Lower 0.3 m cross-bedded sandstone; grading upward into mudstone.	3 (0.9)	112 (34.1)
Cycle. Lower 0.3 m cross-bedded sandstone; grading upward into 0.6 m sandstone with Skolithos; grading upward into mudstone.	8 (2.4)	120 (36.6)
Cycle. Lower 0.9 m cross-bedded sandstone; grading upward into mudstone, bedding plane trails, Rusophycus, flute casts.	5.5 (1.7)	125.5 (38.3)
Cycle. Lower 1.3 m sandstone with Skolithos; grading upward into mudstone.	14.5 (4.4)	140 (42.7)
Covered.	8 (2.4)	148 (45.1)
Silt-shale, grayish red (5R4/2).	1 (0.3)	149 (45.4)
Sandstone (sublitharenite), fine to very fine, grayish red (5R4/2), medium to thinly bedded, planar cross-beds, Skolithos; interbeds of grayish red silt-shale.	2 (0.6)	151 (46.0)
Covered.	9 (2.7)	160 (48.8)
Sandstone with interbeds of silt-shale. Sandstone, fine to very fine, grayish red (5R4/2) to greenish gray (5GY6/1), weathers light brown (5YR5/6 and 5YR6/4), thinly to thickly bedded, beds become thinner and redded upward (thinner beds are redder), planar cross-beds (90%); silt-shale, grayish red, chippy, thinly laminated to thickly bedded (10%); channel at base of interval, bedding plane trails and flute casts throughout.	35 (10.7)	195 (59.4)
Interbedded sandstone and silt-shale. Sandstone, same as above, but not as red, and medium to very thinly bedded (50%); silt-shale, same as above (50%); some channeling, ripple marks at base.	19 (5.8)	214 (65.2)
Sandstone with interbeds of silt-shale. Sandstone, fine to very fine, greenish gray (5GY6/1) to grayish red (5R4/2), weathers light brown (5YR5/6 and 5YR6/4), medium to very thinly bedded, planar cross-beds, limonitic specks (80%); silt-shale, same as above (20%); some channeling, bedding plane trails, tool marks, flute casts, Rusophycus.	30 (9.1)	244 (74.4)
Sandstone with interbeds of silt-shale. Sandstone, same as above (80%); silt-shale, same as above (20%); bedding plane trails, Skolithos (?), very rare interbeds of fossiliferous silt-shale with Lingula.	23 (7.0)	267 (81.4)
Reedsville Formation: 20+ ft (6.1+ m)		
Siltstone, to very fine sandstone, dark greenish gray (5GY4/1) to greenish gray (5GY6/1), medium bedded, massive, fossiliferous, Lingula.	7 (2.1)	274 (83.5)
Siltstone, greenish gray (5GY6/1), weathers dark greenish gray (5G4/1) to brownish gray (5YR4/1), massive, very thinly to thickly bedded, calcareous, fossiliferous, Lingula, Orthorhynchula, Plectonotus (?), differential weathering of more calcareous layers leaves fossils in relief.	8.5 (2.6)	282.5 (86.1)
Siltstone, medium dark gray (N4), weathers olive gray (5Y4/1), massive, very thickly bedded, fossiliferous, Orthorhynchula, Ischyrodonta, Lingula (?).	4.5 (1.4)	287 (87.5)
Lower beds not exposed.		

LOCALITY 36 - POTTS MOUNTAIN/STATE HIGHWAY 311

Section measured along State Highway 311 just north of crest of Potts Mountain, approximately 2.9 miles southeast of Paint Bank, Va.; Craig County, Va.; Potts Creek, Va.-W.Va. 7.5-minute quadrangle (SW); 37°32.1'N, 80°14.2'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: 65 ft (10.8 m) top is covered		
Sandstone (quartzarenite), fine to coarse, locally conglomeratic, very light gray (N8) to pale red (10R6/2), weathers pale yellowish orange (10YR8/6) to medium light gray (N6), very thinly to very thickly bedded, cross-bedded, channeling throughout interval; 1.0 m deep channel of pale reddish brown (10R5/4) conglomeratic sandstone in otherwise very light gray (N8), fine, sandstone at 1.5 m above base of interval, quartz pebbles, 1.0 cm maximum diameter.	65 (19.8)	65 (19.8)
Juniata Formation: 149+ (45.4+ m). Upper 14.6 m is transitional to Tuscarora. Sandstone is quartzarenite, occasionally sublitharenite.		
Covered.	8 (2.4)	73 (22.3)
Sandstone, fine to very fine, medium light gray (N6) to grayish orange (10YR7/4), weathers light olive gray (5Y6/1) to light gray (N7), medium to very thinly bedded, Skolithos; interbedded silt-shale, light olive gray (5Y5/2), chippy to crumbly, thinly bedded to thinly laminated.	17 (5.2)	90 (27.4)
Interbedded sandstone and mudstone. Sandstone, fine to very fine, yellowish gray (5Y7/2) to grayish orange (10YR7/4), weathers light olive gray (5Y6/1) to light gray (N7), thinly to thickly bedded, cross-bedded (planar and trough); mudstone, light olive gray (5Y5/2) to pale red (5R6/2), thinly to thickly bedded, crumbly, Skolithos, decreases in abundance upwards; bedding plane trails in lower part of interval.	23 (7.0)	113 (27.4)
Covered.	37 (11.3)	150 (45.7)
Cycle. Lower 0.3 m sandstone, fine to very fine, greenish gray (5GY6/1) to brownish black (5YR2/1), weathers light olive gray (5Y2/1), cross-bedded; grades upward into mudstone, grayish red (5R4/2), weathers light olive gray (5Y5/2), crumbly to somewhat chippy; channeled at base.	3 (0.9)	153 (46.0)
Cycle. Lower 0.3 m cross-bedded sandstone, same as above; grades upward into mudstone, same as above, with few interbeds of cross-bedded sandstone.	16 (4.9)	169 (51.5)

In the cycles below, the sandstone is quartzarenite to sublitharenite, fine to very fine, greenish gray (5GY6/1) to brownish black (5YR2/1), weathers light olive gray (5Y2/1); the mudstone is grayish red (5R4/2), weathers light olive gray (5Y5/2), crumbly to chippy. Each cycle has a channeled basal contact.

Cycle. Lower 1.4 m cross-bedded sandstone; grades upward into mudstone with bedding plane trails.	9.5 (2.9)	178.5 (54.4)
Cycle. Lower 0.3 m cross-bedded sandstone; grades upward into mudstone.	6.5 (2.0)	185 (56.4)
Cycle. Lower 0.5 m cross-bedded sandstone; grades upward into 0.6 m sandstone with Skolithos; grades upward into mudstone.	8.5 (2.6)	193.5 (59.0)
Cycle. Lower 0.5 m cross-bedded sandstone; grades upward into interbedded cross-bedded sandstone and mudstone.	5.5 (1.7)	199 (60.7)
Cycle. Lower 1.2 m cross-bedded sandstone; grades upward into 0.8 m interbedded cross-bedded sandstone and mudstone; grades upward into mudstone.	6 (1.8)	205 (62.5)
Mudstone, grayish red (5R4/2), crumbly. (top of cycle)	9 (2.7)	214 (65.2)

Lower beds not exposed.

LOCALITY 37 - PETERS MOUNTAIN/ROUTE 311

Section measured along State Highway 311 just north of crest of Peters Mountain, approximately 2.7 miles north-northeast of Paint Bank, Va.; Monroe County, W.Va. (just north of Va. state line); Potts Creek, Va.-W.Va. 7.5-minute quadrangle (NW); 37°36.5'N, 80°14.5'W.

	thickness ft (m)	total ft (m)
Tuscarora Formation: not measured, Covered, contact inferred from float and scattered outcrop.		
Juniata Formation: 334 ft (101.8 m). Upper contact is inferred. All sandstone in Juniata is argillaceous quartzarenite.		
Covered.	100 (30.5)	100 (30.5)
Mostly covered, scattered outcrops of grayish red (5R4/2) sandstone and mudstone.	96 (29.3)	196 (59.7)
Sandstone, medium to fine, grayish red (5R4/2), interbeds of grayish red silt-shale, clay balls.	18 (5.5)	214 (65.2)
Siltstone to silt-shale, grayish red (5R4/2), flaggy to platy.	3 (0.9)	217 (66.1)
Interbedded sandstone and mudstone. Sandstone, very fine, to siltstone, grayish red (5R4/2), medium to thinly bedded, wavy bedded, planar cross-beds, flaggy in spots; mudstone, grayish red, crumbly. Interval is partially covered.	30 (9.1)	247 (75.3)
Sandstone, very fine, to siltstone, grayish red (5R4/2), flaggy.	6 (1.8)	253 (77.1)
Cycle. Lower 0.9 m sandstone, very fine, grayish red (5R4/2), cross-bedded; grades upward into mudstone, grayish red, crumbly.	5 (1.5)	258 (78.6)
Cycle. Lower 1.8 m sandstone, same as above; grades upward into mudstone, same as above, channel at base.	9.5 (2.9)	267.5 (81.5)
Mudstone, grayish red (5R4/2), crumbly.	5.5 (1.7)	273 (83.2)
Sandstone, fine to very fine, grayish red (5R4/2), medium to very thinly bedded, flaggy, channel at base.	16 (4.9)	289 (88.1)
Sandstone, very fine, grayish red (5R4/2), somewhat argillaceous, bedded, but massive appearance.	14 (4.3)	303 (92.4)
Mudstone to silt-shale, grayish red (5R4/2), crumbly to chippy.	2.5 (0.8)	305.5 (93.1)
Channel-fill sequence (stream cut into overbank). Very fine, grayish red (5R4/2) sandstone above; channelled into grayish red, crumbly mudstone below.	10.5 (3.2)	316 (96.3)
Sandstone, very fine, grayish red (5R4/2), medium to very thinly bedded, cross-bedded; interbedded grayish red, chippy silt-shale.	15 (4.6)	331 (100.9)
Silt-shale to mudstone, grayish red (5R4/2), chippy to crumbly.	2 (0.6)	333 (101.5)
Siltstone, grayish red (5R4/2), thinly to very thinly bedded, cross-bedded.	1 (0.3)	334 (101.8)
Reedsville Formation: 128 ft (39.0 m)		
Siltstone, grayish red (5R4/2), poorly bedded to massive, 0.1 m lens of greenish gray (5GY6/1), very fine sandstone (sublitharenite) near base.	6 (1.8)	340 (103.6)
Siltstone, grayish red (5R4/2) with greenish gray (5GY6/1) splotches, medium bedded, massive to crumbly, fossiliferous, very rare Lingula.	14 (4.3)	354 (107.9)
Silty limestone, grading upward into calcareous siltstone, grading upward into non-calcareous siltstone, medium gray (N5), weathers light brown (5YR6/4) to olive gray (5Y4/1), very thinly to very thickly bedded, crumbly at base to massive upwards, fossiliferous, interbeds of olive gray (5Y4/1) clay shale, Orthorhynchula, Modiolopsis, Plectonotus (?), Oniella (?), bryozoa; Lingula in upper 8.5 m.	79 (24.1)	433 (132.0)
Interbedded silt-shale, siltstone and limestone. Silt-shale, olive gray (5Y4/1), weathers brownish gray (5Y4/1), medium to very thinly bedded, chippy; siltstone to very fine sandstone, olive gray, weathers pale brown (5YR5/2) medium to thinly bedded, cross-bedded, wavy bedded, calcareous, limonitic specks; limestone (biosparrite), light olive gray (5Y5/2) and medium gray (N5), weathers light brown (5YR6/4), limestone is rare to absent in upper 3 m.	29 (8.8)	462 (140.8)

Lower beds not measured.

LOCALITY 38 - GAP MILLS

Section measured along W.Va. Highway 3 at gap in Gap Mountain, just north of Gap Mills, W.Va.; Monroe County, W.Va., Gap Mills, W.Va. 7.5-minute quadrangle (EC); 37°33.8'N 80°24.7'W. Section is overturned (Reger & Price, 1926, p. 231; Woodward, 1941, p. 76-77; Hayes, 1974, p. 132-133).

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured		
Sandstone and siltstone, grayish red purple (5RP4/2).	---	---
Tuscarora Formation: 39 ft (11.9 m). Sandstone is quartzarenite.		
Sandstone, fine to very fine, yellowish gray (5YR8/1), thinly to very thinly bedded, Skolithos, moderate yellowish brown (10YR5/4) shale partings.	3.5 (1.1)	3.5 (1.1)
Sandstone, fine to very fine, very light gray (N8), weathers pale yellowish orange (10YR8/6), medium to very thinly bedded, cross-bedded.	6.5 (2.0)	10 (3.1)
Sandstone, fine to very fine, very light gray (N8), weathers pale yellowish orange (10YR8/6), massive, Skolithos.	3 (0.9)	13 (4.0)
Sandstone, same as above, but without Skolithos.	11.5 (3.5)	24.5 (7.5)
Sandstone, fine to very fine, very light gray (N8) with dark yellowish orange (10YR6/6) streaks, Skolithos.	4.5 (1.4)	29 (8.9)

Sandstone, coarse to very fine, very light gray (N8) to grayish orange (10YR7/4), massive, cross-bedded, occasionally conglomeratic, 1 cm maximum pebble diameter.	10 (3.0)	39 (11.9)
Paraconformity		
Juniata Formation: 231+ ft (70.2+ m). Sandstone is quartzarenite, often very argillaceous.		
Mudstone, yellowish gray (5Y7/2), crumbly.	1 (0.3)	40 (12.2)
Mudstone, grayish red (5R4/2) to grayish red purple (5RP4/2), crumbly.	1 (0.3)	41 (12.5)
Mudstone, grayish red (5R4/2), light olive gray (5Y6/1) coloration in burrows and along bedding, medium to very thinly bedded, cross-bedded, Skolithos, light olive gray shale partings.	6 (1.8)	47 (14.3)
Sandstone, fine to very fine, yellowish gray (5Y8/1), weathers grayish orange (10YR7/4), massive, cross-bedded.	2.5 (0.8)	49.5 (15.1)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, to mudstone, grayish red (5R4/2) to light olive gray (5Y6/1), thickly to very thinly bedded, cross-bedded, occasional Skolithos; silt-shale, grayish red, chippy to lath-shaped; bedding plane trails, Cruziana, Phycodes (?)	27.5 (8.4)	77 (23.5)
Cycle. Lower 0.3 m sandstone, very fine, grayish red (5R4/2); grades upward into mudstone, grayish red, crumbly, Skolithos.	9 (2.7)	86 (26.2)
Cycle. Lower 1.6 m sandstone, fine to very fine, grayish red (5R4/2) to light olive gray (5Y6/1), cross-bedded; grades upward into 0.3 m sandstone, very fine, grayish red, Skolithos; grades upward into grayish red, crumbly mudstone.	10 (3.0)	96 (29.2)
Cycle. Lower 0.45 m sandstone, fine to very fine, grayish red (5R4/2) with splotches of light olive gray (5Y6/1), cross-bedded; grades upward into interbedded sandstone and mudstone, crumbly, both grayish red.	5 (1.5)	101 (30.7)
Cycle. Lower 0.75 m sandstone (sublitharenite), very fine, grayish red (5R4/2), Skolithos with light olive gray (5Y6/1) burrows; grades upward into mudstone, grayish red, crumbly.	5.5 (1.7)	106.5 (32.4)
Cycle. Lower 0.9 m sandstone, same as above; grades upward into mudstone to silt-shale, grayish red (5R4/2), crumbly to chippy, Skolithos with light olive gray (5Y6/1) burrows.	14.5 (4.4)	121 (36.8)
Cycle. Lower 15 cm sandstone, fine to very fine, light olive gray (5Y6/1) to grayish red (5R4/2), cross-bedded; grades upward into grayish red, chippy silt-shale.	1 (0.3)	122 (37.1)
Cycle. Lower 0.3 m sandstone, fine to very fine, grayish red (5R4/2); grades upward into interbedded sandstone and platy silt-shale, both grayish red.	3.5	125.5
Cycle. Lower 0.9 m sandstone, fine, light olive gray (5Y6/1) to grayish red (5R4/2), cross-bedded, grayish red clay balls; grades upward into grayish red, chippy to platy silt-shale.	4.5 (1.4)	130 (39.6)
Mudstone, grayish red (5R4/2), crumbly, rare light olive gray (5Y6/1) splotches in slightly coarser beds.	20 (6.1)	150 (45.7)
Interbedded sandstone, mudstone and silt-shale. Sandstone, very fine, to siltstone, light olive gray (5Y6/1) to grayish red (5R4/2), medium to very thinly bedded, Skolithos (50%); mudstone, grayish red, medium to very thinly bedded, crumbly (40%); silt-shale, grayish red, platy (10%).	11 (3.4)	161 (49.1)
Cycle. Lower 0.45 m sandstone (sublitharenite), fine to very fine, light olive gray (5Y6/1) to grayish red (5R4/2); grades upward into mudstone and very fine sandstone, both grayish red, Skolithos.	4 (1.2)	165 (50.3)
Cycle. Lower 1.8 m sandstone, fine to very fine, light olive gray (5Y6/1) to grayish red (5R4/2), cross-bedded, clay balls, bedding plane trails on shaly partings; grades upward into grayish red, crumbly mudstone.	10 (3.0)	175 (53.3)
Cycle. Lower 0.45 m sandstone, fine to very fine, light brownish gray (5YR6/1) to grayish orange (10YR7/4), weathers pale brown (5YR5/2), massive, cross-bedded; grades upward into grayish red (5R4/2), chippy silt-shale with interbedded very fine, grayish red sandstone.	8.5 (2.6)	183.5 (55.9)
Interbedded sandstone and mudstone. Sandstone, fine to very fine, grayish red (5R4/2), cross-bedded, occasional Skolithos (70%); mudstone to silt-shale, grayish red, crumbly to chippy (30%). Channeling is prevalent throughout interval.	10.5 (3.2)	194 (59.1)
Cycle. Lower 0.6 m sandstone, grayish red (5R4/2), cross-bedded; grades upward into grayish red, crumbly mudstone.	3 (0.9)	197 (60.0)
Cycle. Lower 0.75 m sandstone, grayish red (5R4/2), Skolithos; grades upward into grayish red, crumbly mudstone. Base of mudstone is channeled into top of sandstone.	4.5 (1.4)	201.5 (61.4)
Cycle. Lower 0.6 m sandstone, grayish red (5R4/2), cross-bedded, channel at base; grades upward into grayish red, crumbly mudstone.	8.5 (2.6)	210 (64.0)
Cycle. Lower 0.6 m sandstone, grayish red (5R4/2), cross-bedded; grades upward into 0.45 m grayish red sandstone with Skolithos; grades upward into grayish red, crumbly mudstone.	5 (1.5)	215 (65.5)
Cycle (?). Lower 1.35 m sandstone, grayish red (5R4/2) with Skolithos; grades upward into grayish red, crumbly mudstone. Interval is complicated by slippage along bedding.	6 (1.8)	221 (67.3)
Cycle. Lower 0.3 m sandstone, same as above; grades upward into grayish red, crumbly mudstone with interbedded sandstone.	8 (2.4)	229 (69.7)
Cycle. Lower 0.45 m sandstone, same as above; grades upward into grayish red, crumbly mudstone. Channel at base of cycle.	4 (1.2)	233 (70.9)
Cycle. Lower 0.6 m sandstone, very fine, grayish red (5R4/2), Skolithos; grades upward into grayish red, crumbly mudstone.	6 (1.8)	239 (72.7)
Cycle. Lower 1.5 m sandstone, very fine, grayish red (5R4/2), cross-bedded; grades upward into grayish red, crumbly mudstone.	6 (1.8)	245 (74.5)
Interbedded mudstone, and sandstone. Mudstone, grayish red (5R4/2) crumbly; sandstone (sublitharenite), very fine, pale red (5R6/2) to yellowish gray (5Y8/1). Partially covered. Possibly cyclical, 4 cycles, each grading upward from cross-bedded sandstone into crumbly mudstone.	25 (7.6)	270 (82.1)
Lower beds not exposed.		

LOCALITY 39 - JOHNS CREEK MOUNTAIN/ROUTE 601

Section measured along State Road 601 at Rocky Gap on crest of Johns Creek Mountain, approximately 6.0 miles northeast of Newport, Va.; Craig County, Va.; Newport, Va. (NC) and Waiteville, Va.-W.Va. (SC) 7.5-minute quadrangles; 37°26.9'W. Section is repeated by faulting (Hobbs, 1953). Section reported here is on south side of fault and is overturned.

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured.		
Interbedded light olive gray (5Y6/1) shale and grayish red purple (5RP4/2) sandstone.	---	---
Tuscarora Formation: 153 ft (46.6 m)		
Sandstone (quartzarenite), very fine to very coarse, very light gray (N8) to pinkish gray (5YR8/1), weathers light olive gray (5Y6/1), thinly to very thickly bedded, cross-bedded, Skolithos in places, locally conglomeratic, angular to subrounded quartz pebbles, 2.5 cm maximum diameter.	153 (46.6)	153 (46.6)
Paraconformity		
Juniata Formation: 304 ft. (92.7 m). Sandstone is quartzarenite to sublitharenite.		
Covered.	45 (13.7)	198 (60.3)
Interbedded sandstone and silt-shale. Sandstone, medium to fine, light olive gray (5Y6/1), weathers light brown (5YR5/6), thickly to very thinly bedded, light olive gray clay balls; silt-shale, grayish red (5R4/2), chippy; bedding plane trails.	38 (11.6)	236 (71.9)
Interbedded sandstone and silt-shale. Sandstone, fine to very fine, grayish red (5R4/2), and occasionally light olive gray (5Y6/1) (50%); silt-shale, grayish red, chippy (50%). Cycles consisting of cross-bedded sandstone, grading upward into mudstone, are discernable at this approximate position on other side of fault.	49 (14.9)	285 (86.9)
Interbedded silt-shale and sandstone. Siltshale, same as above (90%); sandstone, same as above, flaggy near base (10%). Interval is partly covered.	82 (25.0)	367 (111.9)
Interbedded sandstone and silt-shale, both grayish red (5R4/2), mostly covered.	90 (27.4)	457 (139.3)
Reedsville Formation: 166+ ft (50.6+ m)		
Covered.	78 (23.8)	535 (163.1)
Siltstone to silt-shale, light olive gray (5Y5/2) to dark yellowish orange (10YR6/6), bedded to fissile. Mostly covered, exposure is in drainage ditch.	88 (26.8)	623 (189.9)
Lower beds are covered.		

LOCALITY 40 - NARROWS

Section measured on east side of New River along the northbound lane of U. S. Highway 460 at 'The Narrows', in gap at southwest end of Peters Mountain, approximately 0.4 mile north of the town of Narrows, Va.; Giles County, Va.; Narrows, Va.-W. Va. 7.5-minute quadrangle (NC); 37°21.0'N, 80°48.5'W (Reger & Price, 1926, p. 210; Woodward, 1951, p. 367; Chauvin, 1957, p. 12-15; Hayes, 1974, p. 116-117).

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured		
Interbedded siltstone, grayish red (10R4/2); sandstone, very fine, grayish red; and clay-shale, light olive gray (5Y5/2), weathers pale yellowish orange (10YR8/6).	---	---
Tuscarora Formation: 80 ft (24.4 m). Sandstone and bedded siltstone, grayish red purple (5 RP 4/2)	---	---
Tuscarora Formation: 159 ft (48.4 m). Sandstone is quartzarenite.		
Interbedded sandstone and clay-shale. Sandstone (quartzarenite), fine, medium gray (N5), stained grayish red purple (5RP4/2), Skolithos with grayish red purple claystone in burrows; clay-shale, dark gray (N3).	16 (4.9)	16 (4.9)
Mostly covered, clay-shale, medium gray (N5), apparently with some interbedded sandstone.	17 (5.2)	33 (10.1)
Sandstone, medium to very fine, light gray (N7) to medium dark gray (N4), darker toward the top, somewhat friable in places, dark gray (N3) shaly partings.	19 (5.8)	52 (15.9)
Sandstone, fine, very light gray (N8) to very pale orange (10YR8/2), weathers moderate brown (5YR3/4) at top, massive, fractured.	16 (4.9)	68 (20.8)
Sandstone, medium to very coarse, light gray (N7) to very light gray (N8), cross-bedded, massive.	2 (0.6)	70 (21.4)
Sandstone, medium to fine, very light gray (N8), massive, fractured.	17 (5.2)	87 (26.6)
Sandstone, fines upward, very coarse at base to fine at top, light gray (N7), interbedded zones of very coarse, grayish red purple (5RP4/2) sandstone, massive.	2 (0.6)	89 (27.2)
Conglomeratic sandstone, coarse to very coarse, light gray (N7), cross-bedded, massive, rounded quartz pebbles of 1 cm maximum diameter.	2 (0.6)	91 (27.8)
Sandstone, medium to fine, medium light gray (N6), stained pale red (10R6/2) on cross-beds and burrows, medium to thinly bedded.	6 (1.8)	97 (29.6)
Sandstone, medium to coarse, light olive gray (5Y6/1), medium to very thinly bedded, cross-bedded, some interbedded light olive gray clay-shale. thinly bedded, planar cross-beds, sandstone becomes coarser and less red upward (50%); rare bedding plane trails, Skolithos at top, channel at base.	4 (1.2)	101 (30.8)
Mudstone, grayish red (5R4/2), crumbly, bedding plane trails, bilobate trails, Rusophycus.	6 (1.8)	144 (43.9)
Interbedded silt-shale and sandstone. Siltshale, grayish red (5R4/2), platy (50%); sandstone, fine to very coarse, grayish red to greenish gray (5YR5/6), medium to very thinly bedded, planar cross-beds, ripple marks, clay balls, some channeling.	23 (7.0)	167 (50.9)
Interbedded siltstone and sandstone. Siltstone, grayish red (5R4/2) (60%); sandstone, fine to very fine, grayish red (40%); clay balls, bedding plane trails, bilobate trails, Rusophycus.	36 (11.0)	203 (61.9)
Interbedded siltstone (50%) and sandstone (50%), same as above, some channeling, bedding plane trails, bilobate trails, Rusophycus, Skolithos, some mottling and bioturbation.	19 (5.8)	222 (67.7)
Siltstone, grayish red (5R4/2) with interbeds of grayish red, very fine sandstone, some channeling, bedding plane trails, bilobate trails, (trails more common at top).	87 (26.5)	309 (94.2)
Sandstone, very fine to siltstone, grayish red (5R4/2) and greenish gray (5GY6/1), very thinly to thickly bedded, evenly bedded, occasional beds of grayish red, crumbly mudstone, few grayish red shaly partings and silt-shale beds (more common at top), channel at 9.0 m above base, ripple marks, bedding plane trails, ball and pillow near top.	54 (16.5)	363 (110.6)

	thickness ft (m)	total ft (m)
Reedsville Formation: 276+ ft (84.1+ m)		
Siltstone, grayish red (5R4/2), massive to 2 cm beds.	22 (6.7)	385 (117.3)
Siltstone, dark greenish gray (5G4/1) to medium bluish gray (5B5/1) to moderate yellowish brown (10YR5/4), massive, slightly calcareous, decreasingly fossiliferous upward, fossil molds replaced with black pyrite in places.	19 (5.8)	404 (123.1)
Fossiliferous siltstone, dark greenish gray (5G4/1) to medium bluish gray (5B5/1), weathers olive black (5Y2/1) to moderate yellowish brown (10YR5/4), thinly bedded, evenly bedded, slightly calcareous, decreasingly fossiliferous upward, black pyritic fosil molds in places, Orthorhynchula at base, interbeds of calcareous siltstone with Planolites (?), rare bedding plane trails.	35 (10.7)	439 (133.8)
Interbedded clay-shale, limestone and silt-shale, clay-shale, olive gray (5Y4/1), weathers light olive gray (5Y6/1), laminated to medium bedded, chippy, calcareous; limestone, medium to finely crystalline, grayish blue (5PB5/2), weathers yellowish gray (5Y8/1) to light olive gray (5Y6/1), thinly to very thinly bedded, fossiliferous, dolomitic streaks in some beds, corals, brachiopods, bivalves, bryozoa, crinoids (limestone beds decrease in abundance upward); silt-shale, olive gray (5Y4/1) to medium dark gray (N6), weathers light brown (5YR5/6) to pale yellowish brown (10YR6/2), thinly to very thinly bedded, chippy, calcareous, becomes more massive, less calcareous, and more abundant upward. Lower beds not measured.	200 (61.0)	639 (194.8)

LOCALITY 41 - GAP MOUNTAIN/U. S. HIGHWAY 460

Section measured along southbound land of U. S. Highway 460 at northeast end of Gap Mountain, approximately 1.1 miles southeast of Newport, Va.; Giles County, Va. (just N of Montgomery County boundary); Newport, Va. 7.5-minute quadrangle (SW); 37°17.1'N, 80°28.8'W (Appalachian Geological Society, 1970, p. 124; Hayes, 1974, p. 126-127.

	thickness ft (m)	total ft (m)
Rose Hill Formation: not measured		
Sandstone and bedded siltstone, grayish	---	---
Tuscarora Formation: 159 ft (48.4 m). Sandstone is quartzarenite.		
Interbedded sandstone and clay-shale. Sandstone (quartzarenite), fine, medium gray (N5), stained grayish red purple (5RP4/2), Skolithos with grayish red purple claystone in burrows; clay-shale, dark gray (N3).	16 (4.9)	16 (4.9)
Mostly covered, clay-shale, medium gray (N5), apparently with some interbedded sandstone.	17 (5.2)	33 (10.1)
Sandstone, medium to very fine, light gray (N7) to medium dark gray (N4), darker toward the top, somewhat friable in places, dark gray (N3) shaly partings.	19 (5.8)	52 (15.9)
Sandstone, fine, very light gray (N8) to very pale orange (10YR8/2), weathers moderate brown (5YR3/4) at top, massive, fractured.	16 (4.9)	68 (20.8)
Sandstone, medium to very coarse, light gray (N7) to very light gray (N8), cross-bedded, massive.	2 (0.6)	70 (21.4)
Sandstone, medium to fine, very light gray (N8), massive, fractured.	17 (5.2)	87 (26.6)
Sandstone, fines upward, very coarse at base to fine at top, light gray (N7), interbedded zones of very coarse, grayish red purple (5RP4/2) sandstone, massive.	2 (0.6)	89 (27.2)
Conglomeratic sandstone, coarse to very coarse, light gray (N7), cross-bedded, massive, rounded quartz pebbles of 1 cm maximum diameter.	2 (0.6)	91 (27.8)
Sandstone, medium to fine, medium light gray (N6), stained pale red (10R6/2) on cross-beds and burrows, medium to thinly bedded.	6 (1.8)	97 (29.6)
Sandstone, medium to coarse, light olive gray (5Y6/1), medium to very thinly bedded, cross-bedded, some interbedded light olive gray clay-shale.	4 (1.2)	101 (30.8)
Sandstone, fine, to mudstone, light olive gray (5Y6/1), friable.	0.5 (0.2)	101.5 (31.0)
Sandstone, medium to fine, light gray (N7) to medium light gray (N6), weathers dark yellowish orange (10YR6/6), thickly bedded, cross-bedded.	6.5 (2.0)	108 (33.0)
Sandstone, coarse to fine, grayish orange pink (5YR7/2), medium bedded, cross-bedded.	3 (0.9)	111 (33.9)
Sandstone, medium to coarse, light bluish gray (5B7/1) to greenish gray (5GY6/1), cross-bedded, very rare chert clasts of 0.5 cm maximum diameter.	8 (2.4)	119 (36.3)
Sandstone, fine, very pale orange (10YR8/2) to pale red (10R6/2), medium to thinly bedded, cross-bedded, nodular surface with 2 cm thick limonite rind at base of interval.	9 (2.7)	128 (39.0)
Sandstone, medium to very fine, light bluish gray (5B7/1), medium to thinly bedded, interbedded greenish gray (5G6/1) silt-shale.	31 (9.4)	159 (48.4)
Juniata Formation: 245 ft (74.7 m). Sandstone is quartzarenite to sublitharenite. Upper 8.6 m is transitional to Tuscarora.		
Interbedded sandstone and silt-shale/mud stone. Sandstone, fine to very fine, light bluish gray (5B7/1), stained grayish red (5R4/2) in places, medium to thinly bedded, cross-beds in lower 1.5 m, Skolithos in upper 2.7 m; silt-shale to mudstone, grayish red (5R4/2), platy to crumbly.	17 (5.2)	176 (53.6)
Sandstone, very fine, to bedded siltstone, grayish red (5R4/2), with interbeds of grayish red silt-shale.	11 (3.4)	187 (57.0)
Cycle. Lower 0.85 m sandstone, fine to very fine, grayish red (5R4/2); grades upward into 2.1 m interbedded sandstone (as at base) and grayish red siltstone/silt-shale; grades upward into grayish red, crumbly mudstone.	15.5 (4.7)	202.5 (61.7)
Cycle (?). Sandstone, very fine, grayish red (5R4/2), Skolithos; grades upward into 0.5 m of grayish red silt-shale.	3.5 (1.1)	206 (62.8)
Mostly covered, grayish red (10R4/2) sandstone and silt-shale.	110 (33.5)	316 (96.3)
Sandstone, very fine, to bedded siltstone, dark greenish gray (5GY4/1) to grayish red (10R4/2).	3 (0.9)	319 (97.2)
Covered.	26 (7.9)	345 (105.1)
Sandstone, very fine, light brownish gray (5YR6/1) to grayish red (10R4/2), with interbedded grayish red silt-shale.	4 (1.2)	349 (106.3)
Covered, red soil.	55 (16.8)	404 (123.1)
Reedsville Formation: 102+ ft (31.1 m)		
Covered, brown soil.	43 (13.1)	447 (136.2)

Interbedded silt-shale and clay-shale, weathers light olive gray (5Y5/2) to dark yellowish orange (10YR6/6).	59 (18.0)	506 (154.2)
Lower beds are not exposed.		

LOCALITY 42 - FAGG

Section measured along the north bank of North Fork Roanoke River, just south of western end of railroad tunnel, alongside State Road 603, approximately 1.8 miles southwest of Ironto, Va.; Montgomery County, Va.; Ironto, Va. 7.5-minute quadrangle (C); 37°12.1N, 80°18.2'W (Eubank, 1967, p. 90; Hayes, 1974, p. 128).

Unconformity is also exposed along State Road 603 at Fagg, approximately 3.0 miles southwest of Ironto, Va.; Montgomery County, Va.; Ironto, Va. 7.5-minute quadrangle (C); 37°11.7'N, 80°19.5'W, where 5 ft of Silurian conglomeratiac quartzarenite is unconformably underlain by Reedsville shale and unconformably overlain by Rocky Gap (?) Sandstone and Huntersville Chert (Edwards, 1959, p. 39; Tillman, 1963, p. 75).

	thickness ft (m)	total ft (m)
Huntersville Chert: not measured.	---	---
Ridgeley (?) Sandstone: 10.5 ft (3.2 m). Designated as Rocky Gap Sandstone (?) by Tillman.		
Sandstone (quartzarenite), fine, olive black (5Y2/1), conglomeratic (quartz pebbles, 3.5 cm maximum diameter).	10.5 (3.2)	10.5 (3.2)
Disconformity.		
Silurian Sandstone: 10.5 ft (3.2 m). Sandstone is quartzarenite. Designated as Tuscarora Sandstone by Eubank.		
Covered.	1.5 (0.5)	12 (3.7)
Sandstone, medium to fine. light olive gray (5Y6/1), clay balls of same color.	6 (1.8)	18 (5.5)
Sandstone, medium to fine, medium gray (N5), massive, conglomeratic (quartz pebbles, 10 cm maximum diameter).	3 (0.9)	21 (6.4)
Disconformity		
Reedsville Formation: not measured.		
Shale, olive gray (5Y4/1), platy to lath-shaped, interbedded siltstone of same color.	---	---

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LOCALITY 43 - INGLES MOUNTAIN

Section measured on east side of New River along State Highway 232 at southwest end of Ingles Mountain, approximately 0.9 miles south of Radford, Va.; Montgomery County, Va.; Radford South, Va. 7.5-minute quadrangle (NC); 37°05.8'N, 80°34.8'W. Section is overturned.

	thickness ft	total ft
Rose Hill Formation: 20+ ft (6.1+ m). Top is covered.		
Clay-shale, light olive gray (5Y6/1) with interbedded dark gray (N3) and grayish red purple (5RP4/2) sandstone.	20 (6.1)	20 (6.1)
Tuscarora Formation: 55 ft (16.8 m)		
Sandstone (quartzarenite), coarse to fine, medium gray (N5) to dark gray (N3).	55 (16.8)	75 (22.9)
Juniata Formation: 185 ft (56.4 m). Upper 26.5 m is transitional to Tuscarora.		
Interbedded sandstone and silt-shale. Sandstone (quartzarenite), fine to very fine, dark gray (N3); silt-shale, pale red (5R6/2) to grayish red (5R4/2); sandstone abundance increases upward.	87 (26.5)	162 (49.4)
Silt-shale, pale red (5R6/2) to grayish red (5R4/2); interbedded fine to very fine, light olive gray (5Y6/1) sandstone and light olive gray clay-shale near top.	98 (29.9)	260 (79.2)
Reedsville Formation: not measured.		
Siltstone, greenish gray (5G6/1), massive, fossiliferous, abundant Lingula, rare Orthorhynchula.	---	---
Lower beds not exposed.		

Appendix II: Well log data

Listing of Deep Well Localities

W-1 Marshall 539

W-2 Marion 244

W-3 Preston 86

W-4 Preston 119

W-5 Grant 2

W-6 Hampshire 12

W-7 Hardy 3

W-8 Rockingham W-1432

W-9 Randolph 101

W-10 Randolph 103

W-11 Pocahontas 18

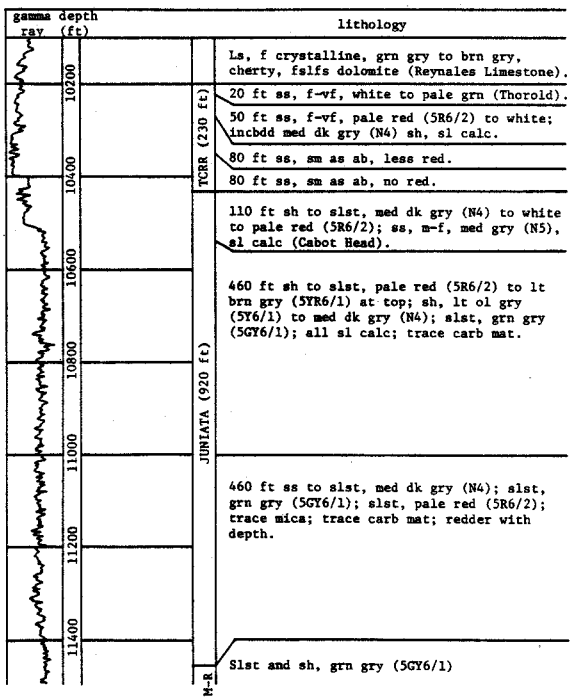
W-12 Pocahontas 21

W-13 Greenbrier 17

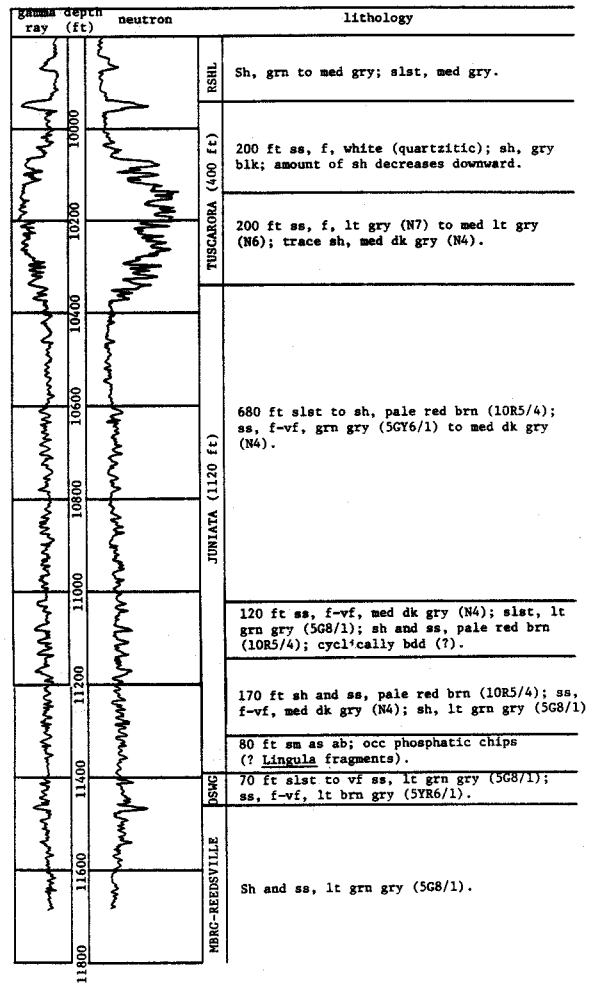
Miscellaneous abbreviations:

bd	bed(s)
bdd	bedded
bdg	bedding
blu	blue or bluish
blk	black
b. p.	bedding plane(s)
brn	brown or brownish
c	coarse
calc	calcareous
carb	carbonaceous
clay-sh	clay-shale
conglom	conglomerate (-ic)
diam	diameter
dk	dark
f	fine
FeOx	iron oxide
fslfs	fossififerous
grn	green or greenish
gry	gray or grayish
intbd	interbed(s)
intbdd	interbedded
ls	limestone
lt	light
mas	massive
mat	material
mat	maximum
mdst	mudstone
mod	moderate
occ	occasional (-ly)
ol	olive
orn	orange
peb	pebble(s)
pnk	pink oe pinkish
prp	parting(s)
qz	quartz
qzite	quartzite
red	red or reddish
silt-sh	siltshale
sl	slight (-ly)
sm as ab	same as above
surf	surface
unfslfs	unfossiliferous
v	very
wx	weathers (-ed)
X-bd	cross-bed(s)
X-bdd	cross-bedded
yel	yellow or yellowish

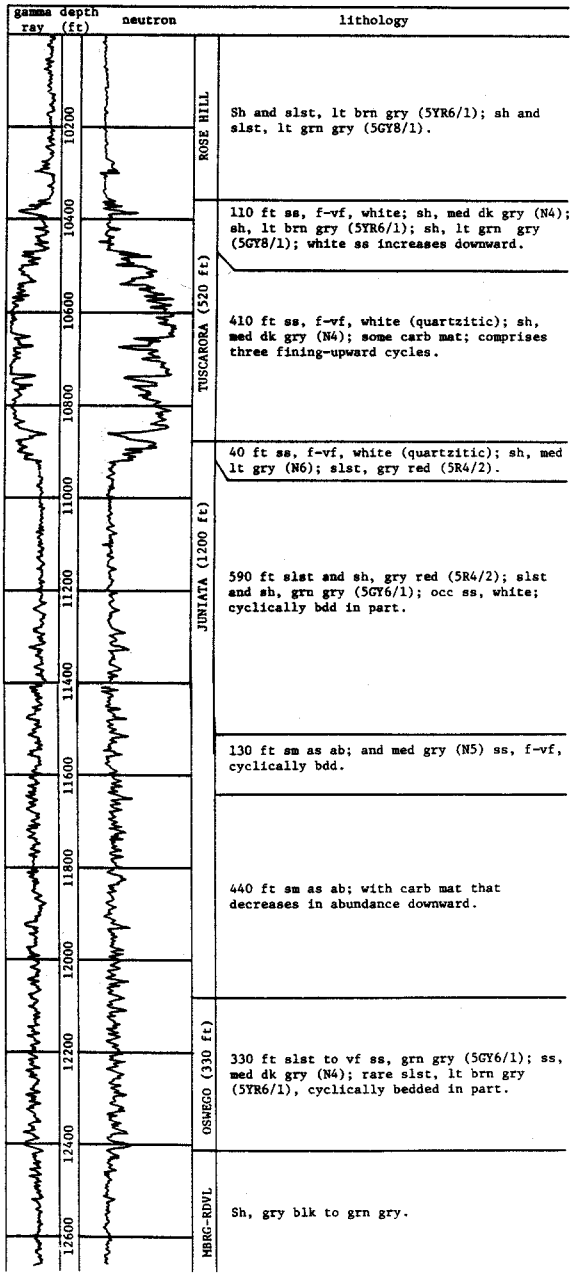
W-1, Marshall 539 (W. Va.), Occidental Petroleum No. 1, J. Burley, 1971
location: 25,000 ft S of lat 39°50'N
8,450 ft W of long 80°30'W
scales: gamma ray: 10100–11500: 0–250 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 1435 ft



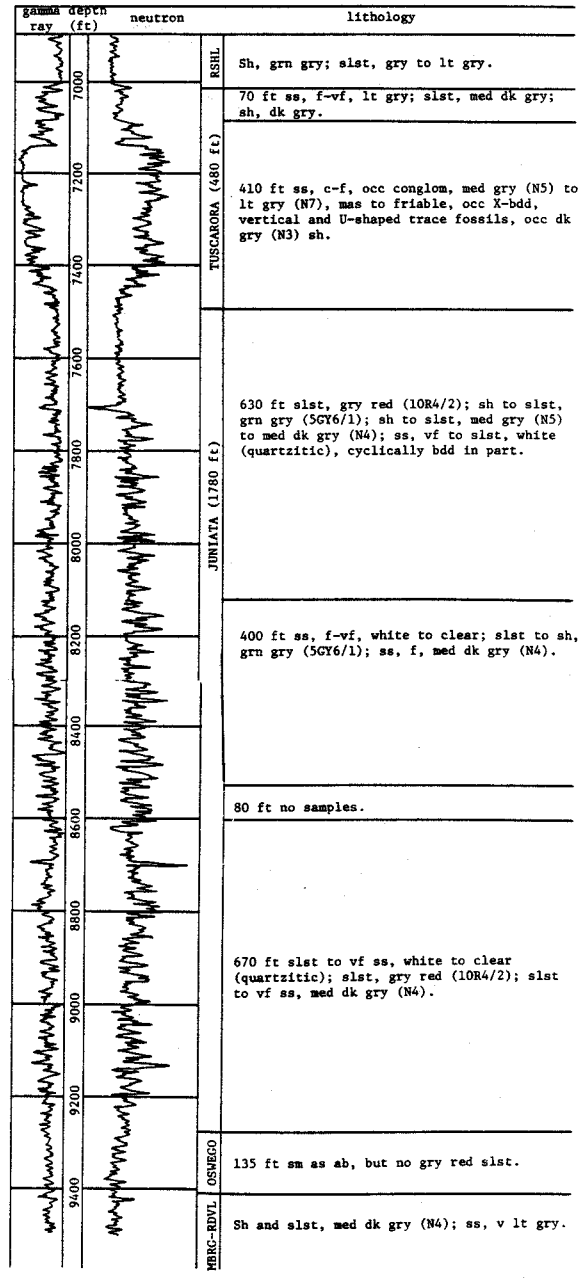
W-2, Marion 244 (W. Va.), Phillips Petroleum, No. A-1, R.R. Finch, 1962
location: 4.76 miles S of lat 39°30'N
0.64 miles W of long 80°00'W
scales: gamma ray: 9800–11800: 0–200 API units
neutron: 9800–11800: 400–2000 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 1342 ft



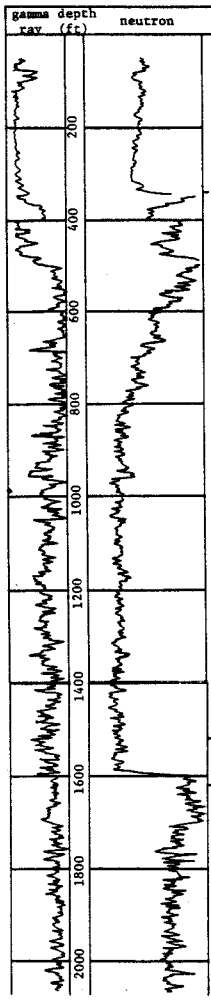
W-3, Preston 86 (W. Va.), Phillips Petroleum, No. A-1, H.G. Walls, 1963
location: 2.39 miles S of lat 39°30'N
2.00 miles W of long 79°50'W
scales: gamma ray: 10,000-12,600: 0-150 API units
neutron: 10,000-12,600: 0-4000 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 1841 ft



W-4, Preston 119 (W. Va.), Cities Service, No. Q-1, USA, 1964
location: 4300 ft S of lat 39°15'N
21,000 ft W of long 79°30'W
scales: gamma ray: 6900-9500: 0-150 API units
neutron: 6900-9500: 1400-1800 API units
lithology from GEOLOG and well cutting and core descriptions by Diecchio.
surface elevation: 2172 ft
cored interval: 7164-7437



W-5, Grant 2 (W. Va.), Shell No. 1, Greenland Lodge, 1965
location: 20,400 ft S of lat 39°15'N
16,300 ft W of long 79°05'W
scales: gamma ray: 0-480: 0-200 API units
480-2100: 0-150 API units
neutron: 0-480: 0-8000 API units
480-1600: 0-4000 API units
1600-2100: 0-800 API units
lithology from well cutting descriptions by Diecchio.
surface elevation: 2362 ft



not sampled

210 ft ss, white to clear (quartzitic); sh, med dk gry (N4) to lt ol gry (5Y6/1).

90 ft ss, white to clear.

60 ft ss, sm as ab; slst, pale red brn (10R5/4) to pale red (10R6/2).

80 ft ss, white to clear to med gry (N5); slst, lt brn (5YR5/6) to lt brn gry (5YR6/1).

690 ft slst, gry red (5R4/2), cyclically bdd in upper portion.

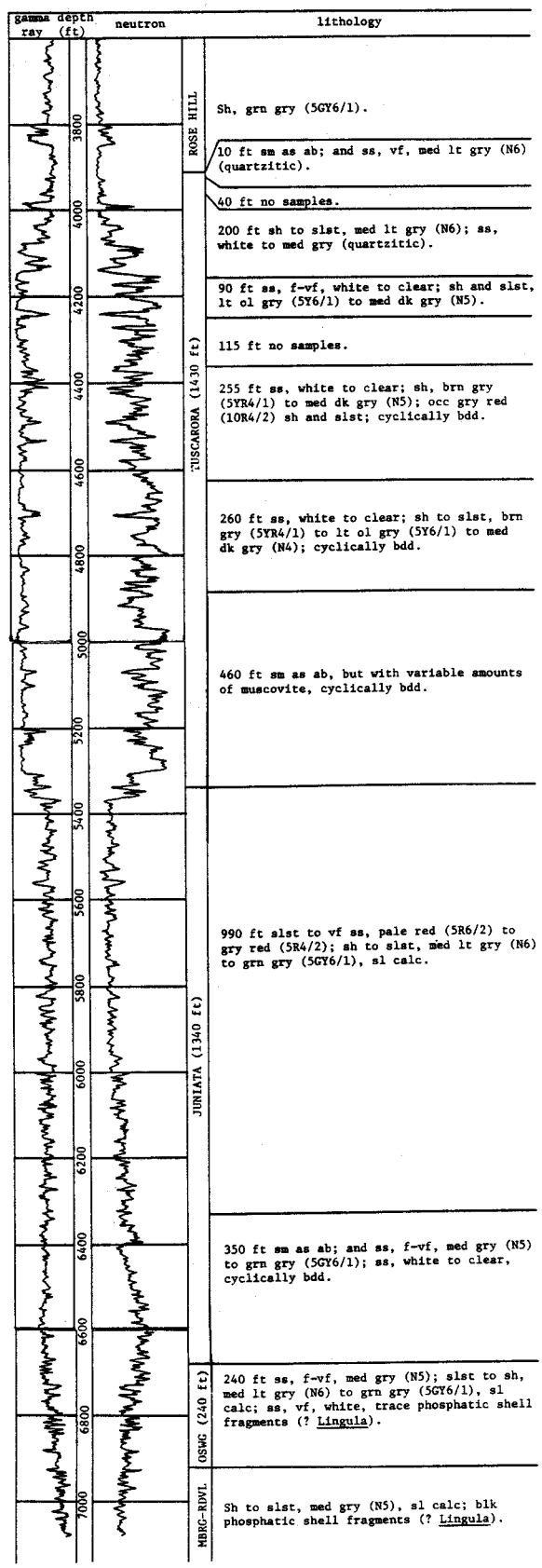
300 ft slst, gry red (5R4/2) to brn gry (5YR4/1); slst, med gry (N5) to grn gry (5GY6/1).

100 ft ss, f-vf, lt gry (N7) to med gry (N5); sh, med gry; trace gry red slst.

Sh, lt gry (N7) to med gry (N5); trace gry red slst; phosphatic chips (? Lingula fragments); sl calc.

W-6, Hampshire 12 (W. Va.), Shell No. 1, O.B. and R. Duckworth, 1964
location: 2100 ft S of lat 39°30'N
17,500 ft W of long 78°35'W
scales: unknown
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 960 ft.

Tuscarora is overthickened, probably due to faulting.



Sh, grn gry (5GY6/1).

10 ft sm as ab; and ss, vf, med lt gry (N6) (quartzitic).

40 ft no samples.

200 ft sh to slst, med lt gry (N6); ss, white to med gry (quartzitic).

90 ft ss, f-vf, white to clear; sh and slst, lt ol gry (5Y6/1) to med dk gry (N5).

115 ft no samples.

255 ft ss, white to clear; sh, brn gry (5YR4/1) to med dk gry (N5); occ gry red (10R4/2) sh and slst; cyclically bdd.

260 ft ss, white to clear; sh to slst, brn gry (5YR4/1) to lt ol gry (5Y6/1) to med dk gry (N4); cyclically bdd.

460 ft sm as ab, but with variable amounts of muscovite, cyclically bdd.

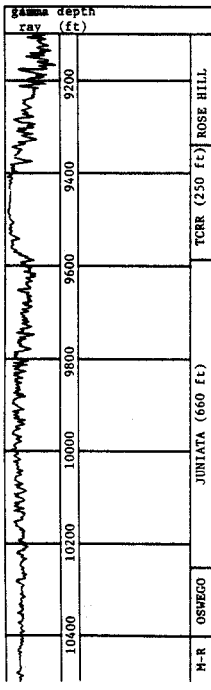
990 ft slst to vf ss, pale red (5R6/2) to gry red (5R4/2); sh to slst, med lt gry (N6) to grn gry (5GY6/1), sl calc.

350 ft sm as ab; and ss, f-vf, med gry (N5) to grn gry (5GY6/1); ss, white to clear, cyclically bdd.

240 ft ss, f-vf, med gry (N5); slst to sh, med lt gry (N6) to grn gry (5GY6/1), sl calc; ss, vf, white, trace phosphatic shell fragments (? Lingula).

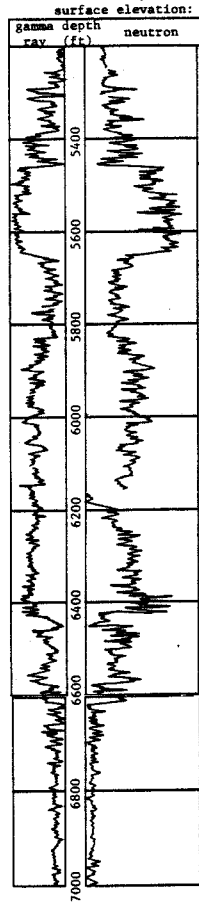
Sh to slst, med gry (N5), sl calc; blk phosphatic shell fragments (? Lingula).

W-7, Hardy 3 (W. Va.), United Fuel No. 1, A. Baughman, 1962
location: 26,000 ft S of lat 39°05'N
13,600 ft W of long 78°45'W
scales: gamma ray: 9100-10,500: 0-200 API units
lithology from GEOLOG and well cutting descriptions by J.O. Sayre, United Fuel Gas Company.
surface elevation: 1965 ft



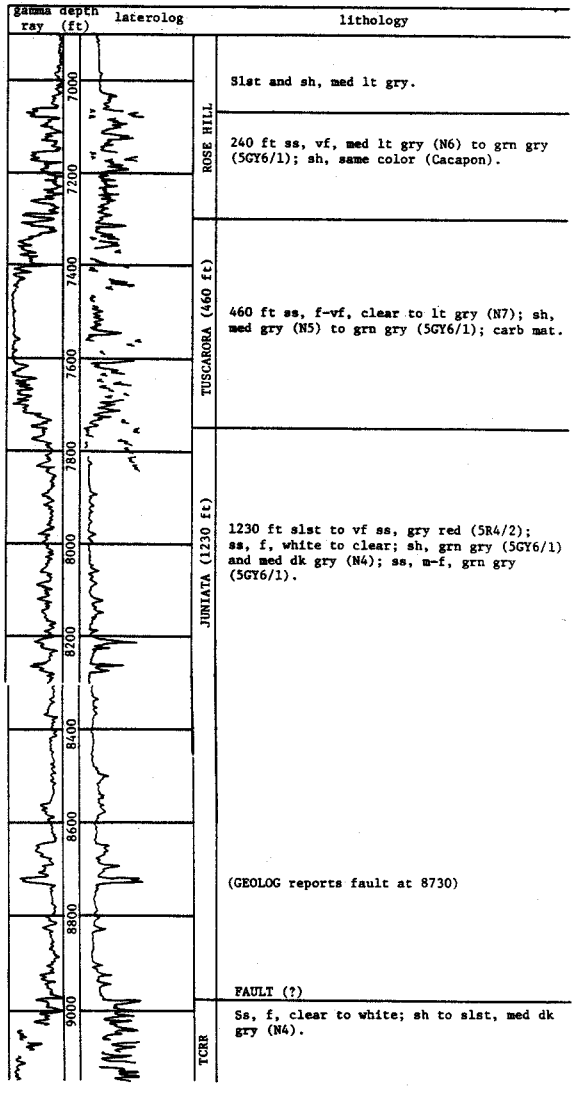
	lithology
ROSE HILL	Sh, lt grn to gry; ss, m-f, gry brn to gry; ls, gry brn.
	90 ft ss, c-f, gry, brn and grn; sh, gry to blk (Cacapon).
TCRR (250 ft)	250 ft ss, m-f, white to clear (quartzitic); sh, dk gry.
JUNIATA (660 ft)	60 ft ss, f-vf, pale grn; sh, gry to lt grn.
	190 ft ss, m-f, pale grn to pnk; sh, lt grn to dk gry; ls, gry brn.
	110 ft ss, c-f, pale grn to red; sh, lt grn to dk gry; ls, gry brn.
	100 ft ss, c-f, white to clear; sh, blk to pale grn; ls, dk gry brn.
	200 ft ss, c-f, white to red; sh, pale grn to dk gry; mdst, red; ls, dk brn.
OSWEGO	150 ft ss, m-f, gry to grn; sh, pale grn to dk gry; ls, brn.
M-R	Sh, pale grn to blk; ss, c-f, white to gry; ls, dk brn; fslfs.

W-8, Rockingham W-1432 (Va.), Shell No. 1, R.J. Whetzel, 1965
location: 25,000 ft S of lat 38°50'N
11,000 ft W of long 78°55'W
scales: gamma ray: 5200-7000: 0-150 API units
neutron: 5200-6168: 0-3000 API units
6168-7000: 0-2000 API units
lithology from GEOLOG, sample description log by S.S. Johnson, Virginia Division of Mineral Resources, and well cutting descriptions by Diecchio.
surface elevation: 1465 ft

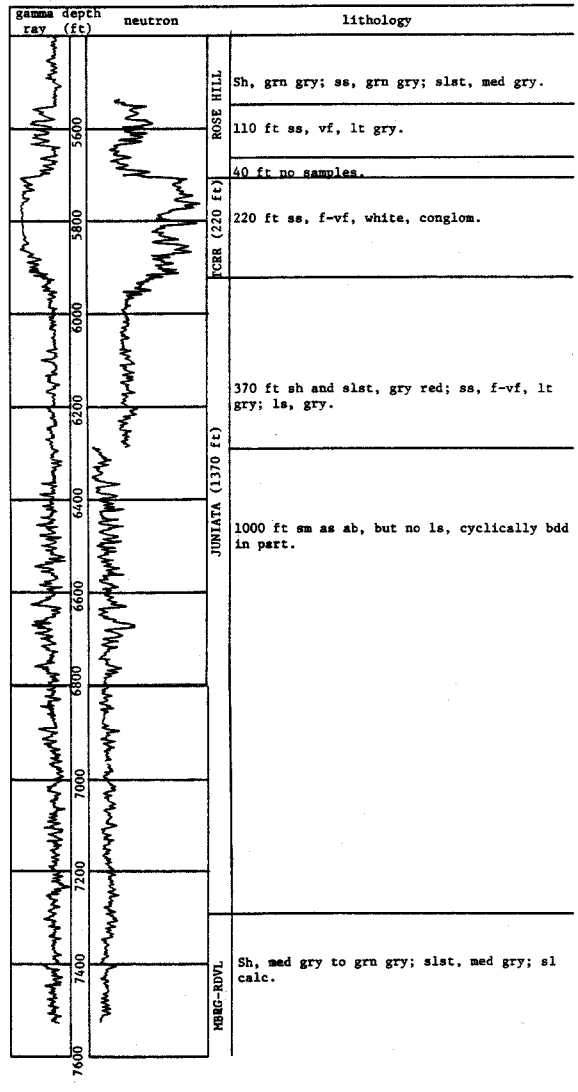


	lithology
ROSE HILL	Sh, grn gry (5G6/1) to med gry (N5) and gry red prp (5RP4/2); ss, lt grn to white (quartzitic). Ss is most abundant component below 5410. No red sh below 5320.
TCRR (220 ft)	220 ft ss, white to lt gry to lt grn; sh, grn gry to med gry. Sh is rare below 5500.
JUNIATA (530 ft)	530 ft slst to vf ss, gry red (5R4/2); ss, white to lt gry; sh, gry red, sl calc; rare lt gry ls; cyclically bedded.
OSWEGO (410 ft)	170 ft ss, f-vf, clear to dk gry (N3); trace dk gry (N3) sh.
	240 ft ss, f, white to dk gry (N3); ss, clear; sh, dk gry (N3). Clear ss is most abundant component below 6450.
MARTINSBURG-REEDSVILLE	180 ft sh, dk gry (N3); ss, vf to slst, med gry (N5). Ss abundance decreases downward.
	Sh, dk gry (N3); ls, lt gry (N7) to dk gry (N3).

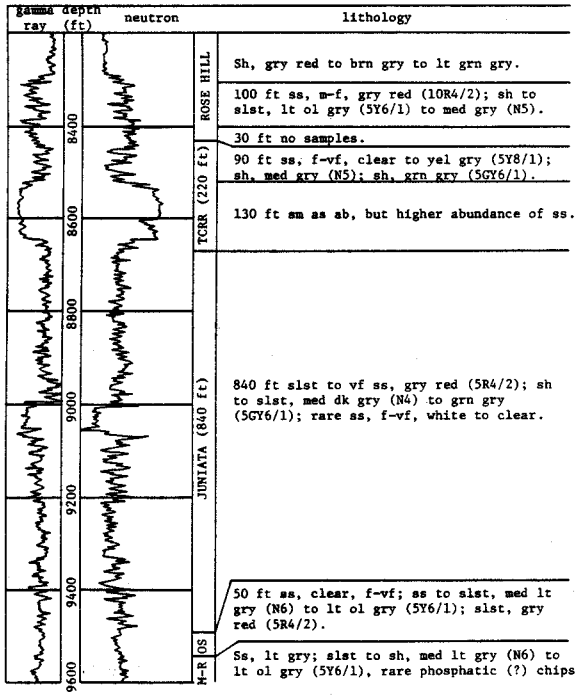
W-9, Randolph 101 (W. Va.), Cities Service No. 2, D.H. Hill and Arnold Consol, 1960
location: 3.38 miles S of lat 38°50'N
1.78 miles W of long 79°40'W
scales: gamma ray: 6900-9000: 0-10 API units
laterolog: unknown
lithology from GEOLOG, sample description log of Columbian Carbon Company, and well cutting descriptions by Diecchio.
surface elevation: 2920 ft



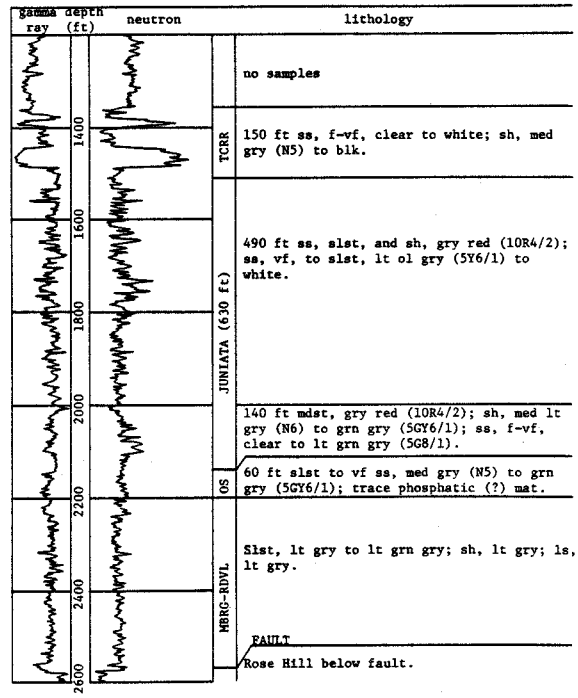
W-10, Randolph 103 (W. Va.), Hope Natural Gas Company, West Virginia Board of Control, 1961.
location: 14,900 ft S of lat 38°45'N
15,650 ft W of long 80°55'W
scales: gamma ray: 5400-7600: 0-15 API units
neutron: 5400-6300: 0-480 API units
6300-7600: 0-3680 API units
lithology from GEOLOG.
surface elevation: 2036 ft



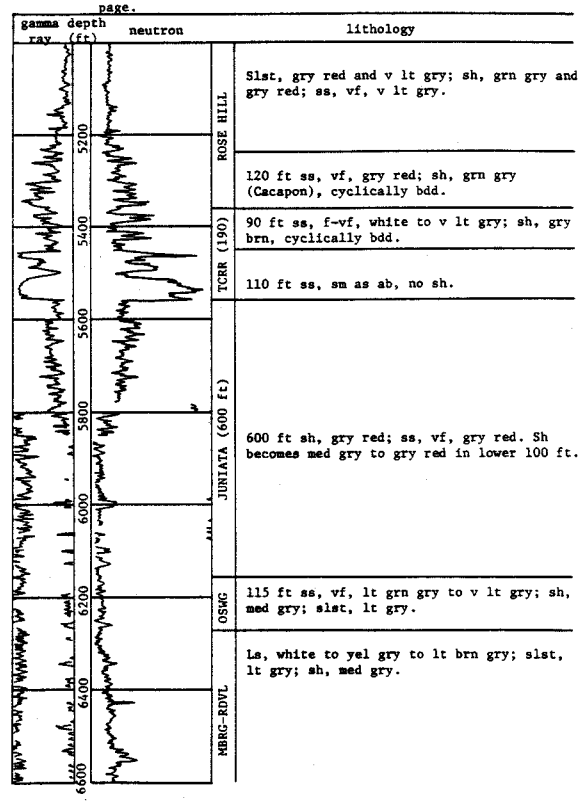
W-11, Pocahontas 18 (W. Va.), Cities Service No. L-1, USA, 1961
location: 2.35 miles S of lat 38°35'N
0.98 mile W of long 79°40'W
scales: gamma ray: 8200-9600: 0-10 API units
neutron: 8200-9000: 0-2400 API units
9000-9600: 600-3000 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 3780 ft



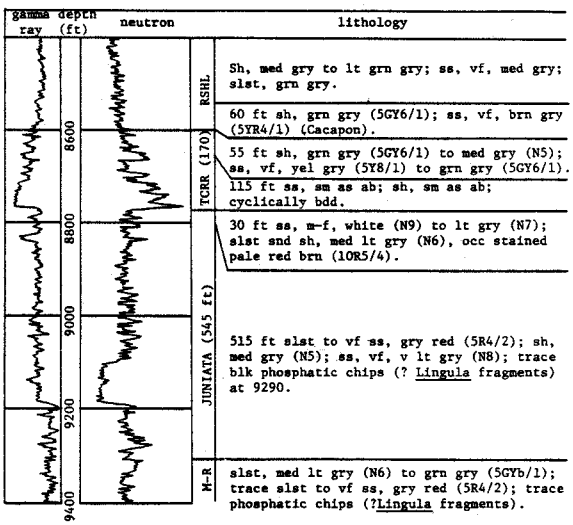
W-12, Pocahontas 21 (W. Va.), Tidewater No. 1, U.S. Forest Service, 1963
location: 5050 ft S of lat 38°10'N
3300 ft W of long 80°00'W
scales: gamma ray: 1200-2600 and 5000-6600: 0-150 API units
neutron: 1200-1360: 0-1340 API units
1360-2600: and 5000-5755: 266-2934 API units
5755-5800: 0-4000 API units
5800-6600: 1600-5600 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 3505 ft



Section repeated by faulting. Depths not continuous from previous page.



W-13, Greenbrier 17 (W. Va.), Union Oil of California No. 1, G. L. Walton, 1967
location: 11,350 ft S of lat 38°05'N
15,100 ft W of long 80°20'W
scales: gamma ray: 84-0-9400: 0-200 API units
neutron: 8400-9100: 0-800 API units
9100-9400: 0-1600 API units
lithology from GEOLOG and well cutting descriptions by Diecchio.
surface elevation: 2786 ft



Sh, med gry to lt grn gry; ss, vf, med gry; slst, grn gry.

60 ft sh, grn gry (5GY6/1); ss, vf, brn gry (5YR4/1) (Cacapon).

55 ft sh, grn gry (5GY6/1) to med gry (N5); ss, vf, yel gry (5Y8/1) to grn gry (5GY6/1).

115 ft ss, sm as ab; sh, sm as ab; cyclically bdd.

30 ft ss, m-f, white (N9) to lt gry (N7); slst snd sh, med lt gry (N6), occ stained pale red brn (10R5/4).

515 ft slst to vf ss, gry red (5R4/2); sh, med gry (N5); ss, vf, v lt gry (N8); trace blk phosphatic chips (? Lingula fragments) at 9290.

slst, med lt gry (N6) to grn gry (5GYb/1); trace slst to vf ss, gry red (5R4/2); trace phosphatic chips (?Lingula fragments).