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Guide Leaflet

Allegheny Front Trip:
Blue Knob - East Freedom - Hollidaysburg -
Williamsburg Area, Pennsylvania

By
Frank M. Swartz

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General geologic character of the
Allegheny Front region between
Johnstown and Williamsburg

The Allegheny Plateau Province of relatively flat Carboniferous rocks, within which Johnstown is located, is terminated on the east by the rise of great anticlinal arches, including those of Morrison Cove and Nittany Valley. Within a few miles these profound upfolds bring to the surface over four miles in thickness of Paleozoic strata, ranging down through the Mississippian, Devonian, Silurian, and Ordovician Systems into the middle part of the Cambrian. The lower part of the exposed sequence consists largely of limestones and dolomites; higher portions are composed mostly of shales and sandstones that total about three miles in thickness.

The Allegheny Front Trip has been arranged to provide visits to many though not all of the parts of this great sedimentary succession, which bears witness to the long continued, repeated Paleozoic inundations of the Appalachian region, and to the correspondingly vast erosion of the old lands of Appalachia on the east. If the day is clear, the trip will also provide panoramic views that finely exhibit geomorphic features of the country, and give insight into the controlling geologic structures. The best of these is seen from Blue Knob fire tower, where from an altitude of about 3200 feet at the tower platform there lies in sight a stretch of country reaching from Laurel Hill on the west to the Broad Top Mountains on the east, and from the vicinity of Tyrone on the north almost to the Maryland line on the south. Fine views are also visible from the points where the route crosses the Allegheny Front east of Windber, and Tussey Mountain east of Williamsburg.

The nature of these panoramas, and of the geologic structures of the area, are indicated by the accompanying block diagram and geologic map, Plates I and II, at the back of this leaflet. Thus the area of the foothills and valley between the Front and Dunning Mountain is essentially monoclinal, bringing to the surface progressively lower beds of the Devonian and Silurian Systems. Morrison Cove and Williamsburg Valley are cut into the Cambro-Ordovician limestones along the middle of a great faulted and complicated anticline. The sequence then plunges once more into the earth, bringing down the Silurian in and alongside Tussey Mountain, then the Devonian and Mississippian, and finally part of the Pennsylvanian in the coal fields of Broad Top Mountain.

Stratigraphic sequence of the
Allegheny Front region between
Johnstown and Williamsburg

The stratigraphic rock succession that rises to the surface in the vicinity of the Allegheny Front between Johnstown and Williamsburg, Pennsylvania, is as follows.

Pennsylvanian System

Monongahela formation (small remnants on a few hilltops)
Conemaugh formation, 900 feet
Allegheny formation, 300 feet
Pottsville formation, 250 feet

Mississippian System

Mauch Chunk red beds, 200 feet (1000 feet in Broad Top area)
Loyalhanna limestone, sandy, cross-bedded, 50 feet
Pocono sandstone, 1000 feet, including resistant Burgoon
sandstone, 300 feet, above, and green and some red sandstone
and shale below.

Devonian System

Catskill red beds, 2500 feet; Butts suggests revival of
name Hampshire for these strata
Chemung shale and sandstone, 2500 feet
Brallier shale, 1800 feet
Harrell shale, dove gray, fissile, 200 feet
Burket black shale, 75 feet
Tully limestone, 2 to 5 feet
Hamilton (Mahantango) shale, 1200 feet
Marcellus black shale, 200 feet
Onondaga shale and limestone, 80 feet
Oriskany group
Ridgeley sandstone, 120 feet
Shriver chert or siliceous limestone, 120 feet
Helderberg group
Mandata shale, 30 feet
New Scotland limestone, 15 feet
Coeymans limestone, 15 feet

Silurian System

Keyser limestone, 140 feet
Tonoloway limestone, 650 feet
Wills Creek shale, 450 feet
Bloomsburg red beds, 50 feet
McKenzie shale and limestone, 350 feet
Clinton group
 Rochester shale, 40 feet
 Keefer sandstone, 15 feet
 Rose Hill shale, 700 feet
 Castanea sandstone, red and green, 25-75 feet
Tuscarora sandstone

Ordovician System

Juniata red beds, 1200 feet
Bald Eagle sandstone, 600 feet to north, disappearing southward
Reedsville shale, 1200 feet
Trenton limestone, 400 feet
Black River limestones, 250 feet
Chazy limestones, 200 feet
Beekmantown group (Canadian System of Ulrich)
 Bellefonte dolomite, 1000 feet
 (Axemann limestone, to northeast)
 Nittany dolomite, 1000 feet
 Larke dolomite, 250 feet (replacing Stonehenge limestone)

Cambrian System

Mines dolomite, 250 feet, with siliceous oolite
Gatesburg sandstone and dolomite, 1750 feet
 (The Larke, Mines, and Gatesburg are referred by Butts to
 Ulrich's Ozarkian System)
Warrior limestone, 1200 feet
Pleasant Hill limestone, Middle Cambrian, 200 feet plus
Concealed below present level of erosion; strata of the
 underlying parts of the Cambrian are brought up in the
 South Mountains to the east near Gettysburg

Route of the Allegheny Front Trip

The route of the Allegheny Front Trip of the Eleventh Annual Field Conference of Pennsylvania Geologists, beginning at Johnstown, Pennsylvania, extends southeastward along highway No. 56 across the southern part of the Johnstown quadrangle and northeastern part of the Windber quadrangle, to the first stop at the summit of the Allegheny Front $1\frac{1}{2}$ miles east of Ogle-town in the Bedford quadrangle. The route of the remainder of the trip, and locations of numbered stops, are illustrated in Figure 1, in relation to boundary lines of the respective 15-minute quadrangle maps of the United States Geological Survey.

General Geologic Features of Area of the Allegheny Front Trip

Beginning at Stop No. 1, the Allegheny Front Trip of the Eleventh Annual Field Conference of Pennsylvania State Geologists affords opportunity to examine the Burgoon sandstone that generally is the principal crest-maker of the Allegheny Front in Pennsylvania, and at the same time provides fine panoramic views of a region in which geomorphic features beautifully reflect the geologic structure as well as the stratigraphic sequence and erosional history. Stop No. 2 is located on an even higher eminence made by the Burgoon sandstone, and provides westward as well as southward, eastward and northward vistas. Stops Nos. 3, 4 and 5 exhibit the Upper Devonian Chemung shales, silty shales and minor sandstones and conglomerates, with abundant fossils that give evidence of accumulation in shallow, well oxygenated marine waters of the Devonian "Golden Age of Brachiopods" rather than in the freshened waters that were the scene of deposition of the overlying Catskill red mudstones, siltstones and sandstones, and in which fossils are sparse although there are a few dermal plates of Devonian armored-skin fishes. The middle and upper Chemung sediments, even where brachiopods are abundant, are in part purplish to purplish red in color, giving predictive evidence of the changes by which the Chemung strata grade laterally into the thickened Catskill red beds of more easterly areas. Locally in the Chemung there are peculiarly enrolled layers that have been termed "storm-rollers" but that perhaps were formed by slumping of the rapidly accumulating clayey sediments rather than by wave or current action. With the overlying Catskill and underlying Brallier shales and siltstones and Harrell and Burket shales, as well as the Hamilton and Marcellus shales of Stop No. 6, the Chemung regionally gives evidence of

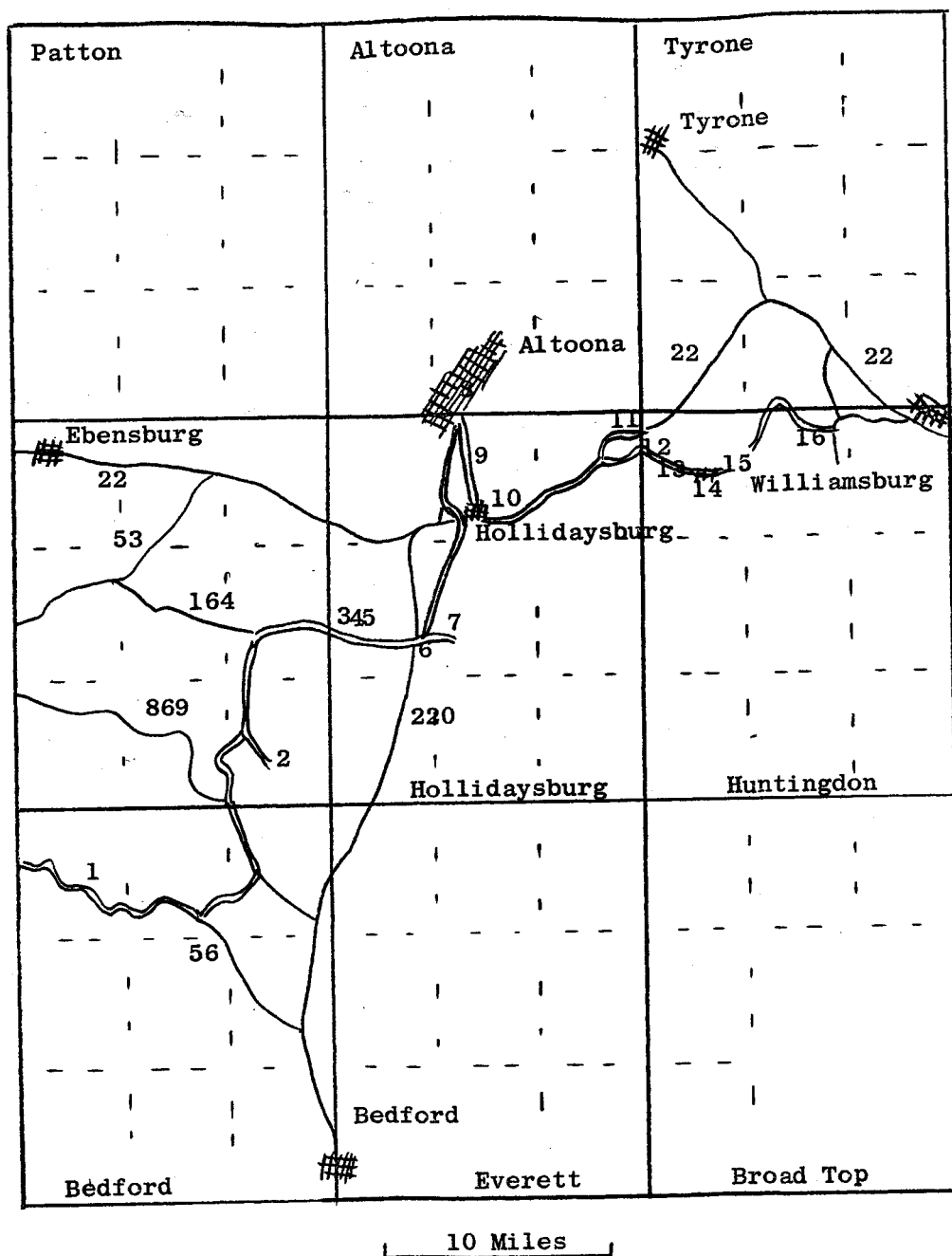


Figure 1. Map of quadrangles of Hollidaysburg - Huntingdon area, showing route of trip and locations of numbered stops.

rapid Appalachian geosynclinal accumulation of many thousands of cubic miles of clays, silts and sands that were eroded from easterly emergent and periodically rejuvenated land surfaces. The Catskill-type rocks represent the fresher-water sediments of the flood plains, lagoons and delta areas of a broad delta-coast; the brachiopod-rich Chemung and Hamilton were deposited in adjacent areas of shallow marine waters; the more sparingly fossiliferous Brallier sediments and especially the Burket and Marcellus black shales accumulated in more offshore areas in which bottom waters became increasingly deficient in oxygen and bottom dwelling animals were reduced in numbers.

Brachiopods again are abundant in part of the Lower Devonian Oriskany sandstone and siliceous limestone and in the Helderberg limestones, as well as in the Upper Silurian Keyser limestone that are visited at Stops Nos. 8 and 10. The brachiopods, and in parts of the Helderberg and Keyser limestones the corals, bryozoa and crinoids, again give evidence of marine, shallow and well oxygenated waters that spread along the Appalachian region and that appear to have opened to oceanic regions toward both the north and south. In the Oriskany Shriver chert or siliceous limestone, trilobites are common in upper beds; complexly ornamented ostracodes are abundant in middle and upper beds, and there are sponge spicules and occasional conularids that suggest some temporary deepening of the Appalachian seas. Unlike the sediments of the Middle and Upper Devonian, and of most of the Silurian, the Oriskany-Helderberg-Keyser beds are not associated regionally with great infloods of clayey and silty sediments, and the easterly land surfaces appear to have been generally low and at the time not subject to rapid erosion.

Stops Nos. 7, 9 and 11 provide exposures of Wills Creek, Bloomsburg, McKenzie, Clinton and Tuscarora sediments of the Silurian System, and like the Upper and Middle Devonian strata reflect accumulation in the Appalachian geosyncline of clays, silts and sands eroded from twice-rejuvenated uplands of the easterly areas of Appalachia. Although thinner than their Devonian counterparts, these Silurian detritals in Pennsylvania must measure more than 20 thousand cubic miles in volume. The Bloomsburg mudrocks and siltstones, somewhat like the Catskill of the Upper Devonian, are a westerly extension of delta-coast red clays, silts and sands that thicken markedly and coarsen toward the east, and replace parts of the marine sediments with which they are associated near the Allegheny Front. The Tuscarora formation at the base of the Silurian is a great mass of well-winnowed quartz sand that has no counterpart in the Middle and Upper Devonian sediments. In cleanliness of quartz sand, many of the Tuscarora beds might be compared with the Ridgeley sandstone of the Lower Devonian Oriskany group, but the cement is silica without the calcite that is abundant in the Ridgeley through much of its extent; there are subordinate interbeds of silty shale; the abundant brachiopod life of the Ridgeley is absent and fossils are restricted to Scolithus and Arthropycus-type worm tubes and burrows, and to rare eurypterid fragments in some of the shale interbeds. The wide geographical extent of the Tuscarora sands, and the type of bedding and cross-bedding indicate that the Tuscarora sediments in general were spread across the floor and in neighboring lagoons of a wide, shallow sea-like body of water; but the lack of

brachiopod faunas comparable to those of the Ridgeley suggests that the waters were not marine in salinity, and the lack of calcite cement raises the question as to whether PH values may have been lowered somewhat below the neutral buffer condition found today in the ocean. Regionally, the Tuscarora sandstone is a westward, sandy tongue from the lower part of the Shawangunk conglomerate that at the Delaware Water Gap replaces both the Tuscarora and Clinton sediments of central Pennsylvania.

The section at Stop No. 9 provides exceptional opportunity to observe some of the ostracode and brachiopod zones of the Rose Hill, Rochester and McKenzie formations. Some of these zones have remarkable lateral as compared to vertical dimensions; the zone of Schuchertella elegans and Kloedenella cornuta has been traced through central Pennsylvania, western Maryland and parts of West Virginia and Virginia over an area of more than 10,000 square miles, but is never more than 10 feet thick and usually is 5 to 8 feet. The rapidity of faunal changes in these beds as compared to the Middle and Upper Devonian may represent in part greater rapidity of faunal evolution, but in part probably is due to a slower rate of accumulation of sediment. At the base of the Rochester shale or top of the Keefer sandstone, the one-foot Roberts (?) iron ore represents the type of self-fluxing "fossil ore" that was widely worked in central Pennsylvania during the time of the Civil War. Other thin layers rich in hematite occur in beds that are lithologically transitional from the Rose Hill shale to the Keefer sandstone, and several miles south of Stop No. 9 there are old workings in hematitic layers in the lower part of the Rose Hill shale.

In the rocks of the Ordovician System, the route of the trip crosses without planned stops the outcrop belts of the Juniata red sandstone and mudstone, Bald Eagle or Oswego gray sandstone and Reedsville shale, all reflective of the Taconic orogeny that elevated easterly land surfaces so that they were subjected to deep erosion. The Bald Eagle sandstone in its comparative coarseness reflects the culmination of what may be regarded as the first phase of the Taconic activity; the rejuvenations that gave rise to the westerly spreading of the Tuscarora sands and Bloomsburg silts of the Allegheny Front area constitute later paroxysms that might also be classed as part of the Taconic orogenic activity in a broader sense.

The Middle and Lower Ordovician and Upper Cambrian limestones and dolomites of Williamsburg Valley represent one of the major examples of carbonate sedimentation of the North American continent, and locally total about one and one-half mile in thickness. The easterly lands that were destined to give rise to the great flood of detritals constituting the bulk of the Upper Ordovician, Silurian and Devonian, and at least part of the Carboniferous sediments of the region, were relatively low and perhaps largely non-existent; quartz sands are abundant in the Upper Cambrian Gatesburg formation but appear to have been derived from the northwest rather than from the east. The Middle Ordovician formations consist mostly of limestones, which are in part highly fossiliferous; some of these limestones have been worked in the past for fluxstone, but none of them near Williamsburg attain the degree of purity found in the Middle Ordovician Valentine limestone which is extensively mined farther to the northeast near

Bellefonte. The Lower Ordovician and Upper Cambrian rocks dominately are dolomites or at least dolomitic limestones; regionally but not necessarily locally in the Cambro-Ordovician limestones there appears to be a tendency of a dolomitic facies to increase toward the west and north-west as compared to the southeast; heightened salinities due to increased relative evaporation in shallowed waters, and lesser inflow of normal sea waters and perhaps of runoff from lands, may have been factors in both regional and local patterns of the dolomitic and limestone facies.

The limestone valley at Williamsburg is cut into the most highly upfolded, local portion of the Nittany Valley Arch; this arch is a major Appalachian anticlinorium, and separates the synclinorium of the Broad Top coal field from the far broader synclinorium of the Allegheny Plateau area to the west of the Allegheny Front. Large but nevertheless secondary overthrusts complicate the structure of the anticlinorium at Williamsburg.

Geology along Route of the Allegheny Front Trip

Geologic features directly along the route of the Allegheny Front Trip, and at the selected stops, can be summarized as follows.

Taking highway No. 56 from Johnstown through Scalp Level and Windber, the trip crosses the Pennsylvanian Conemaugh and Allegheny formations in the northerly extensions of the Somerset and Berlin coal basins. The Pennsylvanian Pottsville sandstone and Mississippian Mauch Chunk red shale rise to the surface just west of Ogeltown in the Bedford quadrangle. At Ogeltown, the Mississippian, cross-bedded Loyalhanna limestone is well exposed in a quarry, with arenaceous laminae or bands characteristically weathered in relief.

Stop No. 1, at summit of Allegheny Front, where it is crossed by Highway No. 56 at an altitude of 2600 feet. Park cars at summit and walk partway down hill. There is a fine view to the east and south, to and beyond ridges made by Tuscarora sandstone. To the east, Dunning Mountain, its height about 2060 to 2200 feet, has a summit scarred by workings for ganister rock used in the manufacture of silica brick. Followed southward, Dunning Mountain is offset by the syncline at Dunning cove, and is then known as Evitts Mountain. Bedford and nearby Bedford Gap in Evitts Mountain are clearly visible on a good day. The anticlinal Wills Mountain rises just west of Bedford, its western limb cut lower than the eastern part, and breached by gaps. West of Wills Mountain, and almost 15 miles farther south, is the tip of Savage Mountain, where the Pocono and Pottsville are brought down by the syncline of the Frostburg coal field.

In the foreground, the Front drops steeply to 2100 feet near the base of the Pocono, then extends into foothills in which the limits of the red Catskill are visible in the soil. Beyond are seen the brownish soils of the Chemung and lower beds, and the Oriskany sandstone rises to the surface in the gentle anticline of small Chestnut Ridge toward Schellsburg.

The lower part of the Burgoon sandstone member of the Mississippian Pocono sandstone is well exposed along the highway near the summit of the mountain; farther west in Pennsylvania, the subsurface extension of the Burgoon is widely known to drillers as the "Big Injun Sand". Downslope along the highway are exposures of lower parts of the Pocono, including red beds presumably representative of the Patton red shale member. Along this part of the Front the base of the Pocono has been drawn at the base of a 180-foot body of greenish sandstone. Lower parts of the Pocono are believed to correspond to the Cuyahoga of Ohio, higher parts to the Logan of Ohio; the lowest part may include equivalents of rocks classified as uppermost Devonian farther west in Pennsylvania and in Ohio.

Return to cars, and continue south on Highway No. 56 to Pleasantville, crossing the broad belt of Catskill red beds, the lower part fairly well exposed, followed by crops of the uppermost Chemung, the underlying parts of that formation being mostly covered. At Pleasantville turn left on blacktop road to Weyant, following about along strike of basal Brallier and Harrell. Burket black shale is exposed along roadside about 1 mile south of Weyant. At Weyant intersect highway No. 869; follow 869 north to Pavia, on Ebensburg quadrangle, where there are extensive exposures of Catskill red beds. At Pavia turn right on dirt road ascending Blue Knob to the Blue Knob fire tower.

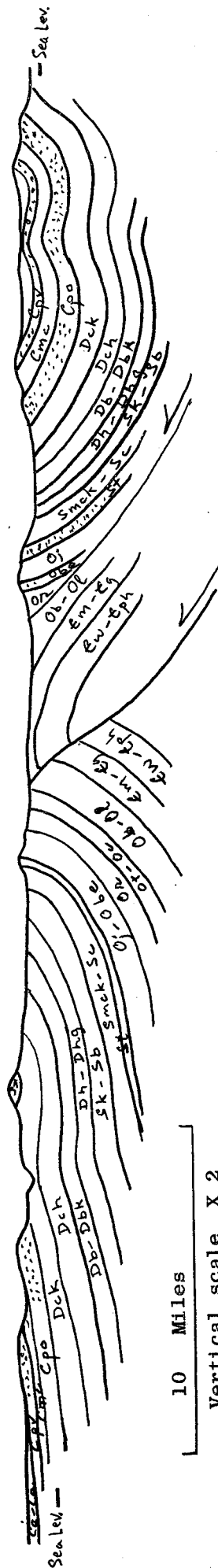
Stop No. 2, at Blue Knob fire tower. Blue Knob and three smaller summits north of it are made by remnants of Pocono sandstone in small outliers separated from the Allegheny Front proper by an upland at about 2400 feet, cut into Catskill red beds and now dissected by the valley of Bobs Creek. The upland appears to preserve part of the old peneplain represented by the tops of Dunning, Evitts, and Tussey Mountains. The summit of Blue Knob is at 3136 feet altitude, the tower platform being about 3200 feet. From the steps above tree-top level, it is possible to look westward across the Front, which here rises to 2700 or 2800 feet, and over the dissected uplands toward Portage and Johnstown with the hills at 2000 to 2200 or rarely 2400 feet, to the higher, anticlinal Laurel Hill. Turning to the northeast, Hollidaysburg and Altoona lie in the middle distance at about 1000 feet altitude; between them, an anticlinal rise of the Tuscarora sandstone makes Brush Mountain. Beyond Hollidaysburg is visible the faulted offset between Canoe and Locke Mountains. Turning to the east and southeast, the summit of Dunning Mountain is a thousand feet below us, and we look across Morrison Cove, with its faulted, anticlinally elevated Cambro-Ordovician limestones to Tussey Mountain made by the eastward plunge of the Tuscarora sandstone. In the far distance can be seen parts of Terrace and Broad Top Mountains, made by the Pocono and Pottsville, respectively. The structure in this direction is about as in Figure 2.

Toward the south the view is similar to that seen from the Front where crossed at highway No. 56.

Turn cars and drive part way down mountain, then turn right on dirt road to Blue Knob corner. The road is poor for 2 miles, then joins a blacktop road at Mount Hope Church on the flat of the old peneplain upland at 2400 feet altitude. Take right fork at church; at Blue Knob corner turn right on highway No. 164; proceed down hill; note the fine views toward Altoona at left; the road crosses Catskill red beds to the foot of the hill at Smith Church corner.

Stops Nos. 3, 4 and 5, on Chemung beds. The Chemung shale and sandstone is exposed almost continuously across its crop to about 1.8 miles from Smith Church. Three stops will be made; one in the upper Chemung, with its Spirifer disjunctus fauna, and with some chocolate colored beds; one about 1.1 miles from Smith Church, to see Saxton (?) conglomerate and a

Crest of Allegheny Front Blue Knob Dunning Mountain Tussey Mountain Broad Top Coal Basin Morrison Cove



10 Miles
Vertical scale X 2

Figure 2. General geologic structure and stratigraphy from Allegheny Front and Blue Knob eastward to Broad Top Coal Basin

Cc-Ca	Conemaugh, Allegheny	Sk-Sb	Keyser, Tonoloway,	Em-Eg	Mines, Gatesburg
CpV	Pottsville	Smck-Sc	Wills Creek, Bloomsburg	Ew-Eph	Warrior, Pleasant Hill
Cmc	Mauch Chunk	St	McKenzie, Clinton		
Cpo	Pocono		Tuscarora		
Dck	Catskill	Oj-Obe	Juniata, Bald Eagle		
Dch	Chemung	Or	Reedsville		
Db-Dbk	Brallier, Harrell, Burket	Ot-Oc	Trenton, Black River, Chazy		
Dh-Dhg	Hamilton, Marcellus, Onondaga, Oriskany, Helderberg	Ob-Ol	Bellefonte, Nittany, Larke		

"storm-roller" bed; a third lower in the Chemung, to collect Dalmanella tioga, Douvillina cayuta, Spirifer mesicostalis, and Spirifer disjunctus. The Chemung of this region is thought to be about the age of the type Chemung of western New York. Its supposed relations to the upper Devonian of Erie County, Pennsylvania, and to that of the Catskill Mountain of New York, are suggested by the accompanying diagram, Figure 3, that represents the present general understanding of the Upper Devonian deposits of the region.

Because their geologic age probably is younger than that of the type Catskill red beds of eastern New York, Butts favors use of the name Hampshire for the Late Devonian red beds of the Allegheny Front, raising of course the problem in stratigraphic taxonomy concerning age versus lithologic similarity and especially physical continuity of deposits.

Continue southeast on highway No. 164. Brallier shale crops out to East Freedom, with moderately good exposures. The thin Harrell, Burket, and Tully are concealed under alluvium at East Freedom. Cross highway No. 220, and Frankstown Branch of Juniata.

Stop No. 6, at first exposure of Hamilton shale. Tropidoleptus carinatus and Chonetes spp. are common, Spirifer mucronatus rare. Continuing along 164, the Hamilton (Mahantango) shale is extensively exposed on the left side of the road; there are then exposures of Marcellus black shale in shale pits to the right of the road. Intersect highway No. 36 and turn right for short distance into gap.

Stop No. 7. Park in abandoned part of highway that forks to left as you enter McKee Gap, after bearing right beyond a railroad overpass.

At and near McKee Gap, the rocks of the Silurian System are turned upright and squeezed close against Dunning and Short mountains. The Silurian section is not very satisfactorily exposed here, although lower Wills Creek, Bloomsburg, and McKenzie can be seen along the railroad just southeast of the railroad overpass, and Tonoloway and lower Keyser are found along a road leading northwest from the highway. The stop is made to see the Tuscarora sandstone which is almost completely exposed in a large quarry. In addition to the character of the rock, which is in general thick-bedded, of nearly pure quartz sand with silica cement, there are two features of special interest. First, at the top of the quarry sequence are inter-bedded sandstones and thin silty shales, the basal surfaces of several of the sandstone layers covered with one of the finest exhibits of Arthro-phycus found in the Appalachian area. Second, red sandstones and a little shale suggestive of the Juniata occur about 50 feet above the base of the Tuscarora, 25 to 35 feet above the footwall; in the same part of the sequence, conical pits on the upper surfaces of some of the beds are the openings of Scolithus worm tubes.

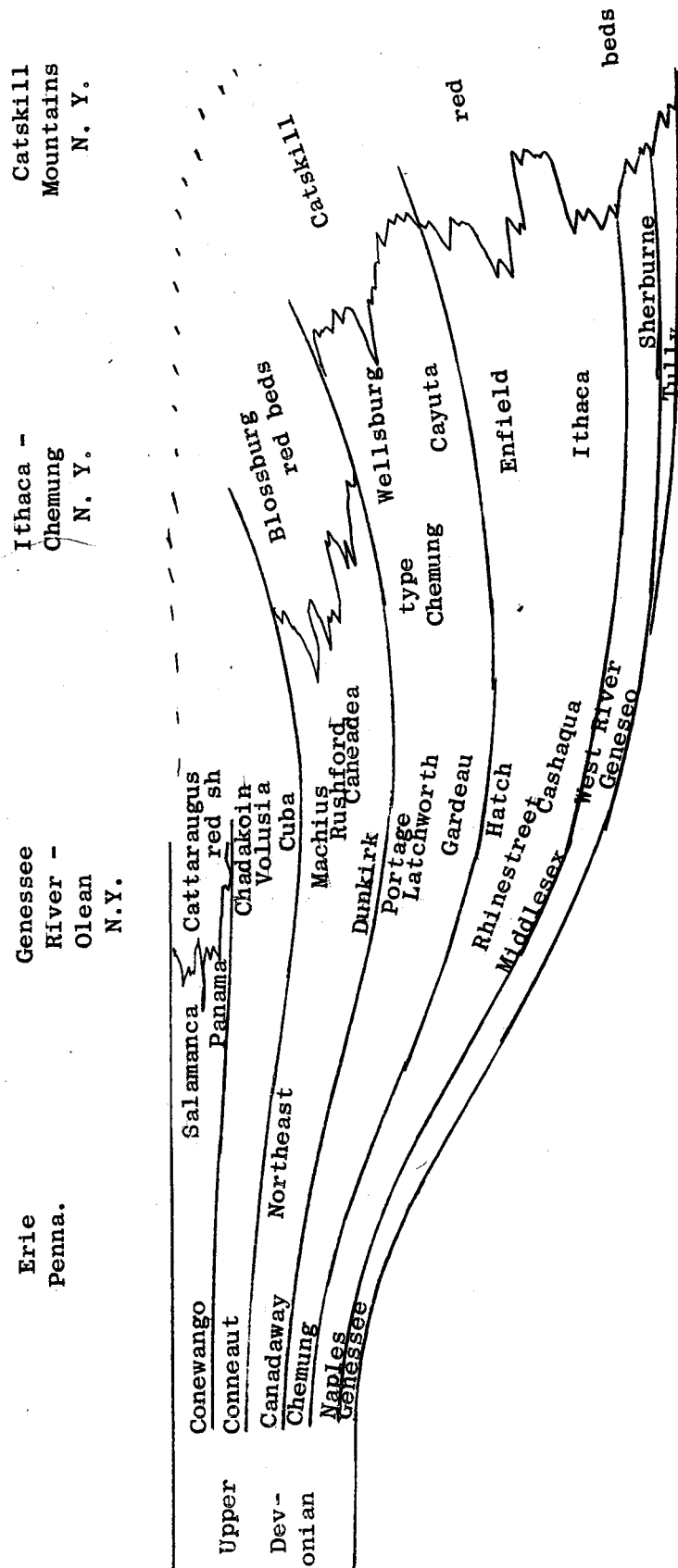


Figure 3. Chart illustrating stratigraphy of Upper Devonian sediments from area near Erie, Pennsylvania, to the Catskill Mountains in eastern New York. The Chemung shales near East Freedom are thought to be approximate equivalents of the type Chemung of the Ithaca - Chemung region of New York, so that the overlying Catskill red beds should be somewhat younger than the type Catskill of the Catskill Mountains.

Returning to the cars, note the hollow cut in the Juniata formation where it rises to the southeast of the Tuscarora of the mountain crest; the subordinate ridge or terrace of the southeastern slope of the mountain is made here, not by grayish Bald Eagle or Oswego sandstone as is true farther north, but by red sandstones of the Lower Juniata that appear to have replaced the grayish layers of the Bald Eagle.

Turn cars and proceed northwestward on highway No. 36, through the outskirts of Hollidaysburg to BethIsrael Temple in the southeastern part of Altoona.

Stop No. 8. The following section is exposed in the bluff of an old quarry on the southeastern side of the highway opposite the temple.

Lower Devonian

Helderberg group

New Scotland limestone

Thin-bedded limestone; lower part somewhat shaly, higher parts containing much dark chert. These thin beds are characterized by the distinctive Eospirifer macropleurus fauna, which provides correlation from New York to Virginia as well as to equivalent beds in western Tennessee. The exposures provide favorable conditions for collecting E. macropleurus as well as associated Isorthis perelegans, Schuchertella woolworthana, Strophonella punctulifera, Meristella arcuata and other species. Lithologically, the limestones compare with the Kalkberg limestone at the base of the New Scotland in eastern New York, rather than with the shales and shaly limestones of the main part of the New Scotland of that area.

18 feet

Coeymans limestone

Thick-bedded, gray, more or less coarsely crystalline, sparingly cherty limestone; upper 2½ feet shaly. Gypidula coeymanensis abundant. As in the New Scotland beds, the characteristic fauna provides correlation of a thin formation over a wide region.

9½ feet

Upper Silurian

Keyser limestone

Thin- to thick-bedded, aphanitic limestone, much of it laminated and weathering platy; well developed mud cracks occur on some bedding surfaces. Contact with Coeymans here

as elsewhere through central Pennsylvania is sharp, disconformable. Leperditia sp. (aa) 12 feet above base. One-foot biohermal mounds occur at 6 feet above base.

29 feet

Upper stromatoporoid reef-bed: thick-bedded with cabbage-like stromatoporoids. Reef-beds of these fossils are widespread in the Keyser limestone.

4 feet

Thick-bedded limestone; many stromatoporoides in lower 2 feet.

3½ feet

Thin-bedded, black limestone. Leperditia gigantea, other Ostracoda.

3 feet

Lower stromatoporoid reef bed.

9 feet

Thin-bedded limestone. Pholidops sp. (a).

5 feet

Thick-bedded gray crystalline limestone; at 10 to 20 feet below top, corals are abundant including Cladopora rectilineata, Halysites catenularia.

37 feet

Nodular, argillaceous limestone, moderately fossiliferous; limestones of this type are persistent in the lower part of the Keyser limestone from central Pennsylvania southward through western Maryland into the Virginias.

8 feet

Thick-bedded limestone, containing fossils presumably of calcareous algae.

24 feet

Tonoloway limestone

Laminated, aphanitic limestone of typical Tonoloway aspect.

12 feet

Concealed.

Return by highway No. 36 to highway No. 220; turn right then left on highway No. 220, toward Hollidaysburg.

Stop No. 9, about one-quarter mile before reaching entrance to Lakemont Park. Upper Clinton and McKenzie shales and limestones are exposed as follows.

Middle Silurian

McKenzie shale and limestone

Middle and upper parts concealed along highway. Material found in gutter and beside telephone poles of side road indicate that McKenzie formation is about 300 to 325 feet thick; the upper 75 to 100 feet consist of gray shale with thin interbeds of limestone that contain Stegerhynchus (Camarotechia) andrewsi, Spirifer Mackenzicus, Homeospira marylandica, Velibeyrichia mesleri, Kyammodos tricornis, Kloedenella gibberosa; these beds are underlain by possibly 10 to 20 feet of Rabble Run red mudstone, then by gray shale and interbedded limestone containing Kloedenella nitida.

200 feet

Calcareous shale and interbedded dark gray aphanitic limestone. Kloedenella intermedia.

25 feet

Thin- to medium-bedded, dark gray, light-weathering aphanitic limestone, with interbedded dark gray calcareous shale that is subordinate in lower part, more common above. Small bodies of flat-pebble limestone conglomerate, filling shallow depressions or trenches, are fairly common. In lower third, limestones are barren of fossils, but in upper two thirds there are thin coquinitic layers containing near top Kloedenella nitida and Kloedenella intermedia, and near middle Reticularia bicostata, Trematospira camura, Velibeyrichia moodeyi, Kloedenia normalia and recurrent Kloedenia ventralis.

60 feet

Thick-bedded, in part oolitic dark gray limestone, weathering into boulder-like masses. Favosites cf. F. niggarensis rare; Reticularia bicostata is abundant locally in lenticular coquinites.

5 feet

Thin- to medium-bedded dark gray limestone with interbedded shale that is abundant in lower part, subordinate near top; in lower part limestones are coquinites composed largely of Whitfieldella marylandica; in upper part limestones tend to become aphanitic and unfossiliferous, although there are some oolitic layers and thin lenticular fossiliferous layers. In addition to Whitfieldella marylandica, there are occurrences of Kloedenia ventralis, Velibeyrichia veronica, Dizygopleura conjugata.

9 feet

Thin-bedded shale, and interbedded gray sandy limestone; Schuchertella elegans - Kloedenella cornuta fauna; Paraechmina postica, Dizygopleura symmetica, Tentaculites niagarensis are common. This zone might be considered to be the top of the Rochester shale; it is repeated by a small fault.

8 feet

Clinton group

Rochester shale

Thin-bedded shale with numerous, thin interlayers of fine- to medium-crystalline limestone; Stropheodonta proutyi and Drepanellina clarki, abundant at many levels, disappear abruptly at the top, and Dalmanites limulus (?) is represented in the Schuchertella elegans zone only by rare fragments.

42 feet

Keefer sandstone

Calcareous sandstone, in part weathering ocherous, and some interbedded shale; at top, a 1-foot bed of fossiliferous hematite corresponds closely in position to the Roberts iron ore of western Maryland. Note that some of the fossil shells are replaced by specular hematite. Schuchertella subplana, Whitfieldella cf. intermedia are common.

15 feet

Rose Hill shale

Thin-bedded olive-colored to purplish shale, with interbedded limestone coquinites that contain Anoplothea sulcata, Mastigobolbina typus, and other species distinctive of the uppermost Rose Hill shale. At the top there are three thin layers of oolitic hematite.

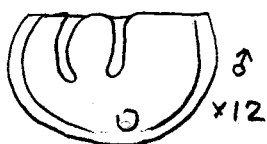
50 feet

Concealed along highway; near bottom of hill are shales containing the Mastigobolbina lata fauna of the middle part of the Rose Hill.

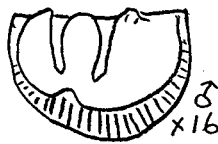
The Lakemont section provides exceptional opportunity for study of the remarkably sharp and thin faunal zones of the upper Rose Hill, Rochester and lower McKenzie beds. All of the zones observed at Lakemont can be traced through section after section from Danville and Williamsport, Pennsylvania, southwestward to the vicinity of Monterey, Virginia, covering an area of more than 10,000 square miles. Several of the ostracode zones, especially, are limited over this whole area to thicknesses of not more than 50 feet, and in several instances of less than 10 feet. Some of the distinctive ostracodes found at Lakemont are illustrated in Figure 4.

Among the fossils found at Lakemont, Mastigobolbina lata was found by James Hall in Middle Clinton beds at New Hartford, New York, and M. typus has been reported by Gillette in the Upper Clinton Williamson shale and Irondequoit limestone. Schuchertella subplana of the Keefer sandstone and Dalmanites limulurus of the Keefer sandstone and Rochester shale are common in the Rochester shale in New York, but the abundant Drepanellina clarki and most of its associated ostracodes are unknown in that State, as are most of the distinctive species of the Schuchertella elegans and Whitfieldella marylandica zones. Reticularia bicostata of the McKenzie beds occurs in New York in the Lockport dolomite, but the diagnostic McKenzie ostracodes have not been found in that area. It is plausible that the Keefer sandstone at Lakemont rather than the shale of the Drepanellina clarki zone is the age equivalent of the Rochester shale of New York; the McKenzie shale and limestone may be a nearer shore facies of parts of the Lockport of western New York, characterized by ostracode-rich faunas rather than by faunas of the more open water regions that characterize at least parts of the Lockport.

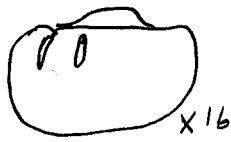
Lithologically, both the Rochester and McKenzie formations at Lakemont and generally in central Pennsylvania consist of shales and interbedded limestones that tend to erode, where not covered by Tuscarora talus, into a belt of low relief between adjoining lines of low hummocks formed on the one side by Keefer sandstone and on the other by siltstones of the Bloomsburg red beds. For mapping purposes, there is much to be said for joining the two formations in a single unit. Nevertheless, and even though the changes are transitional, the lithologic characteristics provide a basis for useful stratigraphic separation. The shales of the Drepanellina clarki zone contain 2- to 6-inch interlayers of gray highly fossiliferous limestones, in which cleavage faces show crystals more or less comparable in size to fine and coarse silt, with some larger crystals that in part at least represent crinoid or crinoid plates. Beginning in the upper part of the Whitfieldella marylandica zone, the highly fossiliferous limestone layers crowded with the shells of this species are replaced by other, very finely crystalline, "dense" or "aphanitic" limestones in which fossil shells generally are rare or absent, and in which there are minor but geographically widespread lenses or stringers of edgewise or flat-pebble limestone conglomerates filling hollows or trench-like depressions possibly cut under mud-flat conditions by waves or rills. The aphanitic limestone layers



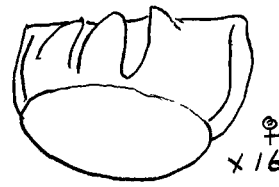
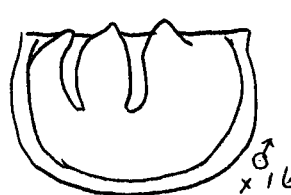
Zygobeyrichia ventricornis
U. & B., lower Wills Creek



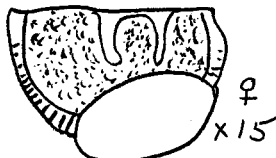
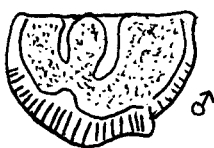
Velibeyrichia mesleri (U. & B.)
upper McKenzie, K. gibberosa zone



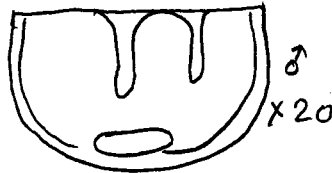
Kloedenella gibberosa U. & B.
upper McKenzie K. gibberosa
zone



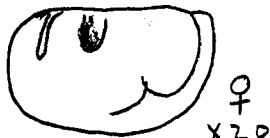
Kyammodos tricornis U. & B.
upper McKenzie K. gibberosa zone



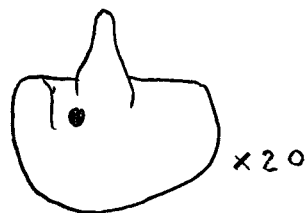
Velibeyrichia moodeyi (U. & B.)
lower McKenzie V. moodeyi zone



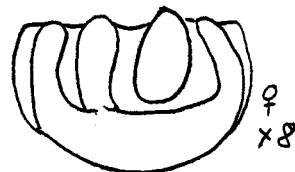
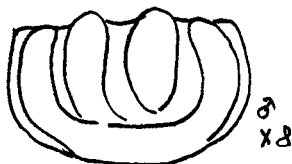
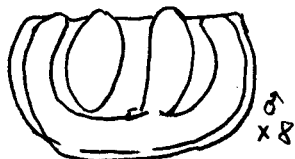
Kloedenia ventralis (U. & B.)
Lower McKenzie K. ventralis zone



Kloedenella cornuta (U. & B.)
Schuchertella elegans - K. cornuta
zone



Paraechmina postica U. & B.
S. elegans-K. cornuta and D. clarki
zones



Drepanellina clarki U. & B. Drepanellina clarki zone, Rochester shale



Mastigobolbina typus U. & B.
M. typus zone of Rose Hill shale



Mastigobolbina lata (Hall)
M. lata zone of Rose Hill shale

Figure 4. Middle Silurian zonal Ostracoda

of this type tend to be dominant in the 50 to 60 feet above the Whitfieldella marylandica zone at Lakemont, and are commonly one-half to one or two feet in thickness; the occurrence is however complicated by development near the base of some oolitic limestones, and at higher levels by beds containing Reticularia bicostata and some other fossils. At higher levels, thin layers rich in ostracodes become common, and other layers are present that are coquinites variably rich in pelecypods, gastropods or brachiopods, or rarely in straight-coned cephalopods; in the upper middle part of the McKenzie the Rabble Run red bed to be seen at Stop No. 11 is a tongue from the base of more easterly occurrences of the Bloomsburg red beds; above this again are gray shales with interbeds of coquinitic limestones containing abundant brachiopods and ostracodes.

The McKenzie formation is thus a lithologic complex of gray calcareous shales and interbedded limestones of diversified types that differs markedly from the overlying Bloomsburg red beds even though it contains a tongue from this formation, and that is less clearly separated from underlying Rochester beds by the development in its lower portion of an increased proportion of limestone interbeds which are in considerable part unfossiliferous. In view of the transitional character of the lithologic change from the Rochester into the McKenzie beds, the writer has separated them, for the purposes of stratigraphic description and measurement, at the abrupt boundary between the Drepanellina clarki and Schuchertella elegans zones, which can be found with almost knife-edge sharpness at section after section from Danville and Rock Haven, Pennsylvania, to Lewistown, and Lakemont, and then to Cumberland, Maryland, and southward to Monterey near Warm Springs, Virginia.

Continue by following No. 220 to Hollidaysburg; at traffic light, turn left on highway No. 22 toward Frankstown and Water Street.

Stop No. 10. Stop three-quarters of a mile east of Hollidaysburg, where high bluffs are formed by the Keyser limestone, and Helderburg and Oriskany beds also are well exposed. The section here is as follows:

Middle Devonian

Marcellus black shale

Fissile black shale, exposed along old road abandoned by present highway. 20 feet

Onondaga shale and limestone

Calcareous, greenish-to yellowish-weathering shale; thickness reduced by small fault. 10 feet

Lower Devonian

Oriskany group

Ridgeley sandstone

Thick-bedded, calcareous, yellowish-weathering sandstone, containing the Costispirifer arenosus, Rensselaeria ovoides var. fauna that shows close identity with the Oriskany sandstone of eastern New York. Near top, Edriocrinus sacculus. 105 feet

Shriver chert

Thin- to medium-bedded, dark impure chert or siliceous limestone, weathering punky, grading below into more shaly-appearing beds. Trilobite zone at top, with Synphoria lophella, Dalmanitoides platyglossis; Metaplasia plicata zone near middle. 120 feet

Helderberg group

Mandata shale

Thin-bedded, calcareous shale. 30 feet

New Scotland limestone

Thick-bedded limestone, with some bedded and some nodular chert; some thin shale interlayers near base. Eospirifer macropleurus fauna. 10 feet

Coeymans limestone

Thick-bedded crystalline limestone. Gypidula coeymanensis fauna; some heads of Favosites helderbergiae. Base very sharply defined where seen weathered above road-level, and containing a few fragments evidently from uppermost Keyser. 14 feet

Upper Silurian

Keyser limestone

Laminated limestone, containing zones of Leperditia gigantea. 43 feet

Medium- to thick-bedded, dense, somewhat argillaceous limestone. Spirifer vanuxemi and Rensselaeria mutabilis above, Pholidops cf. ovata below. 23 feet

Thick-bedded, somewhat lumpy limestone. Merista typa zone, with Calymene camerata. 5 feet

Medium-bedded limestone, with layers and nodules of dark chert. 22 feet

Thick-bedded, generally dense, mostly lumpy impure limestones, containing the Stenochisma deckerensis fauna. 37 feet

Thick-bedded, finely crystalline limestone. 10 feet

Tonoloway limestone

Dense, characteristically laminated limestone, weathering bluish gray. Some layers and lenses of dark chert 10 to 20 feet below top. 90 feet

Return to cars and continue eastward along high No. 22 for $1\frac{1}{4}$ miles to highway cuts just beyond Frankstown.

Stop No. 10A. The stop just east of Frankstown permits reexamination of the Ridgeley sandstone of the upper part of the section at stop No. 10, at a place where some of the rock retains unweathered carbonate cement, and where there also are exposures of shales of the overlying Onondaga formation.

Middle Devonian

Marcellus black shale

Fissile black shale

Onondaga shale and limestone

Concealed; some loose greenish shale. The rocks belonging at this horizon presumably consist of argillaceous limestone and calcareous shale.

30+ feet

Thin-bedded, greenish weathered shale, with a few thin interbeds of argillaceous limestone in upper 25 feet. Orbiculoidea media, Anoplotheca acutiplicata at 20 feet above base.

22 feet

Dark, sparingly arenaceous chert, the quartz sand possibly derived from reworking of some of the summit beds of the Ridgeley sand; post-Oriskany age of the chert is not fully assured.

2 feet

Concealed beneath the chert which is slumped by creep.

1+ feet

----- Disconformity? -----

Oriskany group

Ridgeley sandstone

Thick-bedded, calcareous, coarse-grained sandstone. Uppermost foot is subquartzitic, in part with some cherty cement; there is little or no calcareous cement, perhaps due in part to pre-Onondaga rather than modern weathering; open joints contain small crystals of quartz; this occurrence of permeable sandstone at the top of the Ridgeley may be comparable to occurrences of gas-producing

levels above tight sandstones in some of the gas fields northwest of the Allegheny Front. At 9 to 12 feet below top, there are numerous 3- to 4-mm. grains of quartz; below this level, the rock is more calcareous, and where fresh is medium gray because of the abundant calcareous cement, whereas where weathered it becomes yellowish and somewhat friable; fossils of the Costispirifer arenosus fauna are also more numerous.

40+ feet

Return to cars, and continue northeast along highway No. 22, with low ridge to left made by Oriskany-Helderberg-Keyser beds, low ridge to right made by siltstone or very fine-grained sandstone about at base of Brallier shale.

At about 1 mile beyond stop No. 10A, beyond Geeseytown, the highway curves sharply to the right; just beyond this curve there are exposures of the highest part of the Hamilton (Mahantango) shales overlain by Burket black shale and Harrell gray shale, then by silty shales and siltstones of lowest part of the Brallier shale.

At about 2 miles farther, the highway crosses the axis of the Canoe Valley syncline, and there is a high point that affords a view of Point View Knob, located in the northwestern part of the Huntingdon quadrangle. Point View Knob, like Locke Mountain toward its right and Canoe Mountain toward its left, is made by the Lower Silurian Tuscarora sandstone as it rises to ground surface in the southeasterly limb of Canoe Valley syncline. The Knob is separated from Lock Mountain by the gap cut by the Frankstown Branch of the Juniata River as its waters flow eastward toward junctute with the Juniata; on its other side the Knob is separated from Canoe Mountain by a wind gap eroded along an oblique fault that produces a 2-mile offset in the belt of outcrop of the Tuscarora sandstone. It is of interest that the river did not use the locus of the fault for its escape from Canoe Valley.

After passing Canoe Creek and small Canoe Creek settlement, the highway curves around the tip of a low ridge made by Oriskany, Helderberg and Keyser beds, and then there are exposures for about half a mile of thinly laminated Tonoloway limestone. At 1 mile beyond Canoe Creek, the highway cruves to the right, with extensive exposures of mudstones of the Wills Creek shale that weather to a characteristic yellowish green, that contain interbedded tongues of red mudstones of Bloomsburg type and are underlain by incompletely exposed Bloomsburg red mudstones and siltstones.

At junction with highway No. 203, keep left on highway No. 22. Red soils from the Upper Ordovician Juniata red mudstone and sandstone occur extensively in the road cuts. The highway then crosses the line of the fault offsetting Point View Knob from Canoe Mountain; at about 0.1 mile beyond the crossing over small Township Run park cars at widened part of highway to see section of Silurian beds southeast of the fault.

Stop No. 11. The following section is exposed in the western part of the windgap between Point View Knob and Canoe Mountain, beyond the highway curve at the position of the fault that offsets Canoe as compared to Lock Mountain.

Upper Silurian

Wills Creek shale

Calcareous shale and laminated, impure limestone.

100 feet

Thick-bedded mudrock, weathering greenish and tending to break irrespective of bedding; there are some interbeds of laminated impure limestone and calcareous shale. Tongues of red shale occur 11 to 12 and 18 to 22 feet above base.

92 feet

Bloomsburg red beds

Upper siltstone beds: thick-bedded red mudrock and siltstone, tending to break to hackly fragments.

24 feet

Thin-bedded greenish shale, above,
greenish mudrock, below. 11 feet

Lower siltstone beds: thick-bedded red
mudrock and siltstone, with greenish beds
11 to 21 feet above base. 34 feet

Middle Silurian

McKenzie shale and limestone

Upper marine member

Calcareous shale, weathering greenish,
and interlayers of fossiliferous limestone,
containing Kloedenella gibberosa fauna, with
Homeospira marylandica and Camarotoechia
andrewsi. 22 feet

Red shale. 6 feet

Thin-bedded shale and interbedded lime-
stone, some of limestones containing abundant
Kloedenella gibberosa ostracodes, some with
numerous Homeospira marylandica and Camaroto-
chia andrewsi. Some red shale 18 to 21 feet
above base. 94 feet

Rabble Run red bed member

Red silty shale, breaking across bedding;
8 feet of greenish shale in upper part. 45 feet

Lower marine member

Greenish shale, with several interlayers
of red shale in upper part, and some thin
layers of limestone. 63 feet

Concealed to east.

The sedimentary sequence finely illustrates the intertonguing relations of the Bloomsburg red beds which increase eastward and attain a thickness of 1500 to 2000 feet in the area from Harrisburg to the Delaware Water Gap. The Rabble Run red bed has increased from a few feet of reddish strata in the middle McKenzie near Cumberland and Bedford to the 45 feet seen in the present section, and this change is symptomatic of the lateral replacement of all of the upper McKenzie by the basal Bloomsburg, the upper

marine member of the McKenzie entirely disappearing in this fashion before reaching Lewistown. The thin red layers of the Wills Creek formation also increase in numbers and appear at higher and higher levels of the Wills Creek as that formation is traced toward Harrisburg, until finally the Wills Creek and apparently part of the Tonoloway are transmuted into Bloomsburg. The eastward changes in these strata, and in the lower beds of the Silurian and in the uppermost Ordovician are illustrated by the accompanying chart, Figure 5, based on work by the writer both with C. K. Swartz and separately.

Turn cars as convenient, return to bottom of hill, and turn left on highway No. 203 toward Williamsburg. It is interesting that Williamsburg Gap, which is next entered, has been cut by the Juniata without taking advantage of the fracturing of the fault that breaches and offsets the Tuscarora so short a distance to the northeast.

Entering the gap, note the great talus slopes of white Tuscarora sandstone, followed by exposures of the Juniata red beds and then by the greenish Bald Eagle sandstone which is here about 600 feet thick and forms the southeastern terrace or shoulder of the mountain. (Contrast with sequence at McKee Gap). The Reedsville shale is concealed for the most part, though loose material from the Orthorhyncula stvensoni^{zone} of the uppermost Reedsville can be found.

Stop No. 12. Stop near the first houses of Ganister village at the southeastern end of Williamsburg Gap. Along tracks 200 feet north of the highway are exposures of medium- to thin-bedded, dense, dark Salona limestone of Trenton limestone group, containing Sowerbyella sericea and Dinorthis pectinella. To the southeast of the Trenton large quarries are cut into Black River and Chazy limestone. The purer members of these formations have been opened at locality after locality along their outcrop belt from Bellefonte to Morrison Cove.

Beyond the quarries, near the highway bridge crossing the Juniata, are exposures of the topmost beds of the thick Bellefonte dolomite, the upper member of the Beekmantown group or Canadian of the region. The more distinctive beds of the Bellefonte are thick-bedded though often laminated, and are dense and tend to be much jointed; the joints open so that weathered surfaces have peculiarly gashed patterns. The weathering colors are commonly pale grayish yellow or yellowish white, though some beds are darker colored.

Continuing toward Williamsburg, Bellefonte beds are again exposed at the first railroad crossing. The road then curves left, and again to the right.

Stop No. 13. Beyond the right turn of the highway, stop for a review of the geologic structure and stratigraphy near Williamsburg. To the north across the Juniata River are bluffs formed by the early Upper Cambrian Warrior limestone. The formation contains two sandstone bodies that weather out in strong relief; sandstone blocks possibly from these layers are seen along the highway. The Warrior limestone is the lowest formation that will be in direct view on the trip; the next underlying Pleasant Hill limestone, the lowest formation cropping out in the region,

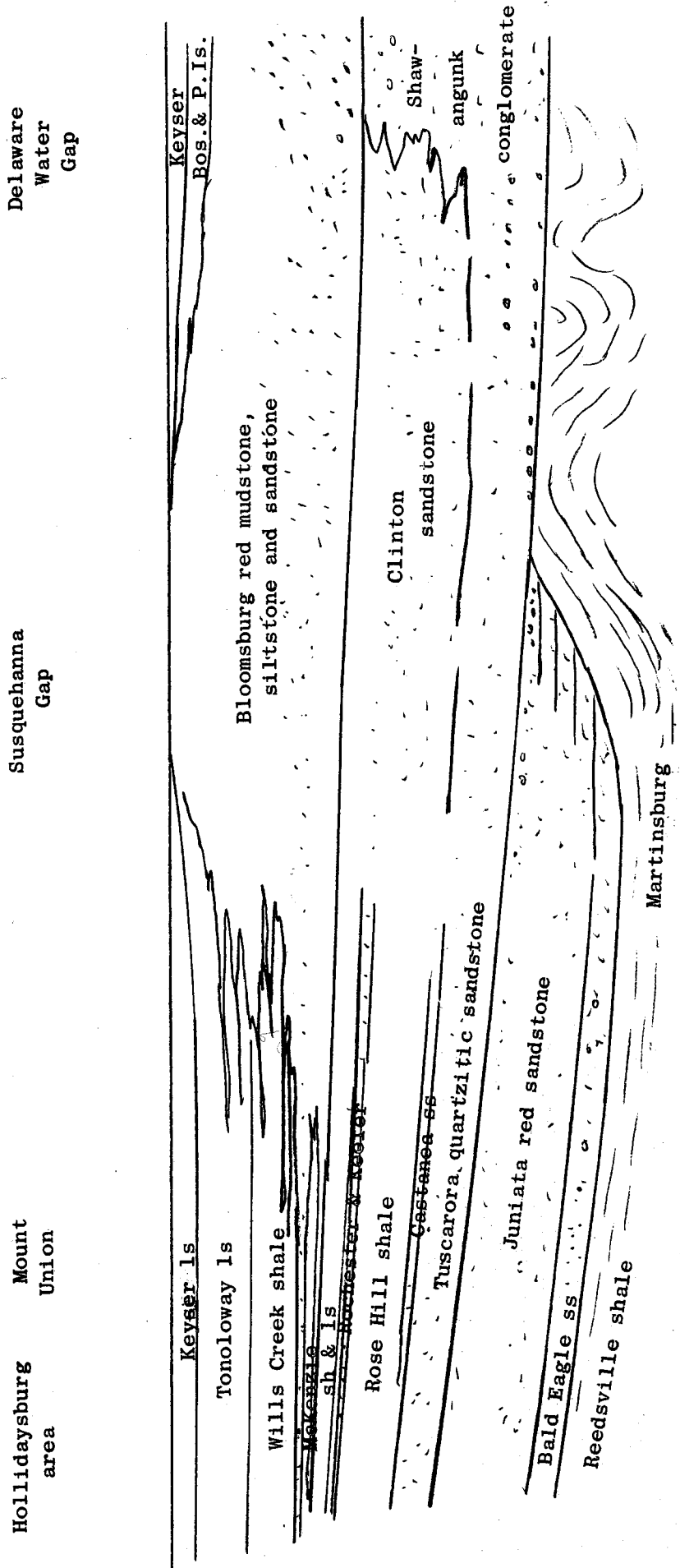


Figure 5. Chart illustrative of stratigraphic changes of Silurian and Upper Ordovician sediments from Hollidaysburg to the Delaware Water Gap, Pennsylvania. Vertical scale not exact, but about one inch equals 1500 feet

except for some locally exposed beds tentatively referred by Butts to the Waynesboro formation, reaches the surface a short distance north of the river, and is also exposed in Morrison Cove to the south. Along the course of the highway, the Warrior limestone lies in direct contact with the Bellefonte dolomite, being brought to this position by the more westerly of two great, longitudinally disposed thrust faults that extend southward for about 20 miles along the Cambro-Ordovician limestones of the valley, and then cut across and offset Tussey Mountain and continue another 15 miles in the Silurian formations. The stratigraphic throw near the point where we stand is about 4000 feet. In the cliff across the river the Warrior is succeeded toward the southeast by Gatesburg sandstone and dolomite, Mines dolomite, Larke dolomite, and Nittany dolomite, the sequence then being interrupted by the more easterly fault that cuts through the site of Williamsburg. The structure as mapped here by Butts is shown in figure 6.

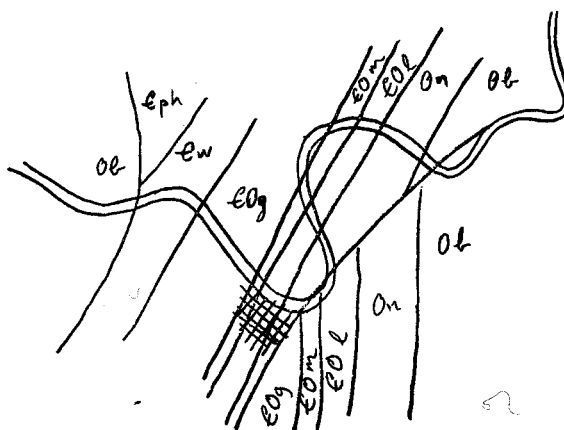


Figure 6. Geologic map of vicinity of Williamsburg, Pennsylvania by Charles Butts; preliminary use of this map in 1941 was made possible by the special permission of Mr. Butts. Scale: 1 inch = 1 mile.

Drive into Williamsburg. One block beyond square turn right and continue to edge of town along road to Beavertown.

Stop No. 14. Stop at edge of town beyond Williamsburg cemetery. The Gatesburg formation is here brought up by the easterly of the two great faults of Williamsburg Valley. It consists of gray dolomite with interbedded quartzitic sandstone layers; one thin layer of oolitic chert can be seen.

The Gatesburg dips toward the southeast, bringing in the overlying Mines dolomite on the neighboring hill. The Mines lacks the quartzitic layers of the Gatesburg and contains more of the layers of oolitic chert. Walk up private lane leading east on the hill slope south of the cemetery; there is much loose chert, in part oolitic, derived from the Mines which here crops out. Looking northward, the tops of the hills of the valley floor rise to an old erosion surface, presumably the Harrisburg peneplain. To the northwest and west are Canoe and Lock Mountains, and between them is Point View Knob, cut off between the gap of the Juniata River and the wind gap at the offsetting fault that was previously visited.

Northeastward, in the eastern outskirts of Williamsburg, is a prominent scar left by a road cut excavated in the upper part of the Larke dolomite and lower part of the Nittany dolomite, the latter having in it, a moderate number of cherty layers. The separation of the dolomite formations of the Beekmantown group from each other and from the highest Cambrian is more difficult here than to the north, due to absence of limestone formations that are present in that direction. The following table compares the Beekmantown and Upper Cambrian rock sequences near Williamsburg and Bellefonte.

Williamsburg

Bellefonte

Lower Ordovician or Canadian

Beekmantown group

Bellefonte dolomite, 1000 feet
(Axemann absent).

Bellefonte dolomite, 2200 feet.

Nittany dolomite, cherty in part,
1200 feet. Lecanospira compacta.

Axemann limestone, 200 feet,
Maclurites affinis fauna.

Larke dolomite, 250 feet, appar-
ently replacing Stonehenge
limestone.

Nittany dolomite, 1200 feet.
Lecanospira rare.

Stonehenge limestone, 600 feet.
Bellefontia zone at top.

Upper Cambrian

Mines dolomite, without quartzitic
sandstones, with oolitic
chert, 250 feet.

Mines dolomite, without quartzitic
sandstones, with oolitic
chert, 250 feet.

Gatesburg dolomite, 1700 feet;
upper member with much sandstone
the sandstones absent in the
lower or Stacey member.

Gatesburg dolomite, with much
interbedded quartzitic sandstone,
1700 feet.

Warrior limestone, with some
thin silty partings, 250 feet.

Warrior limestone, about 500 feet
exposed.

Pleasant Hill limestone, argil-
laceous, 600 feet.

(Concealed below level of erosion)

Middle Cambrian

Waynesboro formation, sand-
stone, red and green shale,
250 feet.

Return to Williamsburg. At square, turn right to take black top
road crossing Tussey Mountain toward Huntingdon.

Stop No. 15. Stop at eastern outskirts of Williamsburg beyond sharp left turn of highway where the roadside cuts observed from stop No. 14 expose the uppermost part of the Larke dolomite and the lower part of the Nittany dolomite. The Larke dolomite is darker gray than the Nittany and contains little chert. Stonehenge limestone, present beneath the Nittany dolomite to the northeast toward Bellefonte where the Larke dolomite is wanting, is absent in turn in the Williamsburg area. In this leaflet in 1941, attention was directed to the need to investigate the possibility that disappearance toward Williamsburg of both the Axemann and Stonehenge limestones of the Bellefonte area, may result from facies changes rather than unconformable erosion or nondeposition. Interfingering of the Stonehenge limestone and Larke dolomite has recently been shown in thesis studies by Donaldson.

Continuing toward Tussey Mountain, there are small exposures of higher parts of the Nittany dolomite and extensive exposures of the Bellefonte dolomite; extensive exposures of the Nittany and Bellefonte also occur along railroad tracks north of the Juniata River. As the road begins to ascend the slope of Tussey Mountain, Chazy, Black River and Trenton limestones are rapidly crossed, with few exposures; exposures of the Reedsville shale are more extensive, and loose slabs containing the Orthorhymcula stevensoni fauna of the uppermost Reedsville have been discovered. The gray Bald Eagle or Oswego sandstone forms prominent ledges at the roadside where a gap with the northwesterly, subordinate ridge of Tussey Mountain, and a large quarry for balast stone has been opened in this sandstone to the right of and below the highway.

The highway turns left before the top of the Bald Eagle sandstone is reached, and crosses the red Juniata deposits at a small angle to the strata, with a long gentle rise in white Tuscarora sandstone just beyond where the entry road to a fire tower turns right at the top of grade at about 2050 feet altitude.

Fine views of the northerly continuation of Tussey Mountain, and of the broad valley in which Huntingdon is located, are visible on a clear day near the summit of Tussey Mountain and at places along the downgrade leading toward the east. Tussey Mountain is offset here by a pitching anticline and adjacent pitching syncline, and the highway crosses the mountain at the middle limb of the loop, caused by these structures. To the northwest from the mountain summit, the northeastwardly extending ridge of Tussey Mountain is located about one-half mile or more from the highway; across low parts of the northerly ridge it is possible to see high parts of Canoe Mountain on the far side of Williamsburg Valley. Five and seven miles to the northeast, respectively, the northeasterly extension of Tussey Mountain is cut by gaps of the Frankstown Branch of the Juniata River and of the Little Juniata River; at about 10 miles, the mountain is bordered on its southeastern side by coal hills formed where the Tuscarora is elevated by small, doubly pitching anticlines.

Part way down the slope, where the highway curves around the anticline offset of the Mountain, and especially at an open swath cut for a power line, there are fine views of the broad valley eroded east of Tussey Mountain in the rising northerly part of the Broad Top Synclinorium. Lowlands near Tussey Mountain are cut in Silurian shales and limestones. Warrior Ridge next forms a westward-facing escarpment held up by the Ridgeley sandstone of the Oriskany group. Other low ridges of the valley region, *

especially Stone Creek Ridge, are formed by resistant beds of the Upper Devonian. From a few vantage points, it is possible to see the northern tip of Terrace Mountain, which is located five miles southeast of Huntingdon and like the Allegheny Front is crested by the Burgoon Sandstone.

Stop No. 16. At an altitude of about 1000 feet, half a mile before reaching the bottom of grade of the eastern slope of Tussey Mountain, upper Rose Hill, Keefer, Rochester, Bloomsburg and basal Wills Creek shale are exposed, and some loose slabs of McKenzie shale and limestone can be found. As compared to the section at Lakemont, the Rose Hill, Keefer and Rochester beds have underbone extensive weathering, that appears to be related to the Harrisburg peneplanation or paleoplanation of the region and that perhaps was accomplished largely during Tertiary rather than Pleistocene or Recent time. At the levels exposed in the road cuts, the thin limestone interlayers shown in the Rose Hill and Rochester shales at Lakemont have been almost wholly removed by solution, and the shales are rose-colored, or tan, due to oxidation of iron compounds as well as of any organic substances that may have been present. Deep weathering at similar altitudes elsewhere in the region may likewise reflect Tertiary work, associated with the Harrisburg peneplane or other geomorphic levels: thus, on Warrior Ridge about 4 miles northeast of Stop No. 16, parts of the Shriver siliceous limestone of the Oriskany group have been deeply weathered to form a siliceous clay; deeply weathered siliceous clays have also been developed in the Gatesburg sandy dolomite southwest of Williamsburg under conditions and at levels that suggest possible relationship to Harrisburg peneplanation.

At Stop No. 16, the zonal fossils found in the upper Rose Hill, Keefer and Rochester at Lakemont are represented by internal and external molds. In addition, Zygobeyrichia ventricornis, with its peculiar conical, subventral spine can be found near the base of the Wills Creek.

Stop No. 16 is the last stop of the trip. Continue to the foot-of-grade and turn left; at the first road fork, bear right to go to Huntingdon and the east, left to go to Water Street and the west.

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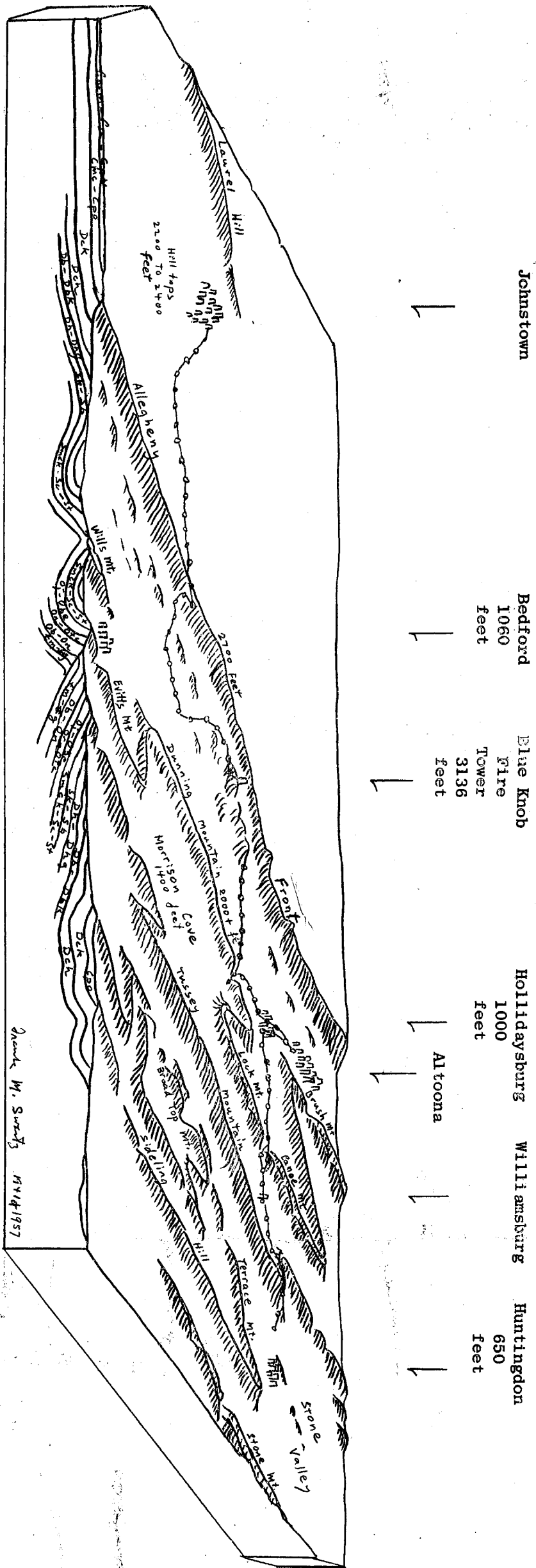
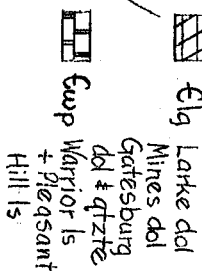


Chart I. Block diagram illustrating geomorphology, geologic structure and stratigraphy of area from Johnstown to Huntington, central Pennsylvania

10 miles



- | Unit | Stratigraphic Position | Notes |
|------|---|-------|
| Cm | Monongahela | |
| Ccm | Coreomaugh | |
| Ca | Allegheny | |
| Cpo | Pottsville cgl. | |
| Cmc | Mauch Chunk red shale | |
| | Loyalhanna of base (west of Allegheny Front) | |
| Cp | Poccano ss, incl. Burgoon ss, above Catskill red beds | |
| Dck | Chemung slt. | |
| Dch | Chemung slt. | |
| Dblk | Brallier sh, above Harrell sh & Burke bl. sh. below | |
| Dmo | Hamilton sh, Marcellus bl. sh. | |
| | Onondaga ls | |
| Doh | Oriskany group | |
| | Ridgely ss | |
| | Shriver sh or ls | |
| | Helderberg gr. | |
| | Mundata sh | |
| | New Scotland ls | |
| | Cocumans ls | |
| Spt | Keiser ls | |
| | Tonoloway ls | |
| | Wills Creek sh | |
| | Bloomensburg reds | |
| | Mokenzie sh or ls | |
| | + Rubble Run reds | |
| | Clinton group | |
| | Rochester sh | |
| | Keefer ss | |
| | Rose Hill sh | |
| St | Castanea ss (ME) | |
| Jfo | Tuscarora of the Juniata, red beds | |
| | Oswego ss | |
| Or | Reedsville sh | |
| Otc | Trenton, Bl. River, & Carlisle ss | |
| Ob | Bee knarbur gr. Bellefonte dol. | |
| | Axeman ls | |
| | Nittany dol | |
| | Stonehenge ls | |