UNITED STATES DEPARTMENT OF THE INTERIOR

SOME STRUCTURAL FEATURES OF THE NORTHERN ANTHRACITE COAL BASIN, PENNSYLVANIA

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SOME STRUCTURAL FEATURES OF THE NORTHERN ANTHRACITE COAL BASIN, PENNSYLVANIA

BY

N. H. DARTON

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SOME STRUCTURAL FEATURES OF THE NORTHERN ANTHRACITE COAL BASIN, PENNSYLVANIA

By N. H. Darton

ABSTRACT

The Northern Anthracite coal basin is a trough or syncline extending approximately northeastward across northeastern Pennsylvania. The coal area is about 62 miles long and about 5 miles wide. In the deepest part of the basin are 18 beds regarded as workable, which have an aggregate thickness of about 95 feet. The total thickness of the coal measures is about 2,000 feet in the deeper part of the basin near Wilkes-Barre, but it diminishes considerably to the east by Scranton and to the west by Nanticoke.

The lowest coal bed cropping out on the mountain slopes on each side of the basin is mostly at an altitude of 1,000 to 1,100 feet, in the deepest part of the trough it descends to about 1,530 feet below sea level. At Wilkes-Barre it is about 1,000 feet below sea level, or 1,500 feet below the surface, and at Scranton it is 250 feet above sea level and about 800 feet below the surface. For much of its course the trough is wide and flat-bottomed, but in most of the region west of Wilkes-Barre it contains subordinate flexures and faults, some of them of considerable magnitude and complexity. For part of their course the axial planes of the arches are bent over far out of the vertical, and in places the faults are overthrusts. Though these structural complexities add considerably to the cost of mining and cause some loss of coal, they add materially to the tonnage of coal available.

In mining coal very detailed maps are made of the workings, with determinations of altitudes at frequent intervals, and in some places with records of thickness of the bed. The coal-mining companies also make many cross sections showing revealed or supposed structural relations, and they have bored many holes to ascertain conditions in areas not yet mined.

INTRODUCTION

The material in this report was prepared in 1936 from all available data on the structure of the Northern Anthracite coal basin. The work was a continuation of a compilation made in 1910 to 1913 in the course of an investigation of the relation between structural features and the emanation of explosive gas in the coal mines.[1]

The basin is a long, narrow, canoe-shaped syncline with various local crenulations, faults, and rolls. The map (pl. 10) shows the structure by contour lines constructed from data given on the very numerous large-scale mine maps. The lowest workable coal bed was used as a datum plane. The mine operations in this bed are extensive, and most of them are shown on mine maps that give abundant data on altitudes. In some areas where the lowest bed had not been worked the altitudes have been deduced from workings in overlying beds, with suitable allowance for the thickness of the intervening rock, which ordinarily is indicated in boreholes. In other places, called "virgin," I have had to rely on records of boreholes from the surface or projections of altitude or structure from the nearest workings. In some places altitude and dip at the outcrop were used. The studies made in 1936 showed that since 1913 workings had been extended, many new holes had been bored, and cross sections had been constructed. New data were also available for partial correction of the base map of the surface. Nearly all of the structure contours were compiled on a scale of 400 feet to the inch.

Throughout the work I have been given unlimited assistance and cooperation by the officials of the many coal companies of Scranton, Wilkes-Barre, Nanticoke, Dunmore, and other places, who not only kindly placed all mine maps at my disposal but also gave access to cross sections, borehole records, and surface maps. The very great liberality of these gentlemen has made available a wealth of material from which the map and sections of this report have been constructed.

THE COAL BEDS

The coal measures in the Northern Anthracite basin have a maximum thickness of about 2,000 feet in the deeper part of the basin west of Wilkes-Barre. The thickness diminishes to the east until in the Pittston region it is 550 feet, at Scranton 600 feet, and east of Carbondale 200 feet and less. The principal beds in these three regions are shown in figure 7.

DATUM BEDS

In the preparation of the structure map of the Northern Anthracite coal basin all available mine elevations on the lowest notable coal bed were used. In a large part of the basin this lowest bed is the principal Red Ash bed. In other areas this bed gives place, apparently at the same horizon, to beds known as Dunmore, ordinarily in two or three splits, the lowest one of which has been used so far as it is recognizable. Undoubtedly in places this lowest bed thins out and disappears, so that the split next above is the one that

[1] Darton, N. H., Occurrence of explosive gases in coal mines: U. S. Bur. Mines Bull. 72, 248 pp., 7 pls., 1915.

is mined or is conspicuous in borehole records. However, where this is the case, the interval between the coal beds is not great and the structure of all is nearly identical, although the datum plane is not precisely at the altitude shown by the contours; this condition is extremely local. In wide areas in which the lowest coal bed is not worked but in part of which the overlying beds have been mined the differences of altitude are known from boreholes. Where such higher beds are only 100 or 200 feet above the Red Ash (or Dunmore) bed the difference in structure may not be great, but where structure is deduced from workings in still higher beds the form and position of axes of flexures, plane of fault, and other structural features may differ greatly. All such areas are differentiated on the map (pl. 10) by broken contour lines. In still other areas, especially in the region southwest of Wilkes-Barre not yet mined, the position of coal beds in virgin ground is indicated more or less closely by numerous boreholes. However, in some of these there is uncertainty as to the identity of certain beds. For such areas dotted contour lines are used, and the structure is taken largely from cross sections made by mining companies, in places modified by my own interpretations. The accuracy of the structure shown in these dotted-line areas will be problematical until mining affords more accurate data. However, it is believed that these hypothetical representations of structure have considerable value as a guide to future mining operations and in the estimation of the tonnage of coal still in the ground.

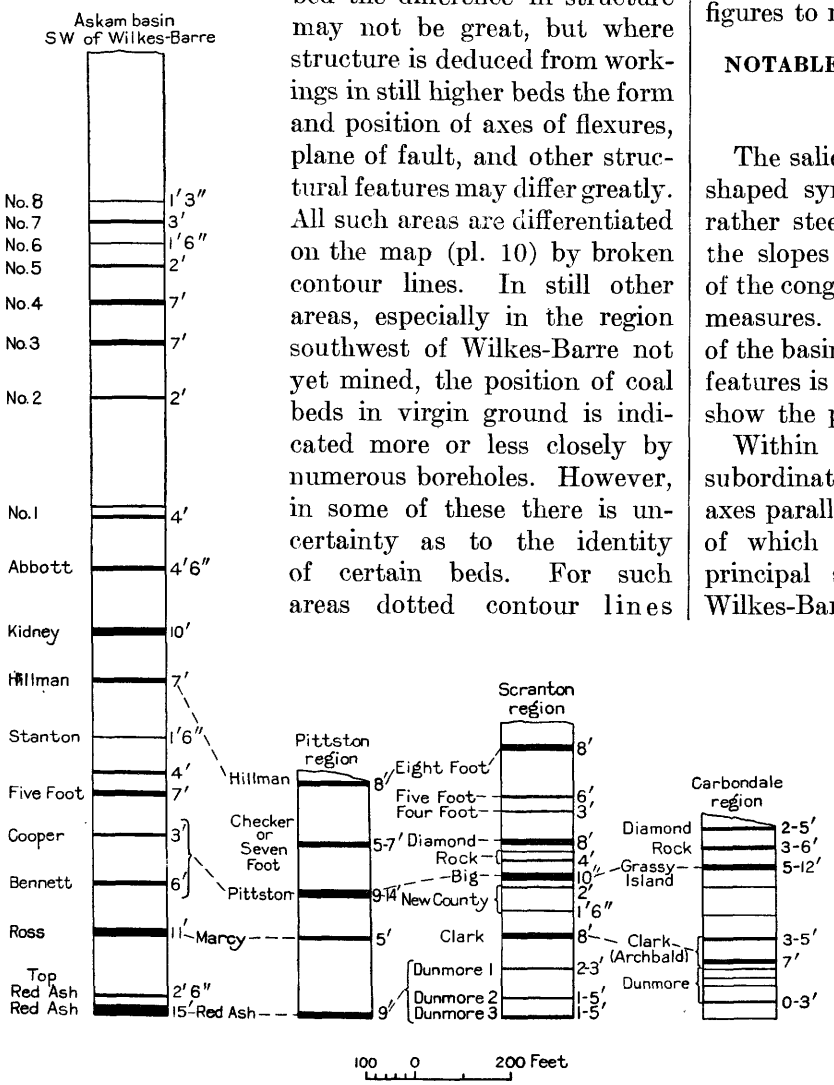


FIGURE 7.—Principal coal beds in different parts of the Northern Anthracite coal basin. In some places the thicknesses as given include waste.

ERRORS IN ALTITUDE

As the altitudes in the mines are not all referred to the same datum plane, the engineers of the various companies have supplied comparative figures for altitudes which can be tied to the level lines newly run by the United States Coast and Geodetic Survey; however, it is undesirable to attempt minor corrections in compiling the data from the mine maps of the many collieries, except in places where 500 or 1,000 feet has been added by mine engineers to avoid the use of negative figures to represent areas mined below sea level.

NOTABLE STRUCTURAL FEATURES OF THE REGION

GENERAL RELATIONS

The salient structural feature of the basin is a canoe-shaped syncline, in large part with flat bottom and rather steep dips on the margins which extend along the slopes of mountain ridges that mark the outcrop of the conglomerate and other hard strata below the coal measures. The greater part of the surface of the center of the basin is a wide rolling valley. An outline of these features is shown in the sections in plate 11, which also show the position of the lowest notable coal bed.

Within the general canoe-shaped basin are many subordinate flexures and faults, most of which have axes parallel to the main course of the basin, but some of which have axes diagonal to this course. The principal subordinate flexing is near and west of Wilkes-Barre, in the deeper part of the basin, where the lowest coal bed locally lies more than 1,500 feet below sea level or about 2,500 feet below the outcrop zone on the bordering mountain slopes.

It is believed that the detailed sections in this report are especially helpful because the structure shown is based largely on actual coal workings and numerous borings. In some areas the flexures and faults show a striking lack of conformity in the various beds one above another, a condition that has been of great economic importance in mining the coal beds and in planning for the extension of workings.

LEE BASIN

Near the west end of the Northern Anthracite coal basin the coal lies in a deep narrow basin that extends along the southern margin of the field from a point near Wanamie to the west end of the mountain ridge south of Mocanaqua. It is known as the Priscilla Lee, or Lee basin. It contains several beds of coal that dip steeply into the center of a narrow trough in which the lower beds descend to considerable depth; the lowest bed is 100 feet above sea level at the boundary line between the West End and Wanamie collieries. In a

few places the beds are worked down to the bottom of the basin, but the mining has been most extensive for a few hundred feet below the outcrops. The principal workings are in the West End colliery near Lee shaft and from the Wanamie shaft 19. In general the beds have a regular slope toward the center of the basin, but in places they are squeezed and strongly faulted. The three sections in figure 8 show the structure of the deeper part of the basin and relations of the principal faults. The structure at the place represented by section B is difficult to understand from the data available, but evidently the coal beds in the bottom of the trough are cut into wedge-shaped blocks and the intervening strata are strongly crumpled.

THE OVERTHRUST FAULT SOUTH AND WEST OF GLENLYON

One of the largest faults in the Northern Anthracite basin disrupts the coal measures in the central part of the West End colliery and passes eastward for a long distance in collieries 7 and 6 of the Susquehanna Coal Co. Some of the relations north of West End colliery are shown in sections A to D, plate 12. The dominant feature in these sections is the fault along which there is overthrust from the south, at an angle averaging about 45°, of 640 to 800 feet and vertical displacement of about two-thirds that amount. To the east the overthrust block is broken by a fault along which a wedge of the lower strata has been uplifted. In most of the area the southerly dip of the fault plane carries the lowest coal bed down to altitudes between 130 and 165 feet above sea level, as determined by extensive mining operations.

The amount of overthrust diminishes eastward from the area crossed by the sections shown in plate 12. In the area southwest of Glenlyon the precise structural relations are not revealed, but the lower coal beds have

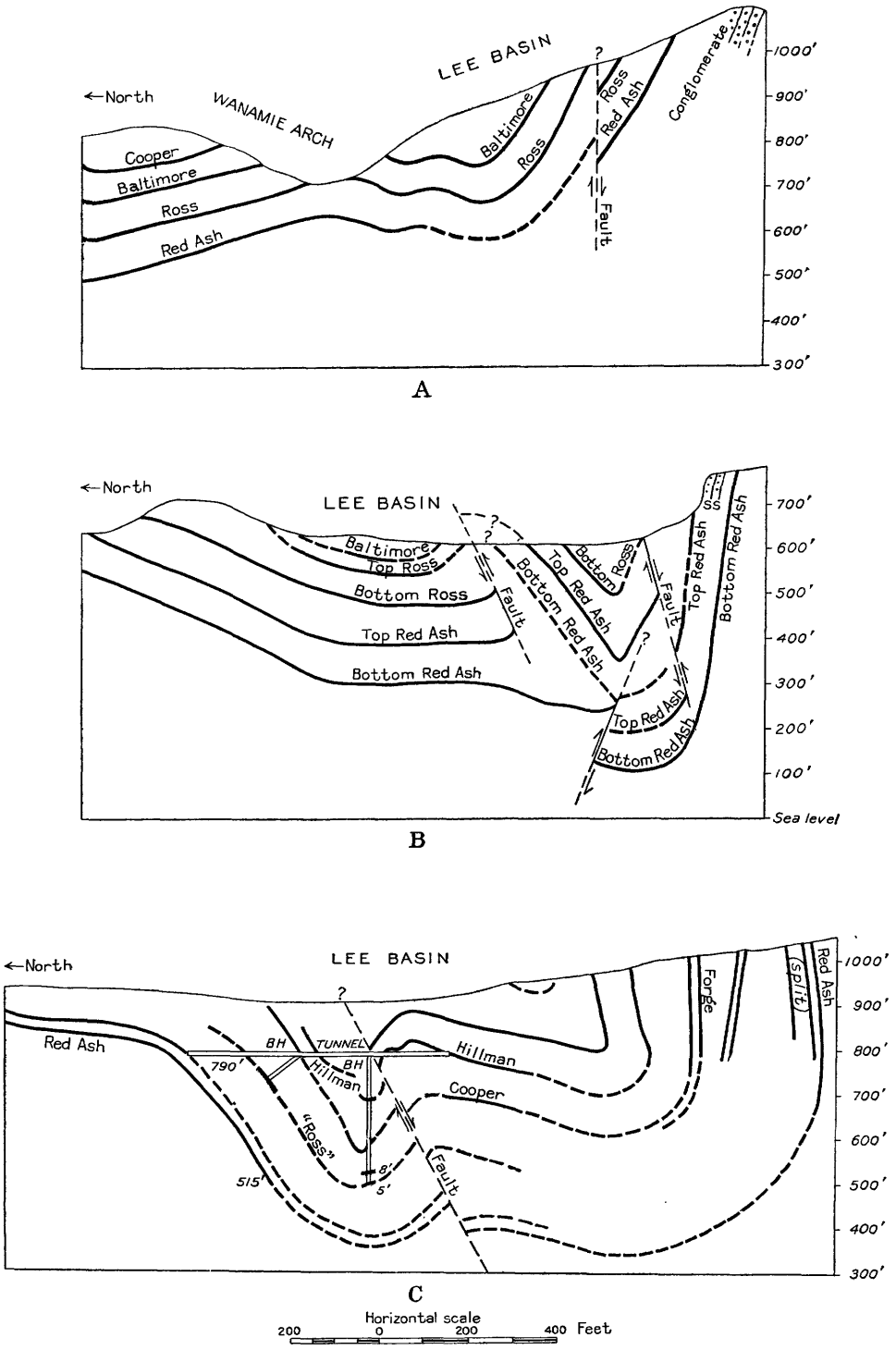


FIGURE 8.—Sections across the Lee basin in and east of the Glenlyon colliery: A, 800 feet east of Wanamie shaft 19; B, on the boundary between West End and Wanamie collieries; C, one mile west of Wanamie shaft 19 (1,800 feet west of section B). Compiled from sections in offices of the coal companies. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes of coal beds given are at end workings; other figures give thicknesses of coal beds in boreholes, including waste.

been mined far down the south dip and also in places on the north dip. In the workings the ends of galleries on the two sides have differences in altitude of 500 to 700 feet, in large part due to steep high overturn of the beds. Doubtless these differences are partly the results of faulting, but faults have been definitely recognized at only a few points. The four sections of plate 13 show the principal features. Most of the relations shown in section A are deduced from borehole records.

Some details represented in these sections are hypothetical, for generally the coal is not mined up to the fault or in some of the steep pitches. Also the interpretations of borehole records are always more or less uncertain. Eastward from section A the arch appears to continue as a sharp upturn, probably in some degree overturned and faulted.

The five sections of plate 14 show the principal features of the upturn and some details of the adjoining

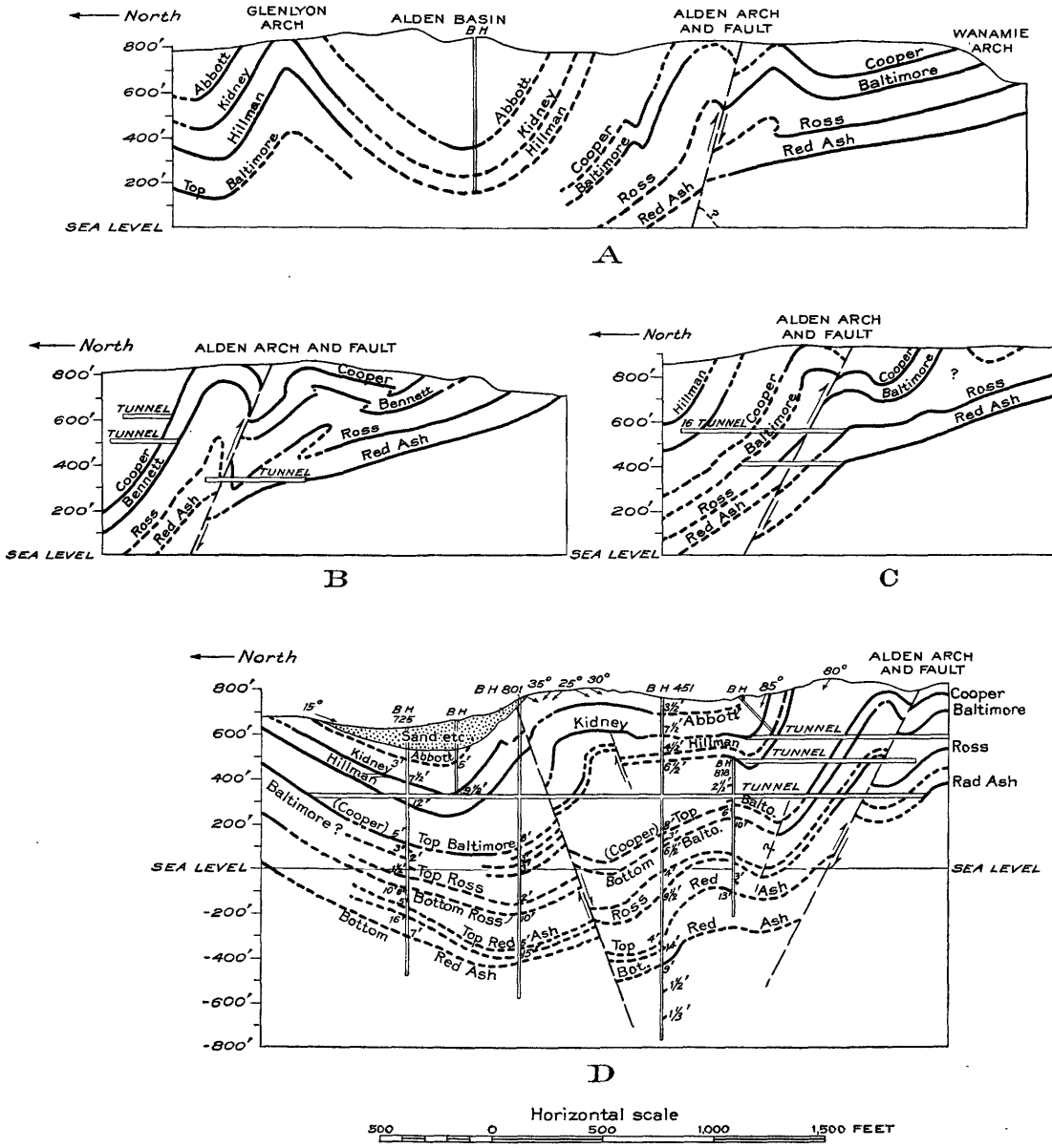
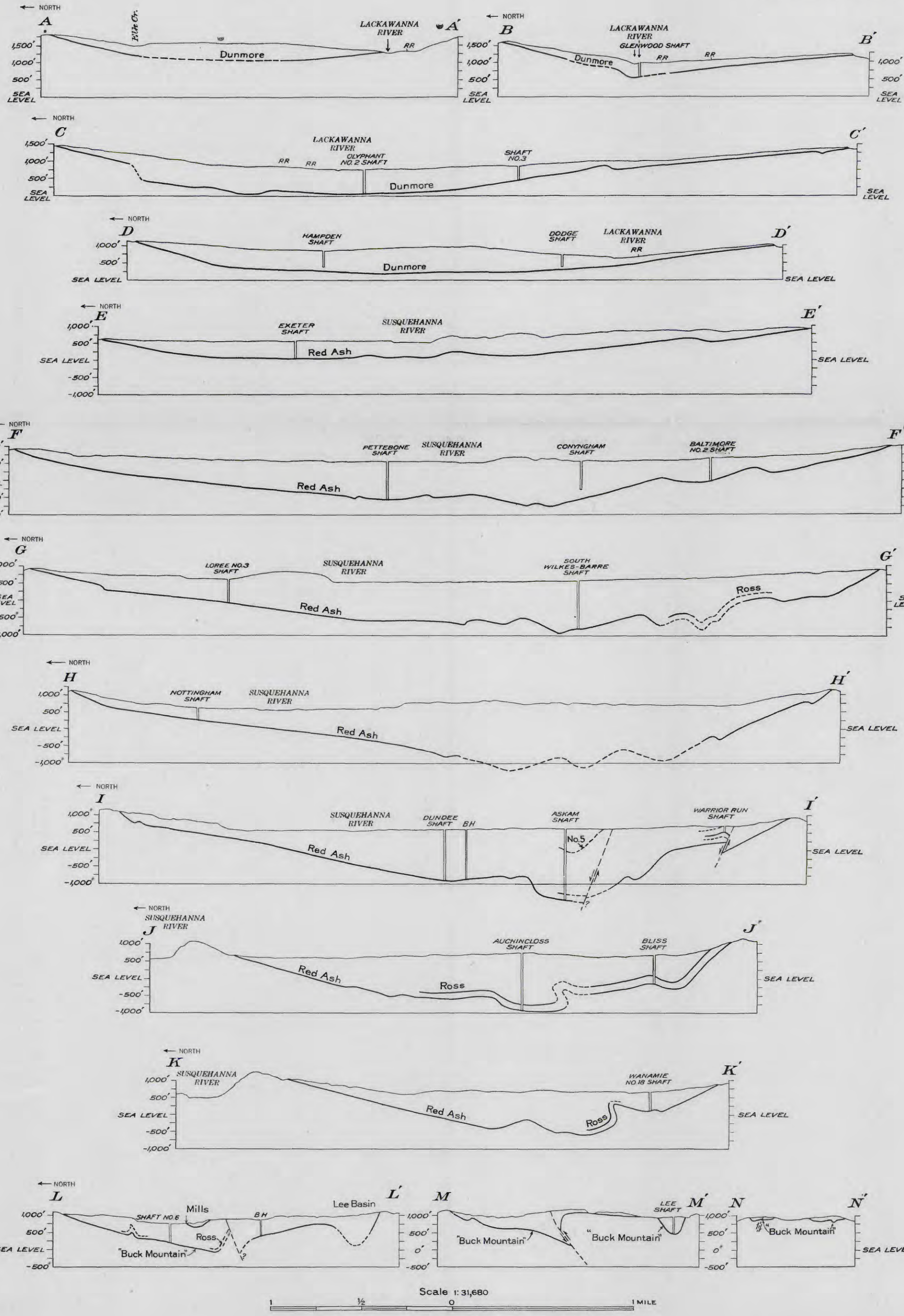


FIGURE 9.—Sections across Alden arch and fault in Wanamie colliery north of shaft 19: A, 1,300 feet east of section D (shows also some relations of Alden basin and Glenlyon arch); B, about 400 feet east of section D, near tunnel 16; C, 800 feet east of section D; D, N. 10° W. of Wanamie shaft 19. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Thicknesses of coal beds given are in boreholes and include waste.

The Alden arch passes entirely across the Wanamie colliery as a sharp upturn of the coal beds. Apparently it is faulted for much of its course, with an uplift of 100 to 200 feet on the north side. Figure 9 shows the relations of this uplift in the area north of shaft 19, as far as they are indicated by mining and by borehole records.

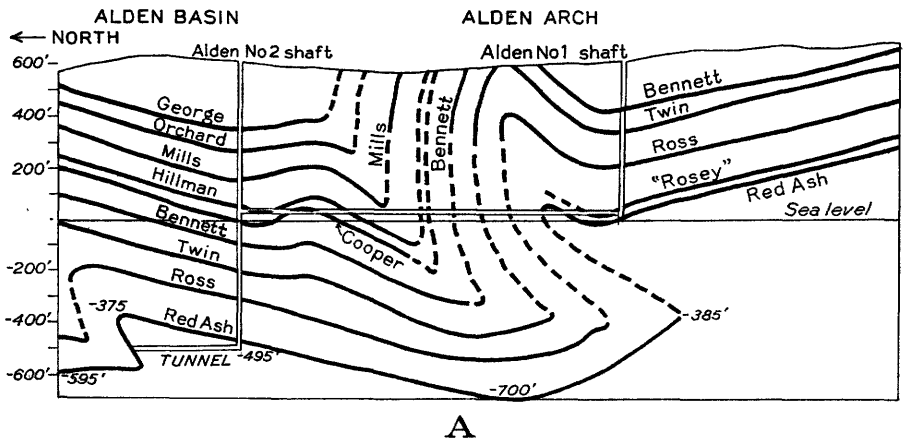
basin to the north, which I have called the Alden basin. Several tunnels and many boreholes afford abundant data for section E, but the identification of beds in the borehole records is not entirely certain.

In the lower beds of the Alden colliery are two steep arches, as shown in section A, plate 14. They extend eastward through the Bliss and Auchincloss collieries

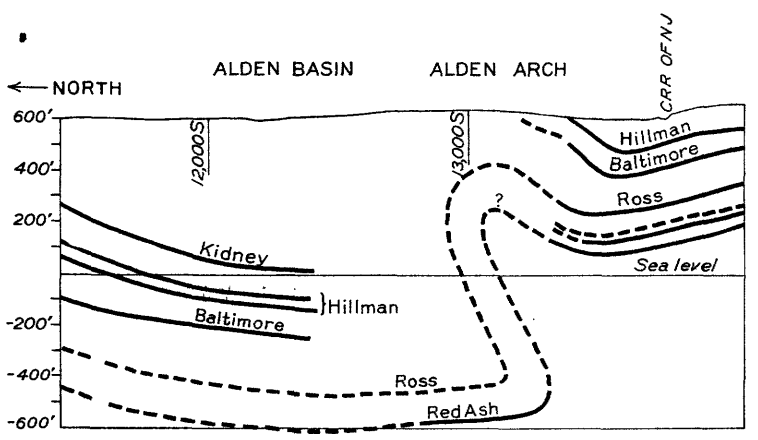


SECTIONS ACROSS THE NORTHERN ANTHRACITE COAL BASIN.

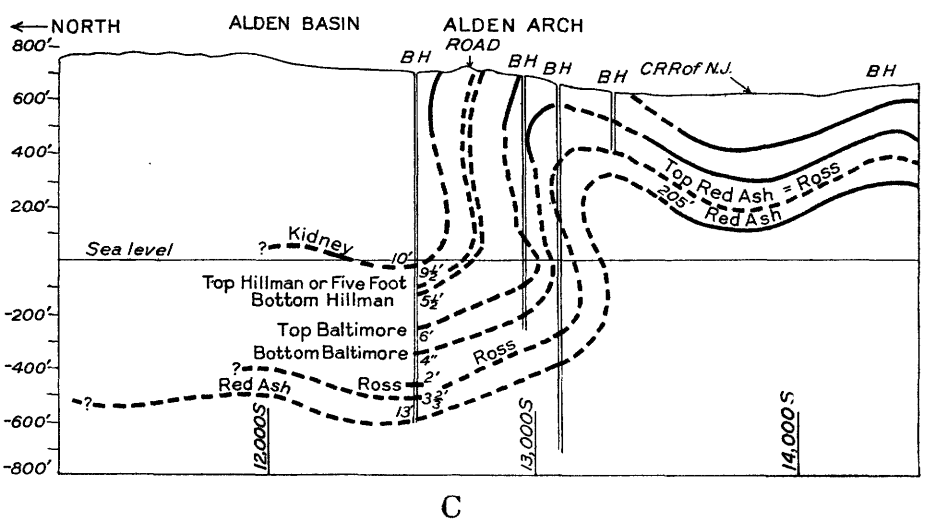
Show structure of lowest coal bed along lines shown on map, plate 10. BH, Borehole.



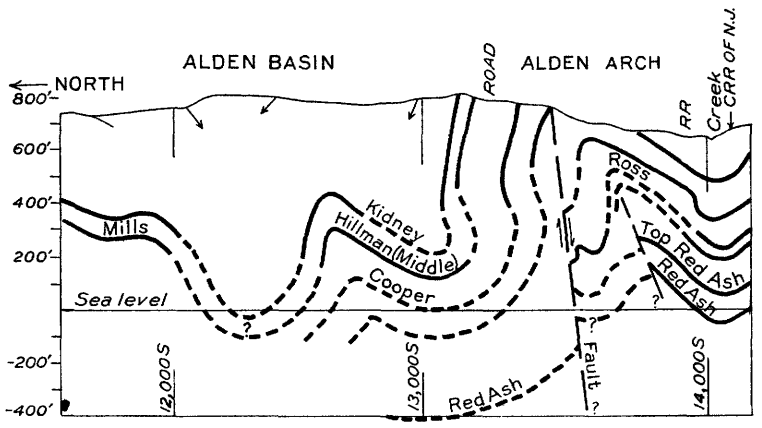
A



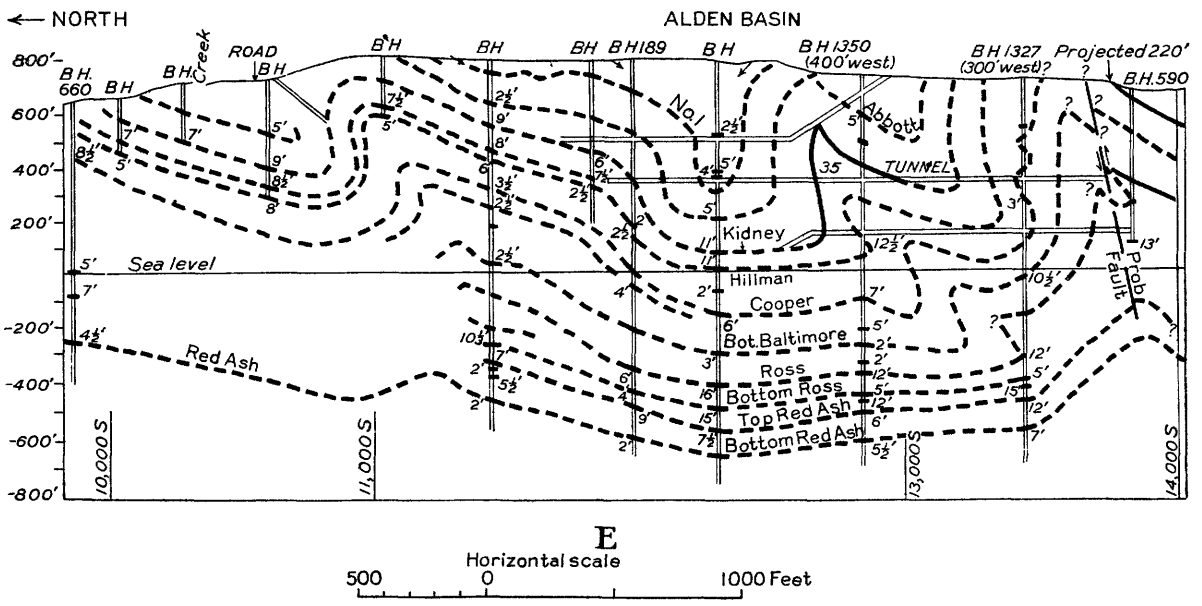
B



C



D

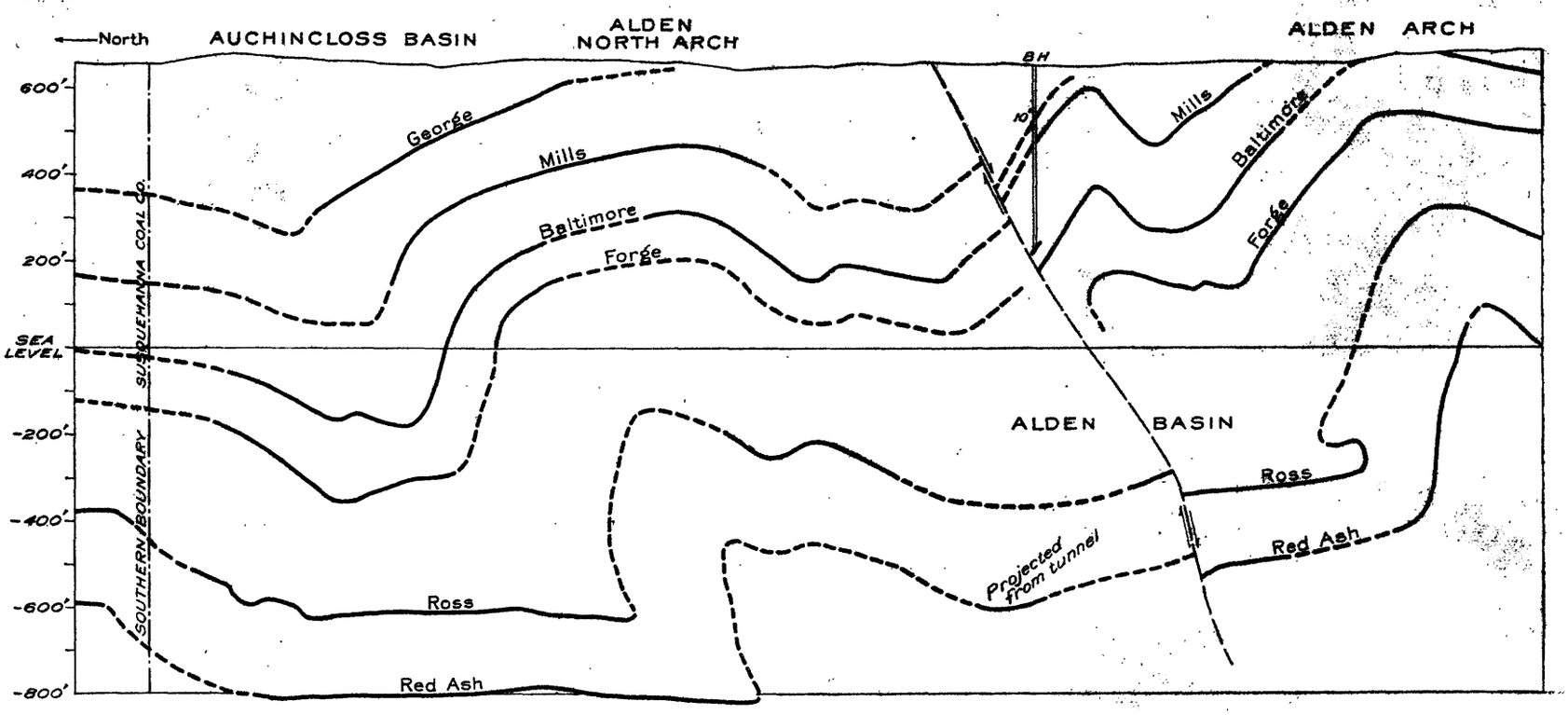


E

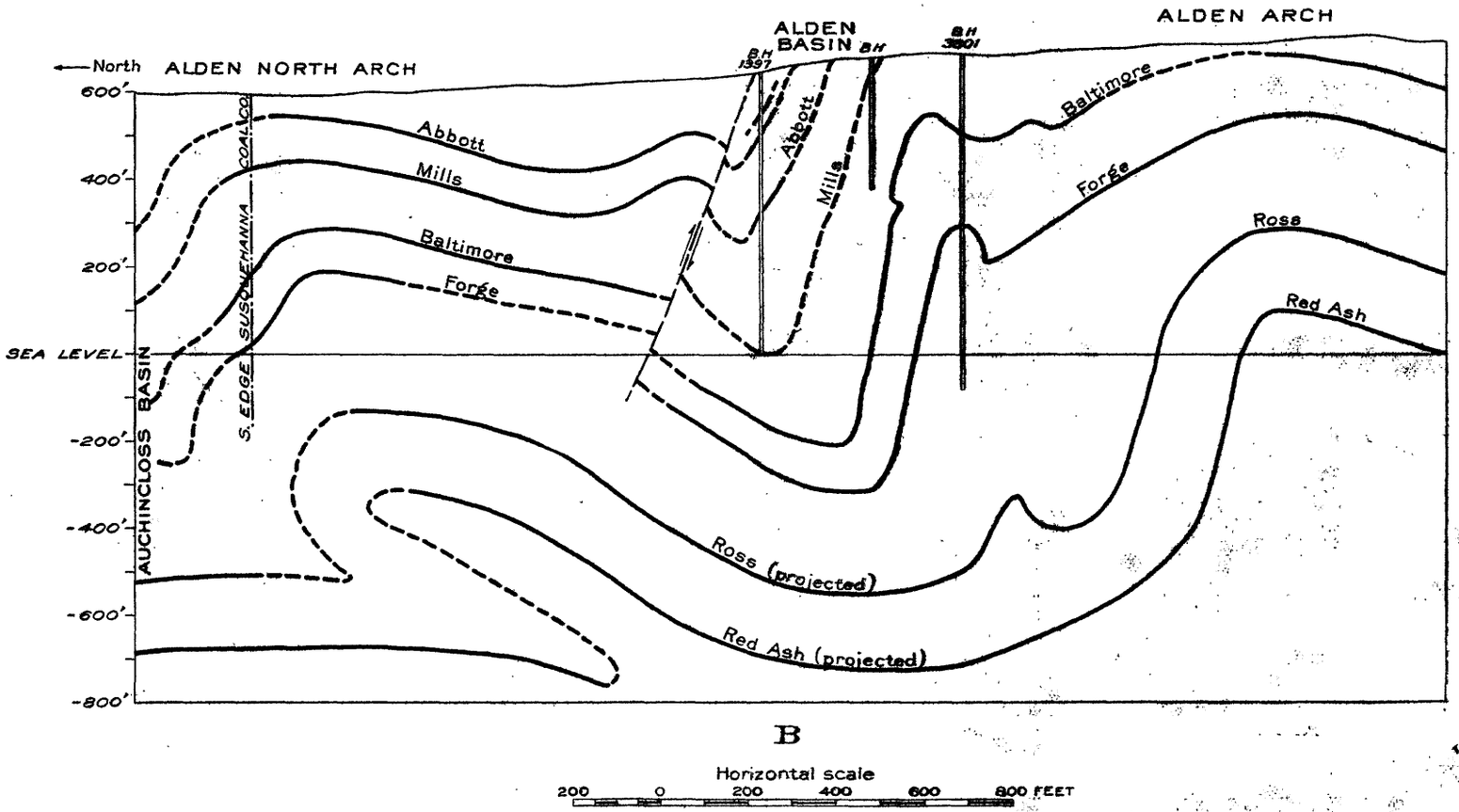
Horizontal scale
500 0 1000 Feet

SECTIONS OF ALDEN ARCH IN WANAMIE AND ALDEN COLLIERIES.

A, Through Alden shafts; B, 2,000 feet west of Alden shafts; C, 700 feet east of Wanamie shaft 18; D, 1,300 feet west of Wanamie shaft 18; E, 1,600 feet west of Wanamie shaft 18. BH, Boreholes. Broken lines are hypothetical; solid lines represent mined coal. Altitudes at a few points in mine workings and thicknesses of coal beds in boreholes including waste are given. Lines marked 12,000 S, etc., are mine map coordinates.



A

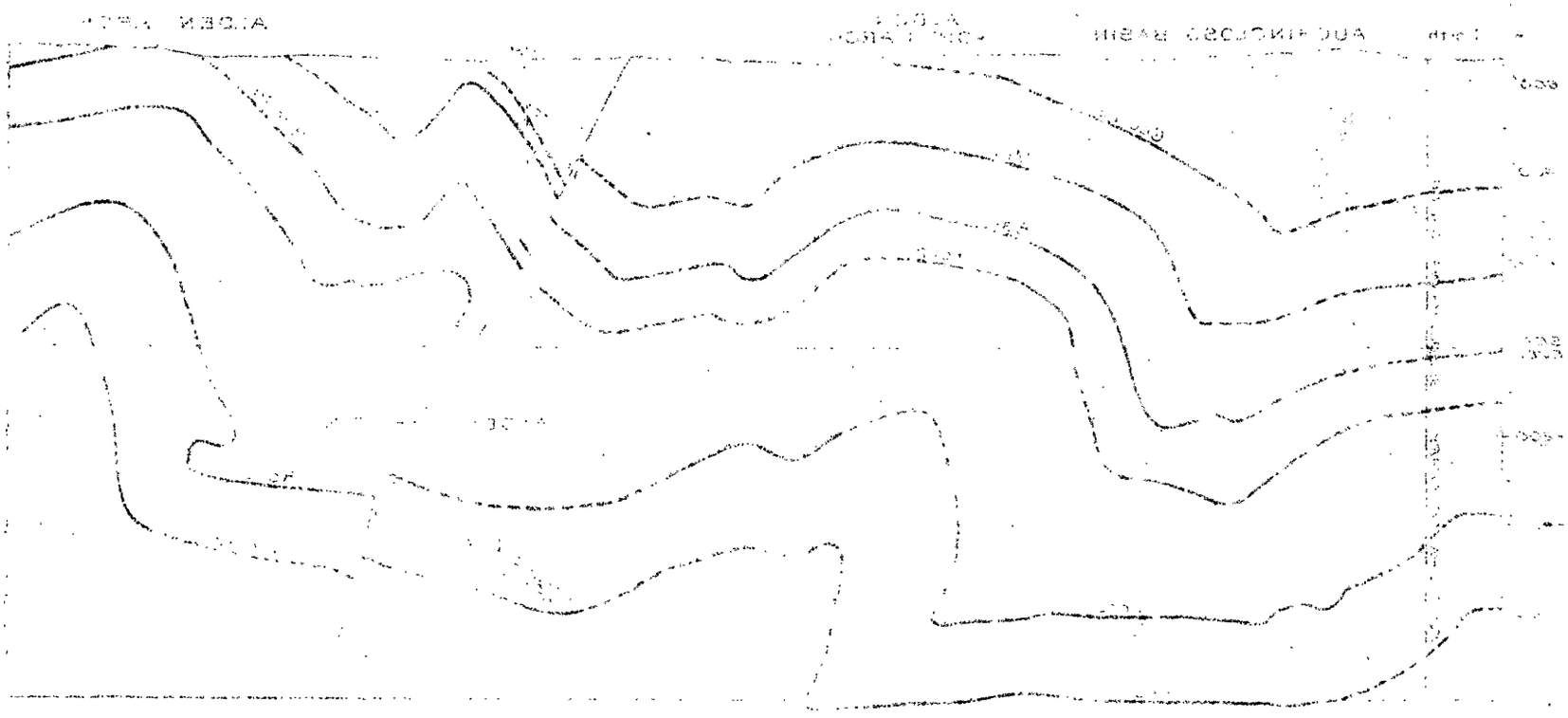


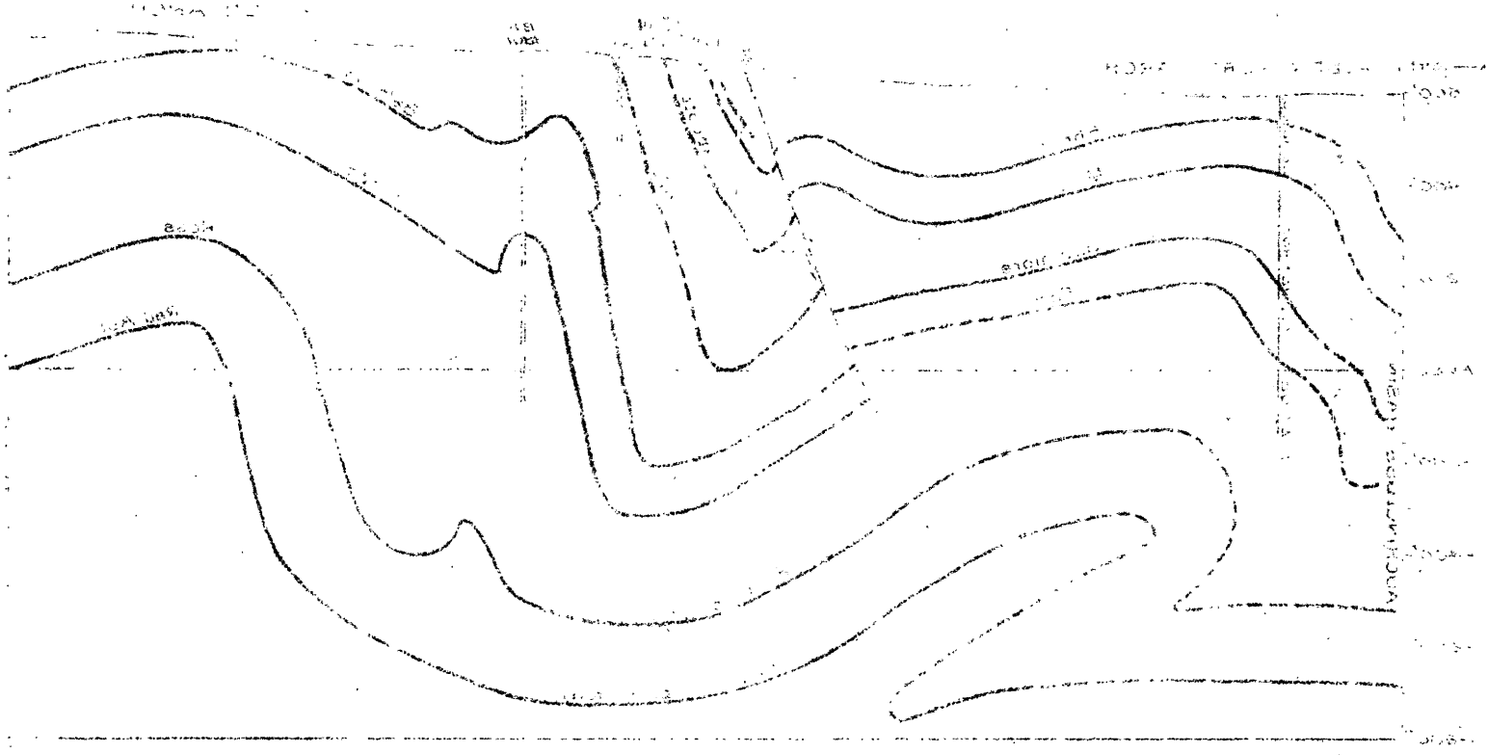
B

Horizontal scale
200 0 200 400 600 800 FEET

SECTIONS ACROSS ALDEN BASIN, EAST OF ALDEN.

A, 2,200 feet west of shaft 1, Auchincloss colliery; B, 1,600 feet west of section A and along east boundary of Alden colliery. Compiled from sections in offices of coal companies. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Thickness of coal bed in one borehole is given.





but change considerably in shape and relations, especially in the flexing of the upper coal beds—Forge and higher beds. Some features are shown in plate 15. These sections show that Red Ash workings extend from the north down to altitudes of 760 feet and 815 feet below sea level under the overturn of the arch or on the north side of the Alden basin. In this basin, near the area represented in section B, the Red Ash bed is mined from the south upward to an apex 310 feet below sea level, which is 630 feet above the underturned edge about 500 feet farther south. Near section A, where the Red Ash bed descends to an altitude of —815 feet, mining has not progressed up the uplifted limb of the Alden north arch, but it seems likely that the Red Ash bed here reaches an altitude of about —450 feet without much overturning. The faults in the Alden basin in these sections are of small but undetermined amount, and their precise relations are not revealed by mining. In the arch on the south side of the basin the Red Ash bed rises 500 feet in section A and 815 feet in section B, as determined by mining. Lack of symmetry of the folds in the different coal beds is strikingly exhibited in these two sections.

ALDEN NORTH ARCH

One of the most marked features in the Auchincloss colliery is the eastern extension of the arch that passes just north of Alden shaft 2. To the eastward it changes from an overturn to an arch of moderate height on which the strata rise on the south side of the Auchincloss basin. Some of its relations south and southeast of the Auchincloss shafts are shown in plate 16. Section C shows the overturn conspicuous in section B of plate 15. Here the Red Ash bed has been worked down to —936 feet near the bottom of the basin, whereas some galleries from the south have followed it at an altitude of —478 feet at a point almost directly over the deeper chambers—an uplift of 458 feet vertically. It may rise to or beyond the point at which borehole 1581 has cut a "thick bed of coal" about 340 feet below sea level. This overturn is absent in the strata between the Forge and George beds. As shown in section B, plate 16, the vertical difference in altitude of the beds as the result of folding is probably 550 feet, but there is little evidence of overturning of the axis of the arch. In section A, plate 16, the difference in altitude is less, but, owing to the small amount of mining and borehole data, the

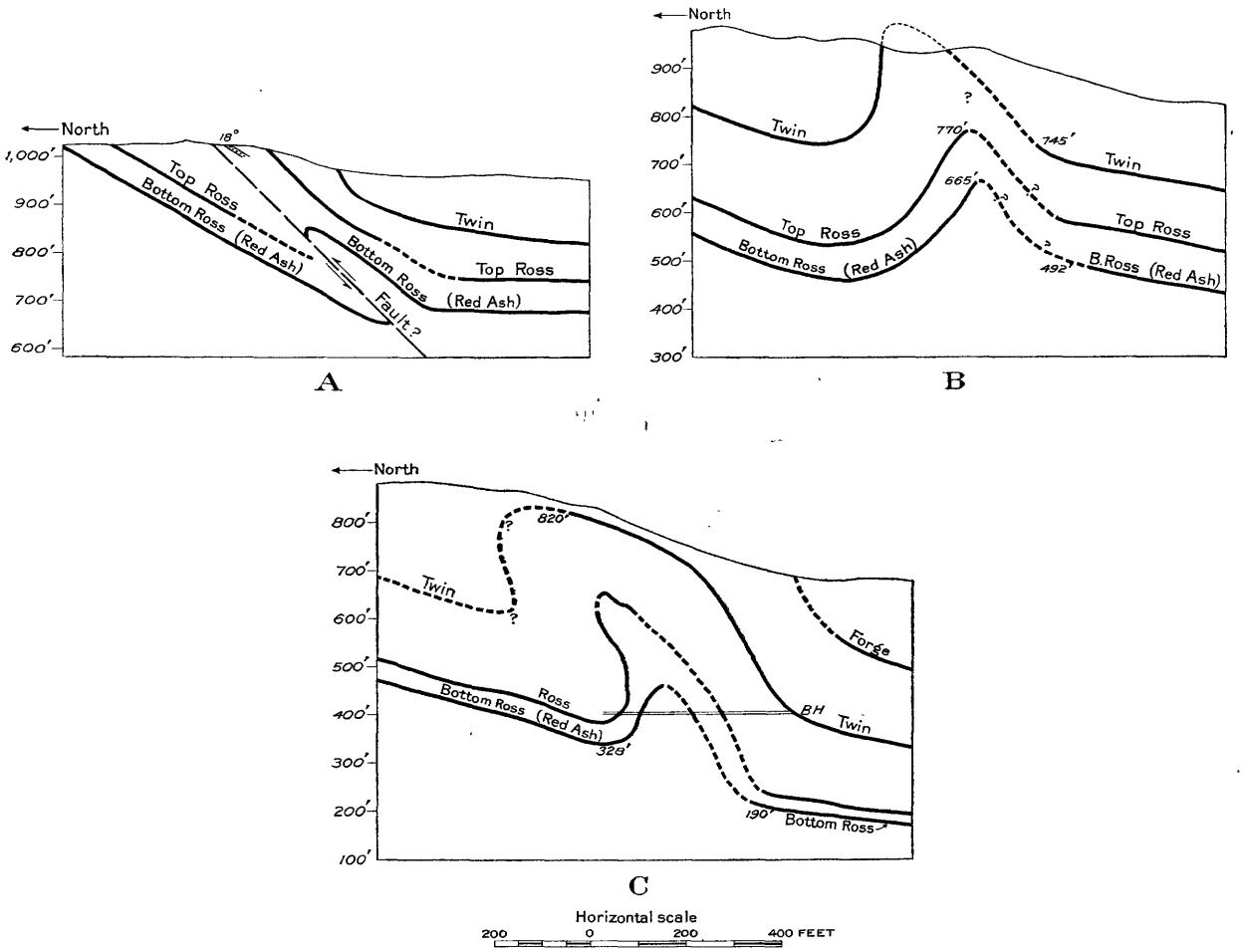


FIGURE 10.—Sections across anticline north and west of Glenlyon: A, Along west boundary of Glenlyon colliery; B, just north of shaft 7; C, north of shaft 6. Compiled from sections by Susquehanna Coal Co. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes of coal beds given are at end workings.

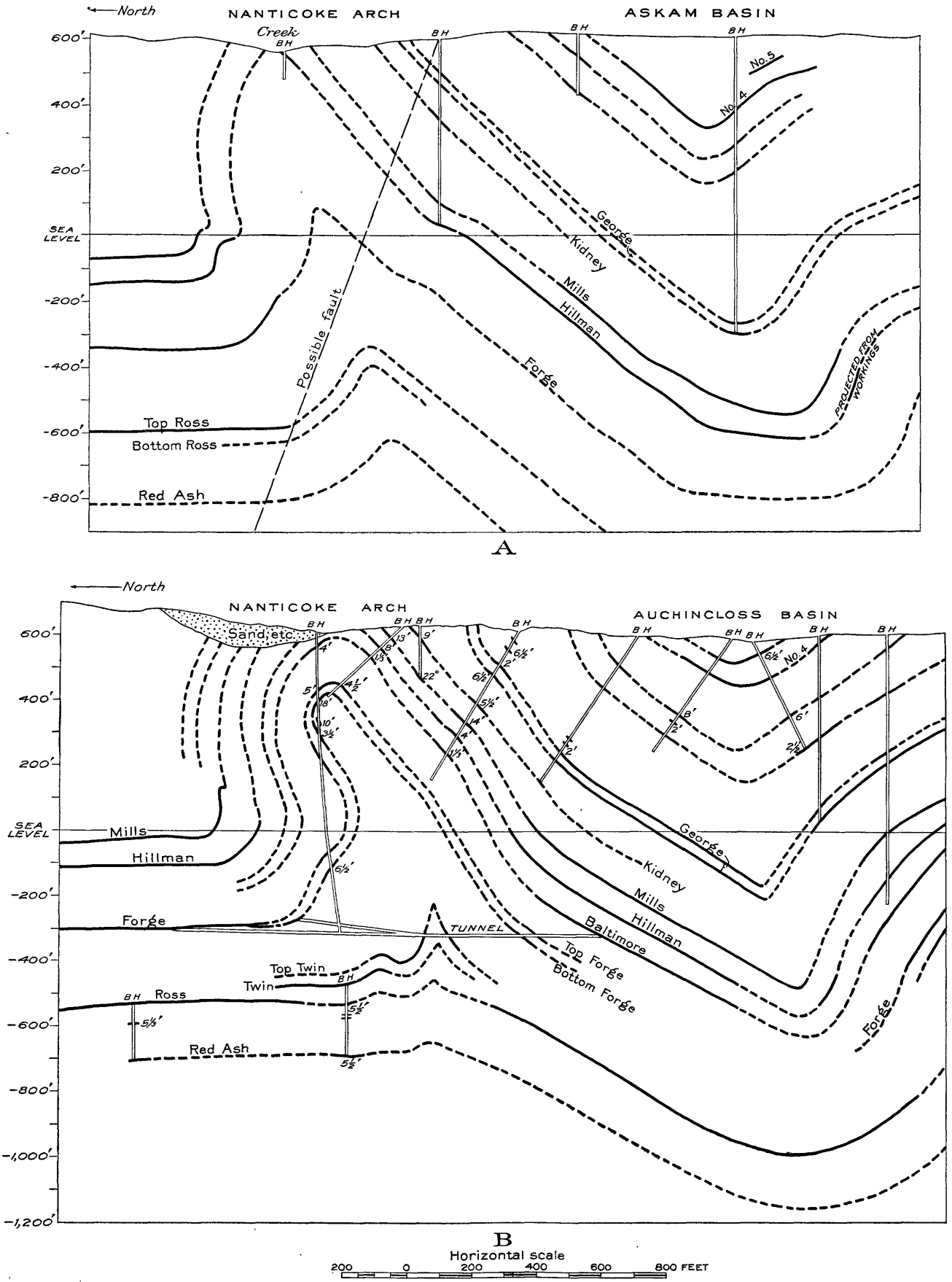


FIGURE 11.—Sections across the eastern extension of the Nanticoke arch and the Auchincloss-Askam basin: A, North of Truesdale shaft; B, 2,500 feet east of Auchincloss shaft. Compiled from sections by Glen Alden Coal Co. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Thicknesses of coal beds as given in boreholes include waste.

amount is not known. In the Auchincloss basin just north of the arch, however, the Red Ash bed descends nearly to −1,200 feet, and the basin deepens still more in its extension eastward to Askam shaft.

GLENLYON ROLL

In the workings of the Glenlyon colliery on the mountain slope is a sharp "roll," probably somewhat faulted, which extends entirely across the colliery and eastward to and across the Stearns tract. It is mostly in beds between the Red Ash and Twin coals, and the uplift averages about 200 feet on the north or mountain side of the slope. Some features are shown in the three cross sections of figure 10. This roll presents considerable variation in form. The extent and relations of breaks or faults that may exist are not revealed by the mining operations. The greatest amount of deformation in the area is about halfway between shafts 6 and 7.

NANTICOKE OVERTURN AND FAULT

A great overturn of all the higher coal measures along the southern edge of the mines of the Susquehanna Coal Co. in Nanticoke southward from Washington Street is broken by a sharp thrust fault along part of its course. The lower measures are much less flexed and fractured. The principal features of this deformation are shown in plate 17. This flexure originates in a sharp anticline southeast of Newport in which the lower strata are arched 200 feet or more. East of the area represented in section A the uplift rises considerably and continues as the high arch extending along the

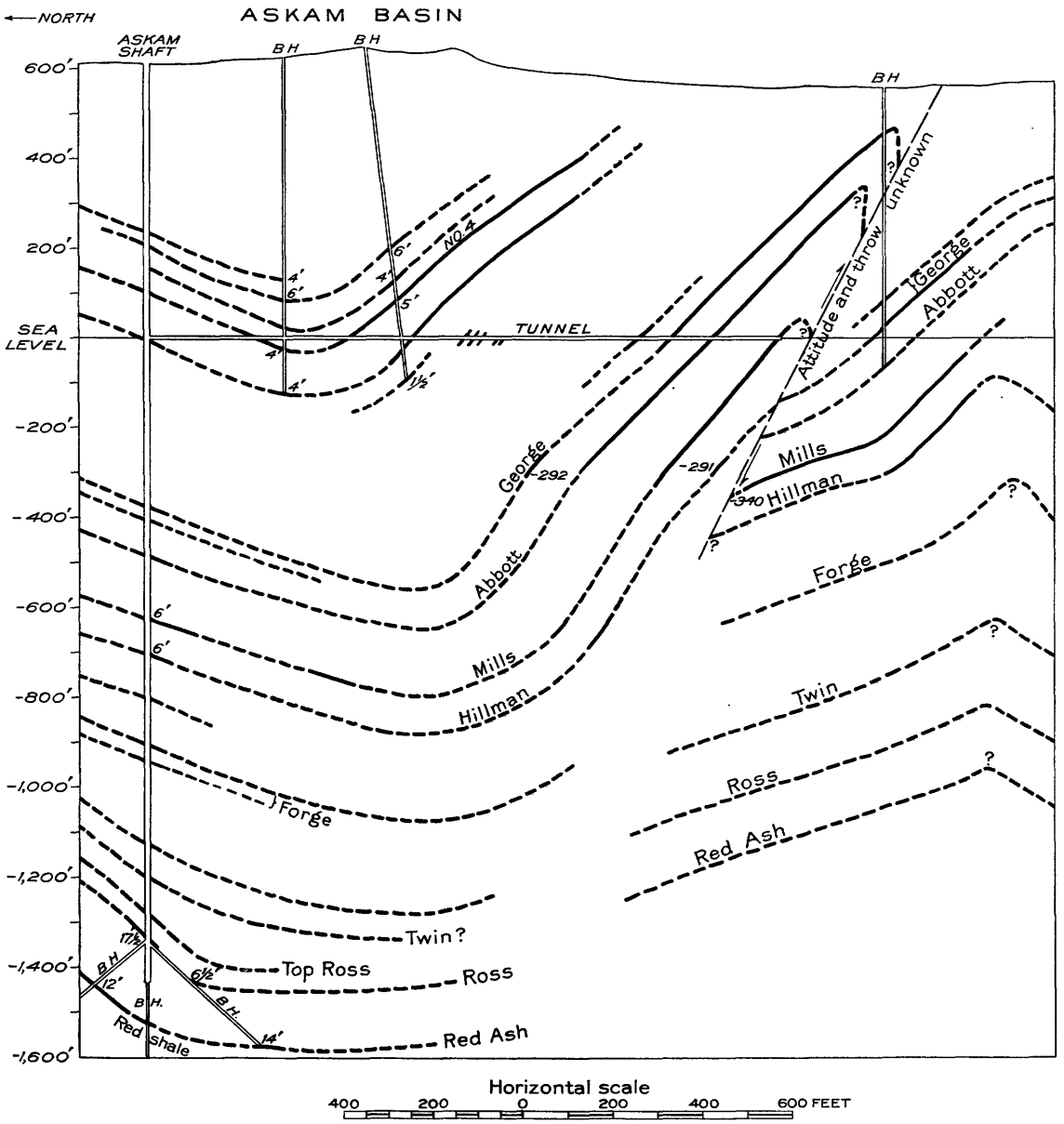


FIGURE 12.—Section from Askam shaft southward, showing probable relations of the Alden north fault and the Alden arch. From section by the Glen Alden Coal Co., slightly modified. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes given are at end workings; thicknesses of coal beds as given in boreholes include waste.

north side of the Auchincloss-Askam basin. In and near the southeastern corner of Nanticoke it has the relations shown in section B, figure 11. The relations about 3,600 feet farther east are shown in section A of the same figure.

The features shown in these sections are partly revealed by mining on the slopes of the uplift, by tunnels, and by many boreholes. Some coal beds given in the borehole records may not be interpreted correctly, but the data appear to be sufficiently definite to indicate the structure shown by the broken lines. It is evident that throughout this uplift the strongest deformation is in the upper measures, between the Forge and George beds. The Ross and Red Ash beds are much less flexed. However, all the measures dip steeply into the Auchincloss-Askam basin, where finally the Red Ash bed passes to a depth more than 1,500 feet below sea level. This is just south of the Askam shaft, where the Red Ash coal bed lies at a depth of slightly more than 1,500 feet below sea level. Here this coal bed is about 12 feet thick. The strata rise sharply to the south out of this basin, apparently along a fold broken by a reverse fault, which is probably a continuation of the Alden north fault shown in figure 12.

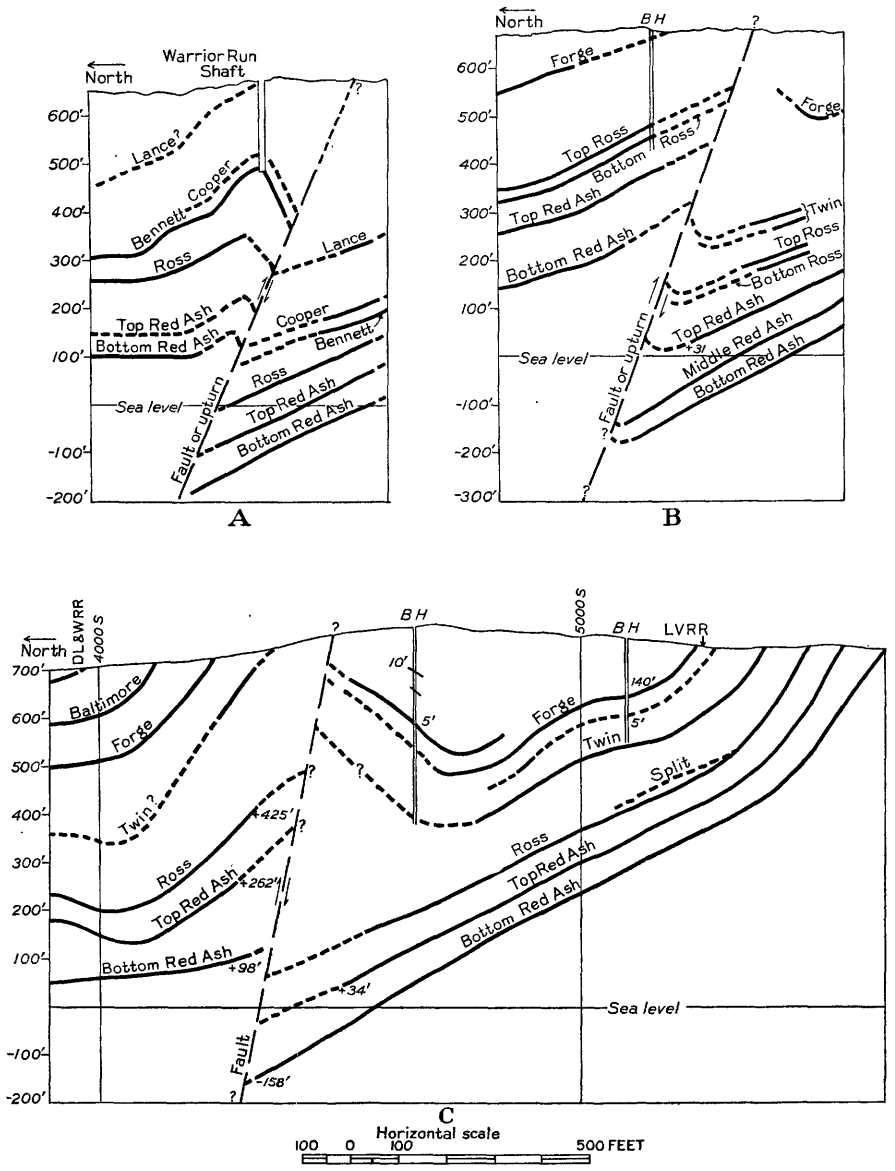


FIGURE 13.—Sections across the Warrior Run fault between Truesdale shaft and Warrior Run shaft: A, Through Warrior Run shaft; B, 2,000 feet east of Truesdale shaft; C, 800 feet east of Truesdale shaft. Compiled from sections in offices of coal companies. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes of beds given are at end workings; thicknesses of coal beds given are in boreholes and include waste; lines marked 4,000 S, etc., are coordinates on mine maps.

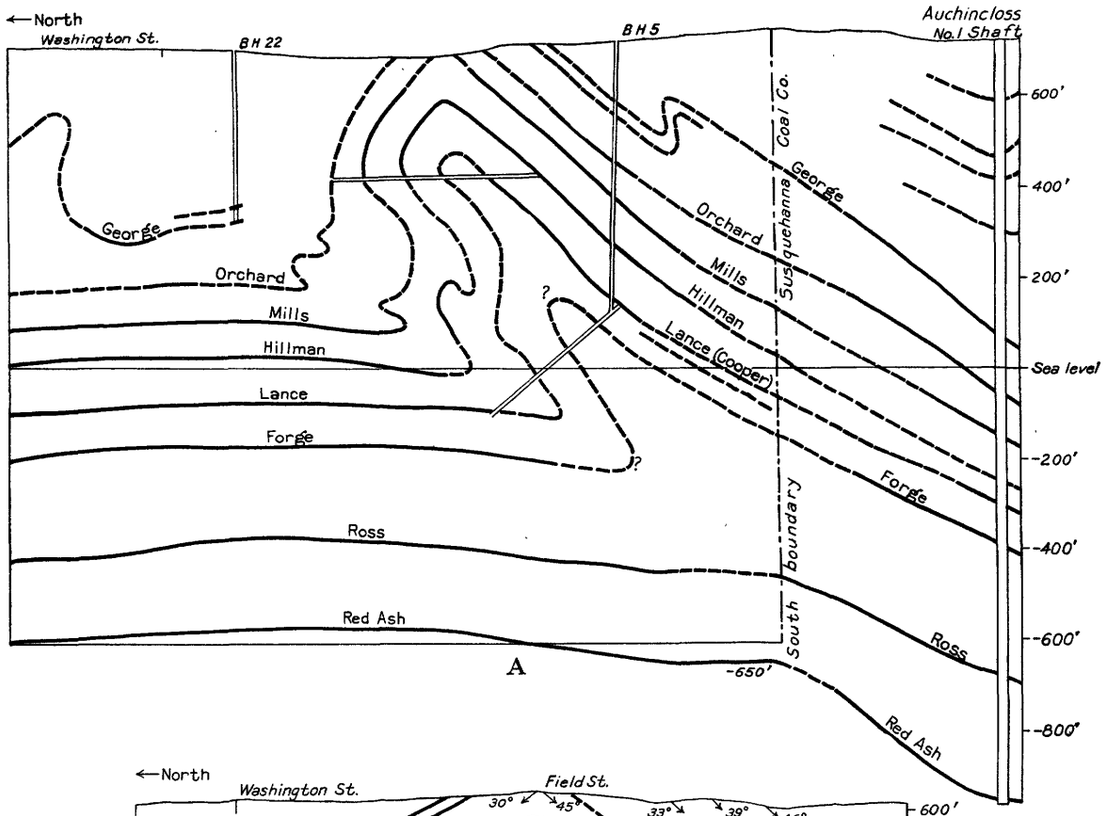
Workings in the Hillman and higher beds reveal a fault with uplift on the north side and vertical displacement of about 200 feet. The relations in the lower beds are unknown.

WARRIOR RUN FAULT

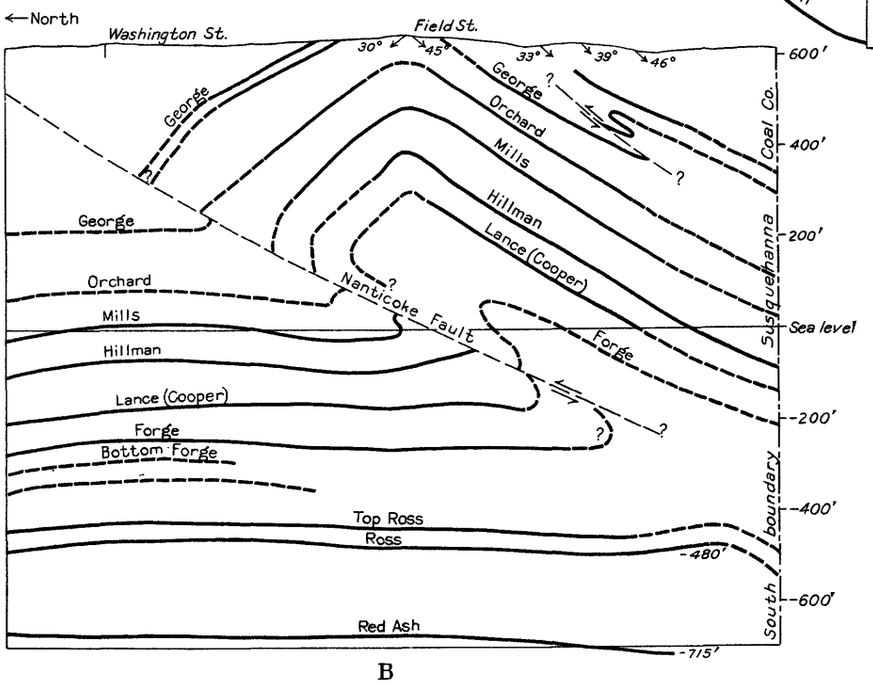
A sharp, considerably fractured upthrust, extends from the southern part of the Bliss colliery to and beyond Warrior Run colliery. The uplift, which is mostly the result of faulting, is on the north side of the flexure; the displacement ranges from 200 to 350 feet in greater part. In workings southeast of Truesdale shaft the bottom Red Ash bed is mined up to an altitude of 235 feet on the north side and down to 158 feet below sea level on the south side of the fault. The principal features of this fault are shown in figure 13, in which broken lines suggest relations not revealed by mining. The western and eastern terminations of this upthrust are not indicated on available mine maps.

DEEP BASINS NORTH OF SUGAR NOTCH

As shown in cross sections G–G′, H–H′, I–I′, plate 11, the deeper part of the basin west of Wilkes-Barre is traversed by several plications of considerable amplitude. Their axes are nearly parallel to the general east-northeast strike of the whole basin and they pitch up and down several hundred feet. One notable rise is an anticline or arch that extends west with gradual downward pitch from Maxwell colliery and passes north of the eastern extension of the Askam basin. Another high arch extends through the southern part of the Inman and Loomis collieries. As the Red Ash bed is not worked in this region and the higher beds are mined only in relatively small areas, the data for most of this region are mainly records of boreholes in which the identity of coal beds as reported is somewhat



A



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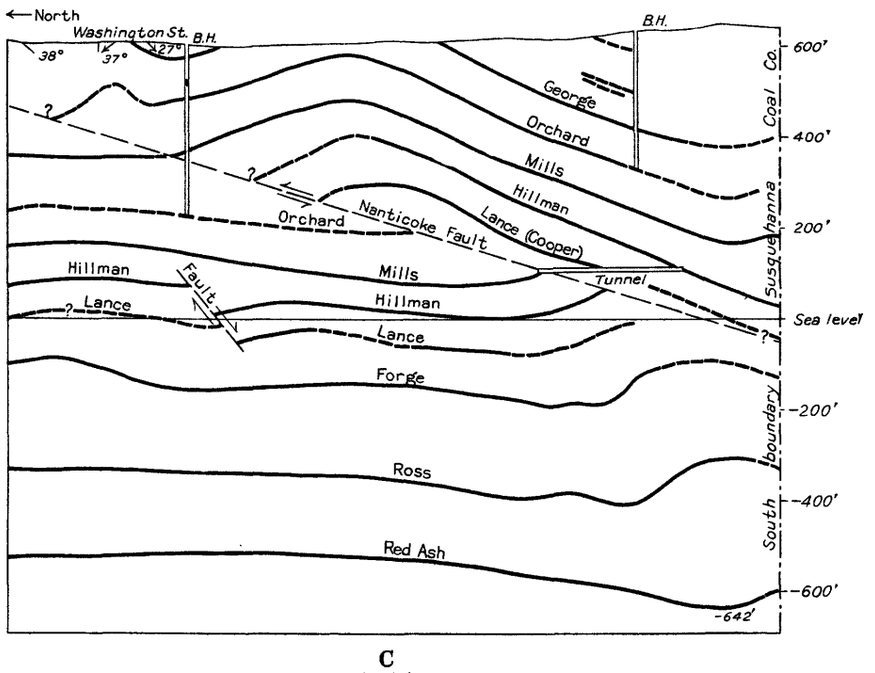
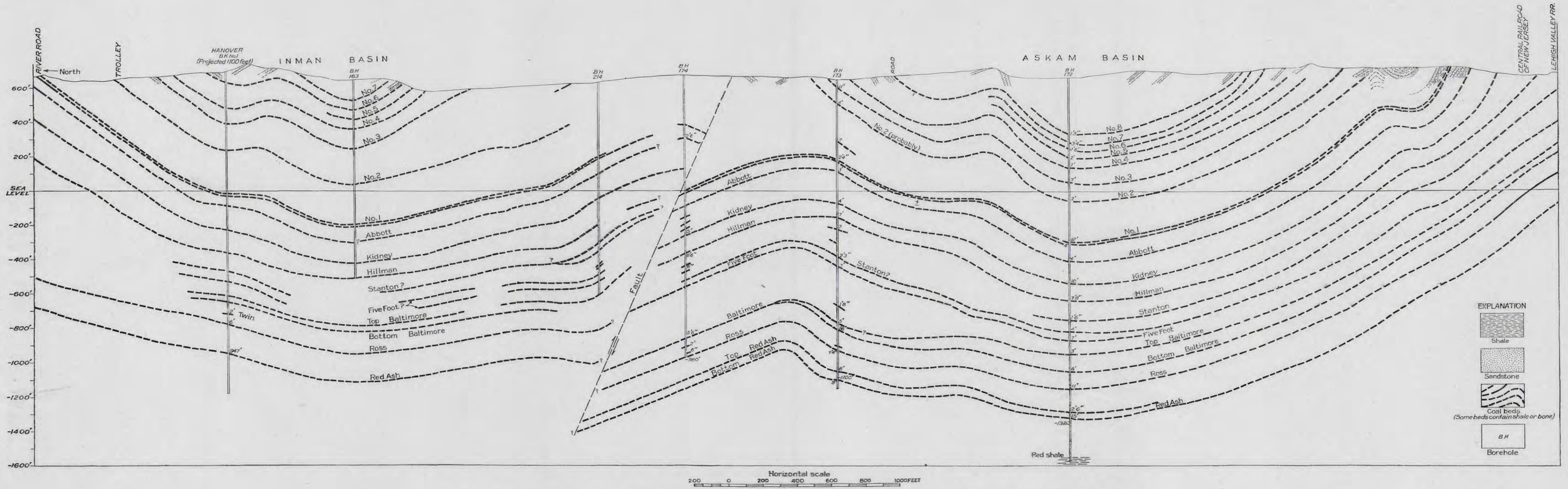


C

Horizontal scale
200 0 200 400 Feet

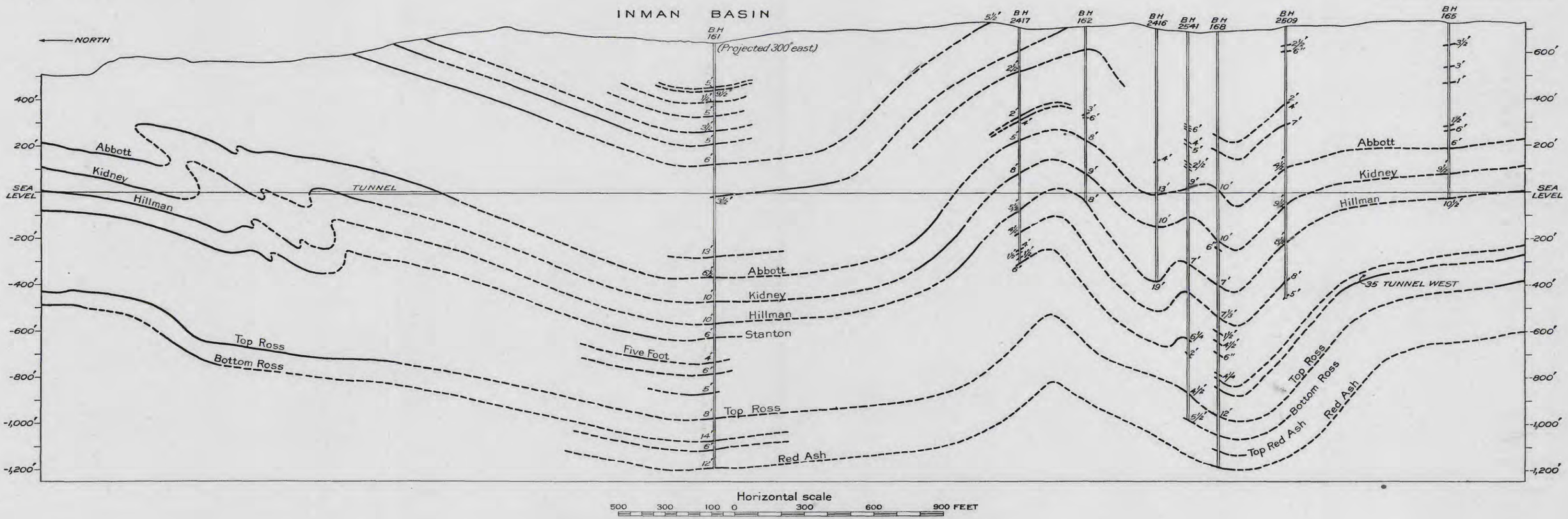
SECTIONS ACROSS OVERTURN AND FAULT IN MINES OF SUSQUEHANNA COAL CO. IN THE SOUTHERN PART OF NANTICOKE.

A, North of Auchincloss shaft: B, 900 feet west of section A; C, 1,500 feet west of section B. Compiled from sections by Susquehanna Coal Co. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes of coal beds given are at end workings.



SECTION ACROSS THE CENTRAL PART OF THE NORTHERN ANTHRACITE COAL BASIN NORTHWEST OF SUGAR NOTCH, THROUGH THE "BIDDLE TRACT."

Based mostly on records of boreholes (BH). Thicknesses of coal beds as given in boreholes usually include waste.



SECTION ACROSS INMAN BASIN AND ADJOINING ARCHES WEST OF INMAN SHAFT.

Compiled from sections by Glen Alden Coal Co. BH, Boreholes. Broken lines are hypothetical; solid lines represent mined coal. Thicknesses of coal beds as given in boreholes include waste.

uncertain. Therefore on plate 10 most of the contour lines are dotted to indicate that they are largely hypothetical. Plate 18 shows an interpretation of the available data.

A mile farther east, in the Inman colliery, the Abbott, Kidney, and Hillman beds have been mined in small areas, and in certain districts the Ross beds also, and there are several deep boreholes, so that the representation in the section in plate 19 is fairly satisfactory.

SOUTH WILKES-BARRE REGION

As shown by cross section G–G′ of plate 11, the strata in the western part of Wilkes-Barre are considerably flexed, although the basins are not as deep and most of the dips are less steep than in the region to the west. In the South Wilkes-Barre colliery the strata present a succession of flexures in which, however, the lowest coal beds have not been mined to any great extent. A basin with steep dip on its south side passes through the northern part of Ashley and near the Stanton shaft. Some relations of the flexures in this region are shown in figure 14, which represents an area across the basin about 2,300 feet west of Stanton shaft. In this section, as in others, the structure revealed by mining is indicated by solid lines and inferred structure features revealed, especially in the Baltimore bed. Some of these variations in the form and position of the flexure are shown in figure 15.

NANTICOKE TO KINGSTON REGION

On the north side of the Susquehanna River from Nanticoke to Kingston the coal measures gradually rise to the east, as the axis of the basin rises in that direction. In general, the dip is steep on the mountain slope along the north side of the basin, and several faults and flexures extend into the margin of the basin on a slightly oblique course. The relations of most of

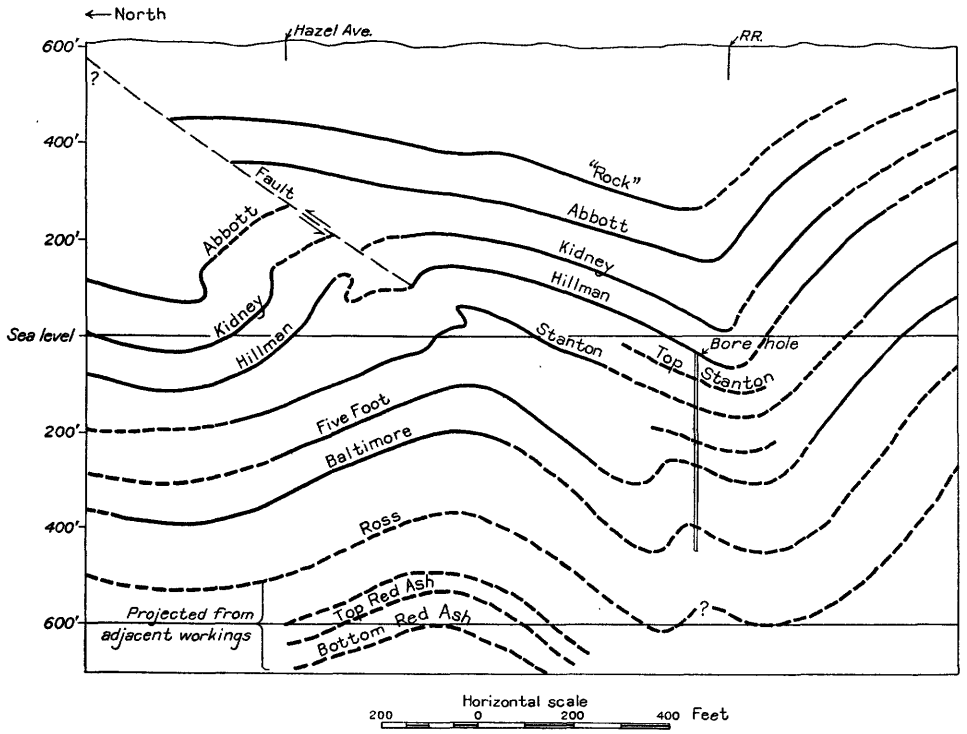


FIGURE 14.—Section in the southwestern part of South Wilkes-Barre colliery. Compiled from section by Glen Alden Coal Co. Broken lines are hypothetical; solid lines represent mined coal.

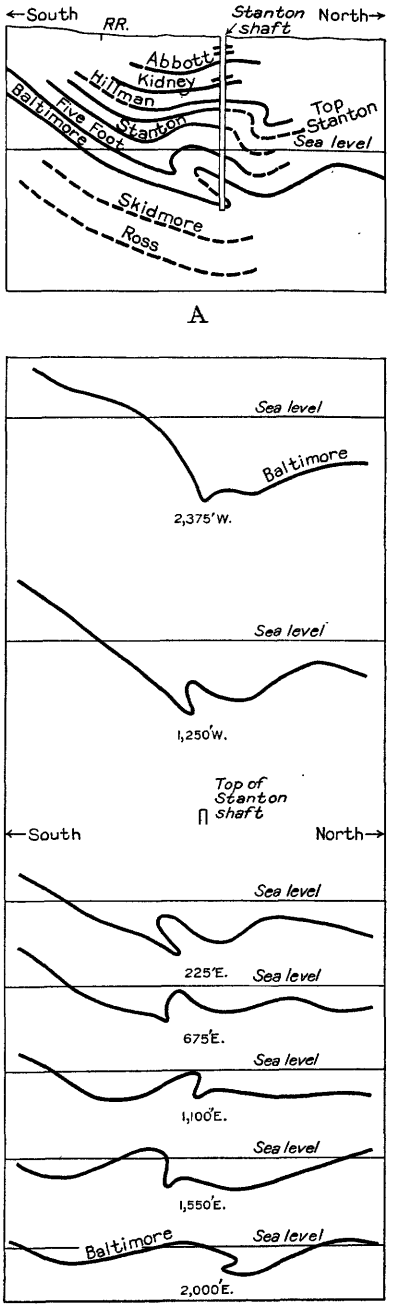


FIGURE 15.—Sections in Stanton colliery, South Wilkes-Barre, showing flexing in Baltimore coal bed: A, Through Stanton shaft; B, sections at intervals from a point 2,375 feet west of the shaft to a point 2,000 feet east of the shaft. Sections by W. J. Richards. Looking west.

by broken lines. The crest of the anticline to the north is broken by a fault that disrupts the Abbott bed about 140 feet. The uplift is on the south side, and the flexure merges into a sharp crumple in the Stanton bed. In extensive workings about the Stanton shaft this crumple has been well explored and some interesting these features are shown by the contour lines in plate 10 and by cross sections G–G′, H–H′, and I–I′, plate 11, all constructed in greater part from mine maps of Red Ash workings. Some details, especially along zones of steep dips and overturns, have had to be sketched hypothetically

because the coal is generally not mined in the more disturbed places and also because some of the old mine maps are rather dim or meager as to altitudes. One of the local upturns and a fault in Nottingham colliery are shown in figure 16.

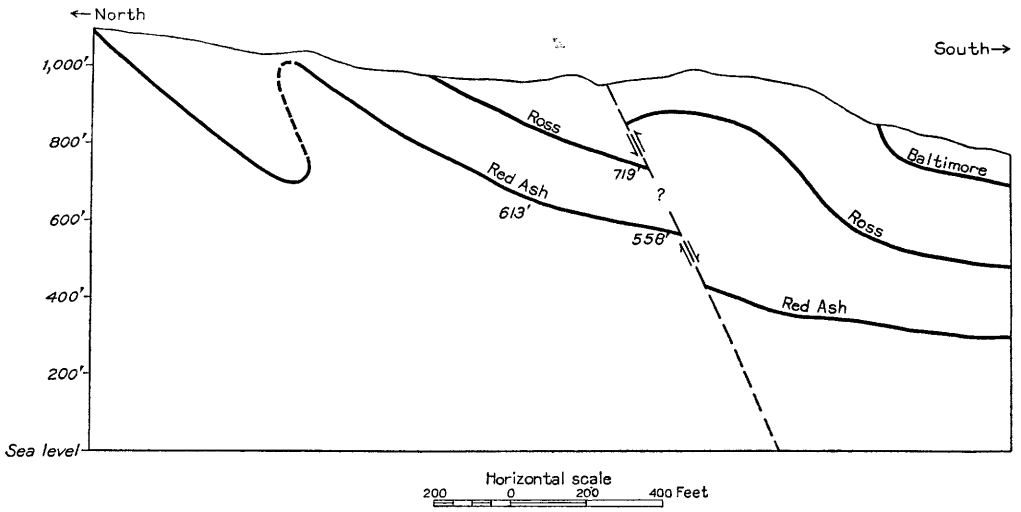


FIGURE 16.—Section across fault and roll in the northwestern part of Nottingham colliery, Plymouth. Figures given are altitudes of coal beds.

Some details of a fault and small upturn in the Loree colliery are shown in figure 17.

In the Pettebone colliery in Kingston the Red Ash bed is plicated by a sharp overturn, or overthrust fault, with axis trending nearly due west, and although this break is reflected in the Ross bed by an arch it is lost in higher beds. These beds, however, are extensively arched south of the shafts. Some relations are shown in figure 18. This section also shows the splitting of the Baltimore or Pittston coal bed into the Cooper and Bennett beds. Such splitting of beds is an interesting stratigraphic feature of the coal measures in the Wilkes-Barre district.

PITTSTON REGION

From Wilkes-Barre to and beyond Pittston the bottom of the Northern Anthracite basin is near the Susquehanna and Lackawanna Rivers, with a continued but irregular rise of the beds to the east. The rise is such that the Red Ash bed, whose altitude is slightly more than 700 feet below sea level in Kingston, is 200 feet above sea level in Pittston and about 500

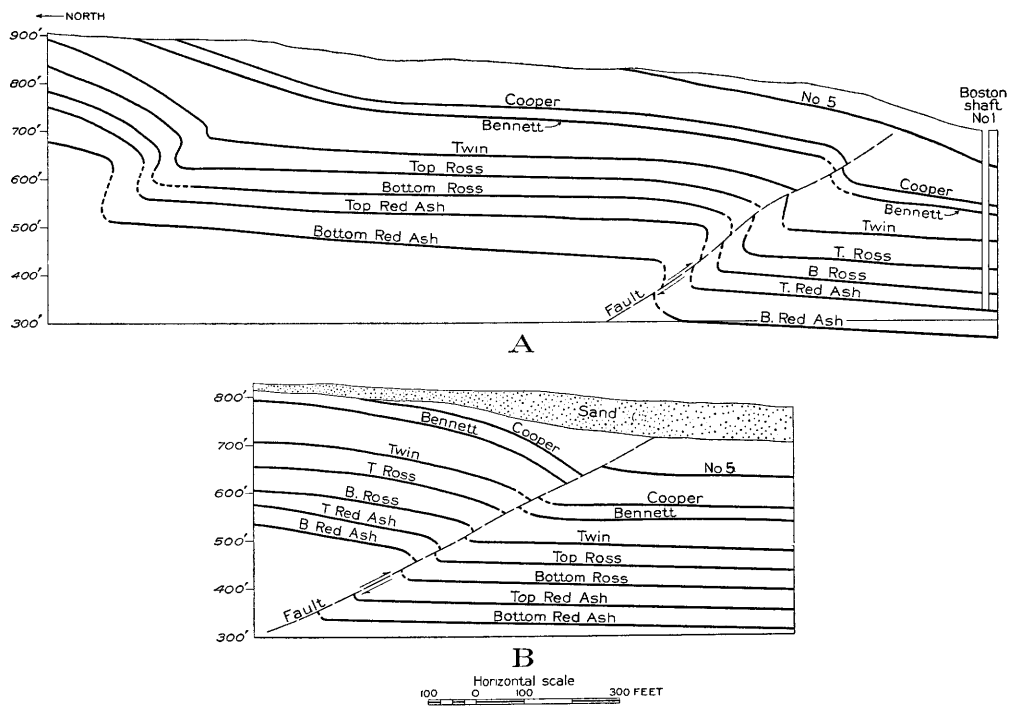


FIGURE 17.—Sections showing fault in Loree colliery, Plymouth: A, North of Boston shaft; B, West of Boston shaft.

feet above sea level at Old Forge. The bottom of the basin is wide and in most sections nearly horizontal. There is a rapid rise of the beds on the mountain slope to the north and a gradual rise through a succession of flexures on the slope to the south, notably in the prominent anticline at Heidelburg colliery, between configuration is shown on plate 10, and in part in cross sections E–E′, F–F′, and G–G′ of plate 11. Most of the contours shown in this general area are from mine workings in the Red Ash bed, but in a few areas they are deduced from workings in the Marcy and other higher beds.

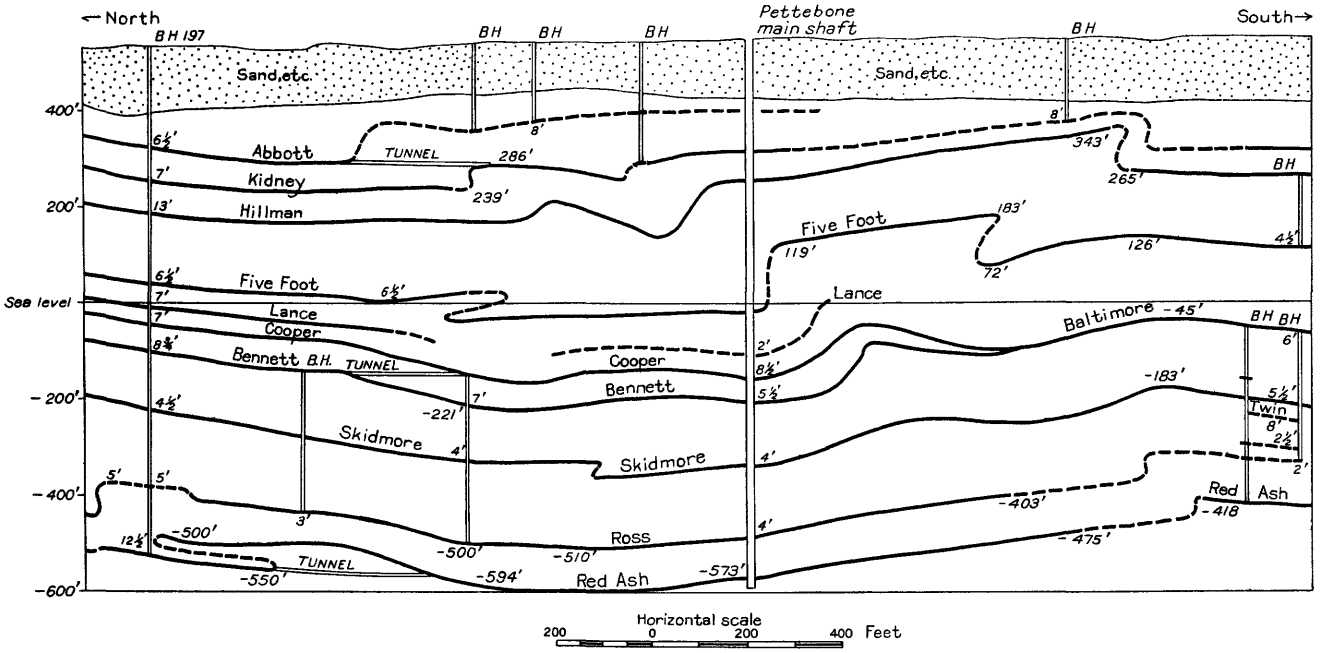


FIGURE 18.—Section of Pettebone colliery, Kingston. BH, Borehole. Broken lines are hypothetical; solid lines represent mined coal. Altitudes and thicknesses of coal beds are given.

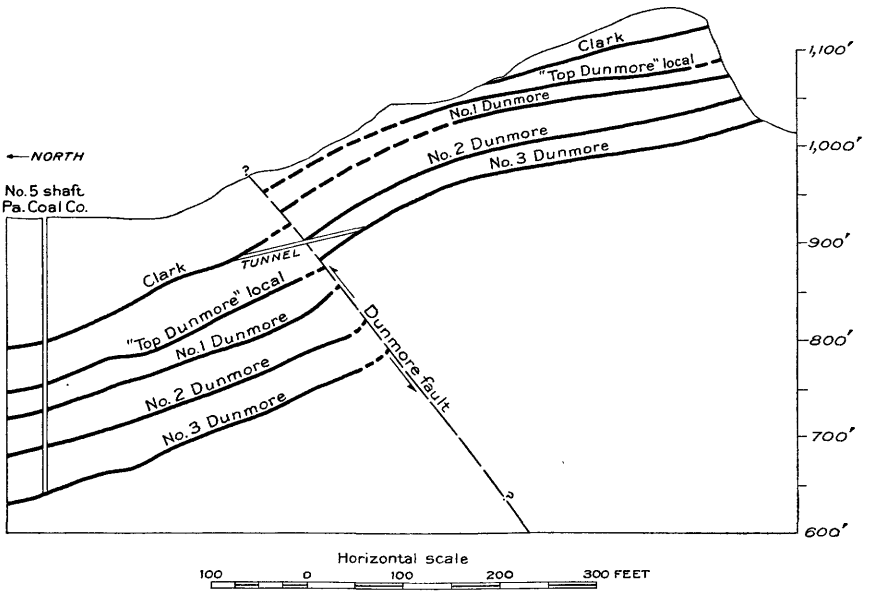


FIGURE 19.—Section across Dunmore fault just south of Pennsylvania Coal Co. shaft 5.

Inkerman and Laflin. These flexures on the south slope extend from a point south of Laflin through Plains and the Pettebone colliery and from Baltimore colliery to the South Wilkes-Barre colliery. They are extensively explored by mining operations. Their

SCRANTON REGION

The city of Scranton extends entirely across the coal basin, which in that vicinity has a width of slightly more than 4 miles. In the wide, flat bottom of the basin the lowest coal bed descends to an altitude of about 200

feet below sea level, or about 900 feet below the surface. This bed rises rather steeply on the adjoining mountain slopes to altitudes of 1,100 to 1,300 feet. Most of the dips are regular, but local varying dips and faults extend diagonally into the basin. One subordinate flexure parallel to the strike makes a sharp upturn or fault that extends from Capouse colliery to and beyond Stoors colliery. Another, which enters the basin in Meadowside and Spencer collieries, trends west of south and extends across Bellevue, Sloan, and Archbald collieries. It is very prominent in colliery 5 in the southern part of Dunmore and in Spencer colliery, where the upturn of the beds, on its west side, is more than 100 feet. (See fig. 19.) A slight doming of the strata is notable in the southern part of Nay Aug Park, where the red Mauch Chunk shale is cut by Roaring Brook. A low anticline extends through Pine Brook colliery and thence northwestward between Hampton and Sloan shafts, and a similar flexure slightly deforms the coal measures in the Green Ridge and Diamond collieries. The effects of these flexures are visible mainly in upper beds.

DICKSON TO JERMYN

Dickson is in the bottom of the coal basin. A short distance east of that place the lowest coal bed lies a few feet below sea level, as in Olyphant shaft 2. The relations are shown in section C–C^1, plate 11. At Olyphant colliery and eastward the bottom of the general basin rises considerably to a high in the eastern part of the old Raymond colliery; the axis of the deeper part trends east-northeastward and passes through Sterrick Creek, Riverside, and Gravity Slope collieries. As in many other parts of the basin, it is nearly flat bottomed in the middle and the dips are steep along the mountain sides. At Glenwood colliery in Jermyn the middle of the basin deepens locally about 200 feet, with relations shown in section B–B^1, plate 11. Its axis here is shifted far to the north. The coal measures are traversed by several anticlines or faults. One notable uplift, the Winton arch, passes through the city of Olyphant and the village of Winton, another extends due east from Jessup, and a third extends from a point east of Peckville through the old Riverside workings. The relations of these features are shown on plate 10 insofar as data are available.

MAYFIELD TO FOREST CITY REGION

In the region east of Mayfield, through Carbondale to Forest City, the coal basin is a trough about 700 feet deep, becoming gradually more shallow toward the east. The lower coal beds have been extensively worked, but they are not very definitely correlated with the Dunmore beds farther west, although they occur in about the same position above the conglomerate of the Pottsville formation and below other coal beds that extend far to the west. A thickening of intervening sandstone in the Elk Creek district makes the precise representation of the structure difficult, especially on the 1,100- and 1,200-foot contour lines north of Northwest colliery. The dips are mostly at low angles, and although the angles vary considerably, the beds lie nearly level at many places in the center of the basin and become much steeper on the mountain slopes. A small anticline trending nearly eastward crosses the Lackawanna River in Northwest colliery, lifting the strata on its axis so that the red Mauch Chunk shale is revealed in the river banks for a short distance. This flexure extends some distance westward nearly, if not quite, to Coal Brook. Another lower anticline parallels it for a short distance on the south in the old Simpson colliery.

The relations of the few very small crumples or faults in some of the beds in collieries between Mayfield and Forest City were not ascertained.

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