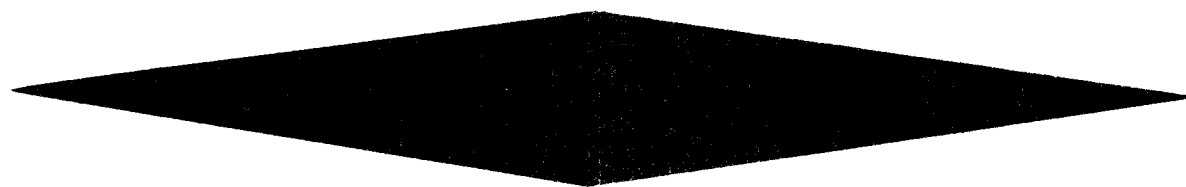


NUMBER 73



Atlas of Pennsylvania Coal
and Coal Mining
PART I
Bituminous Coal

GEORGE F. DEASY
and
PHYLLIS R. GRIESS

COLLEGE OF MINERAL INDUSTRIES

THE PENNSYLVANIA STATE UNIVERSITY

University Park • Pennsylvania



Bulletin of the

MINERAL INDUSTRIES
EXPERIMENT STATION

Mineral Conservation Series

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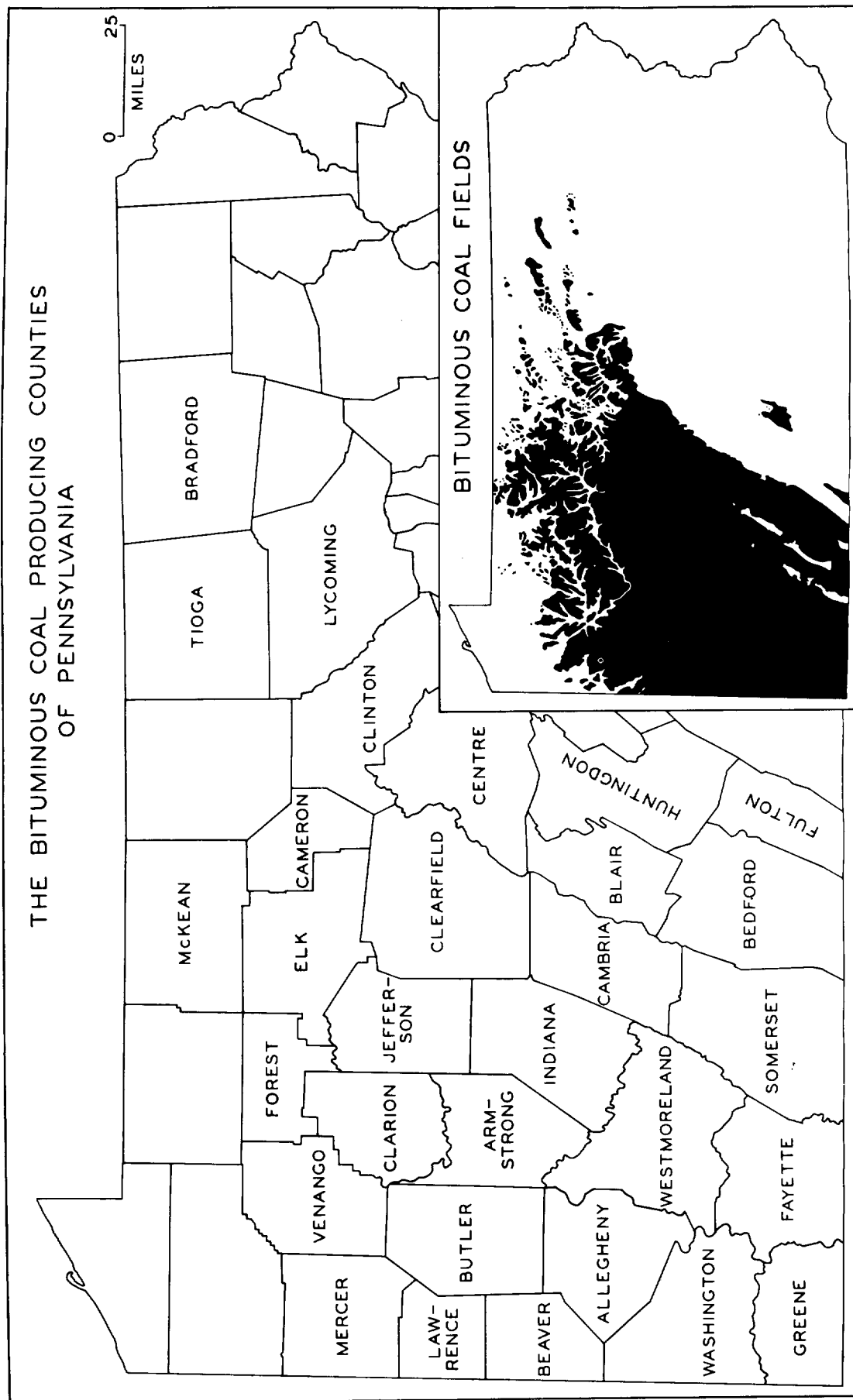
M. L. Keith, Editor
Mineral Conservation Section
of the Experiment Station

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PRELIMINARY REMARKS

The Atlas of Pennsylvania Coal and Coal Mining brings together selected data on the Commonwealth's coal resources and coal mining industry and presents them in graphic form. Included are maps dealing with geological, historical, engineering, economic, production, employment, safety, and transportation facets of the subject. It is hoped that the Atlas will serve as a basic reference which will provide information regarding the coal industry of the Commonwealth to both layman and specialist. It should be of interest and use to educators, conservationists, coal mining companies, research and planning organizations, coal users and unions, and to federal, state, county, and local governmental agencies.

The Atlas is issued in two volumes. Part I, the present volume, deals with bituminous coal and coal mining; Part II, which will follow, treats of anthracite. The approximately 100 maps in this volume are arranged in six groups. Introductory maps represent Pennsylvania's relative position among states in the mineral and coal mining industries of the United States. A second group of maps deals with Pennsylvania's bituminous coal fields as well as selected coal seams within those fields, and a third group analyzes the composition and heat value of the Commonwealth's bituminous coal. The fourth group of maps is devoted to employment and labor factors in the bituminous industry, and the fifth is concerned with mines, mining methods, and accidents. A final group represents the production and shipment of coal from the Commonwealth's bituminous coal fields.

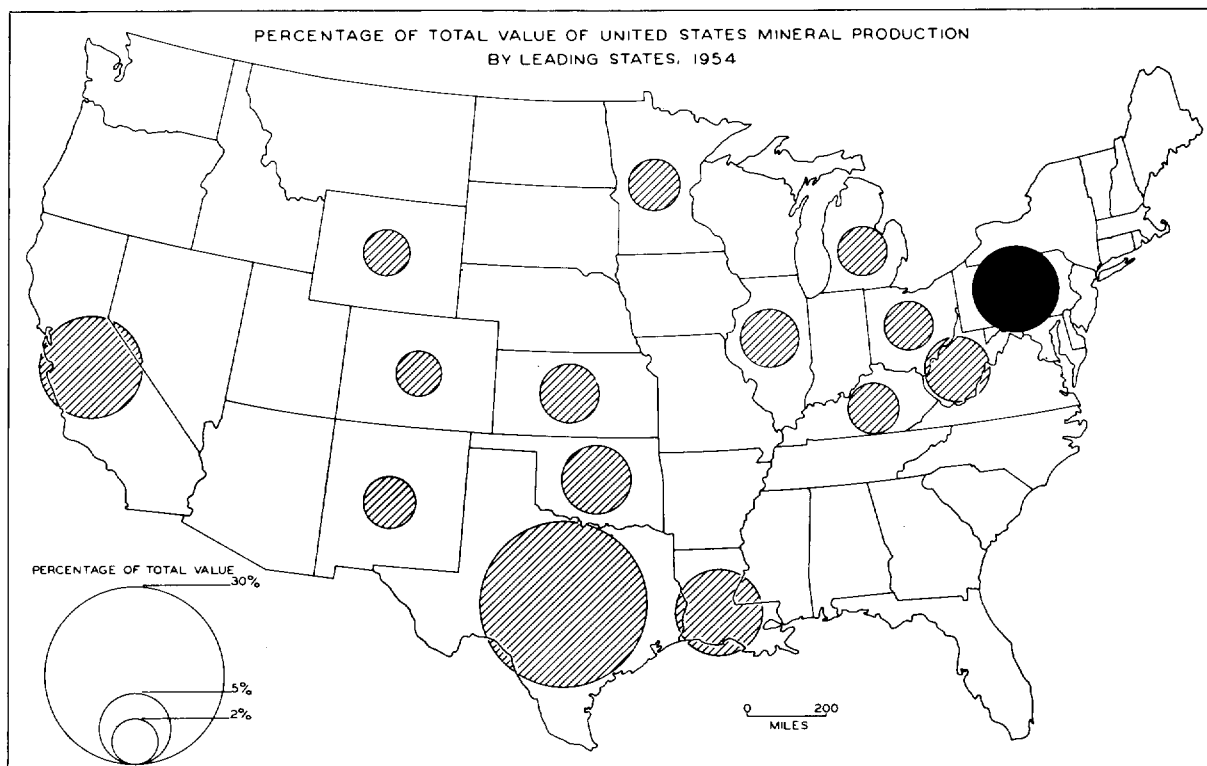
Sources of information that were of assistance in the preparation of this volume are many and varied. Special acknowledgment is due the Pennsylvania Department of Mines and Mineral Industries, and the Bureau of Mines of the United States Department of the Interior. Other sources include such Federal agencies as the Department of Agriculture, Department of Commerce, and Corps of Engineers; such Commonwealth agencies as the Department of Internal Affairs and Department of Labor and Industry; such industrial organizations as the National Bituminous Coal Institute, National Coal Association, Central Pennsylvania Open Pit Mining Association, Central Pennsylvania Coal Producers Association, and Western Pennsylvania Coal Operators Association, the Pittsburgh Consolidation Coal Company and Princess Coal Sales Company, and the United Mine Workers of America. Both published and unpublished materials were obtained from these sources. Field work by the authors supplied additional information. The vertical section on page 10 is from Dutcher, Ferm, Flint and Williams (1959).

Interpretations of some of the maps included in the Atlas are contained in a number of publications written by the authors and issued by the College of Mineral Industries, The Pennsylvania State University. Titles of such publications may be obtained from the College. The authors gratefully acknowledge the help of Mr. D. M. Kohn, Mr. J. L. Pensyl, and Mr. J. Viletto Jr., graduate assistants in geography, in compiling data for and drafting some of the maps.

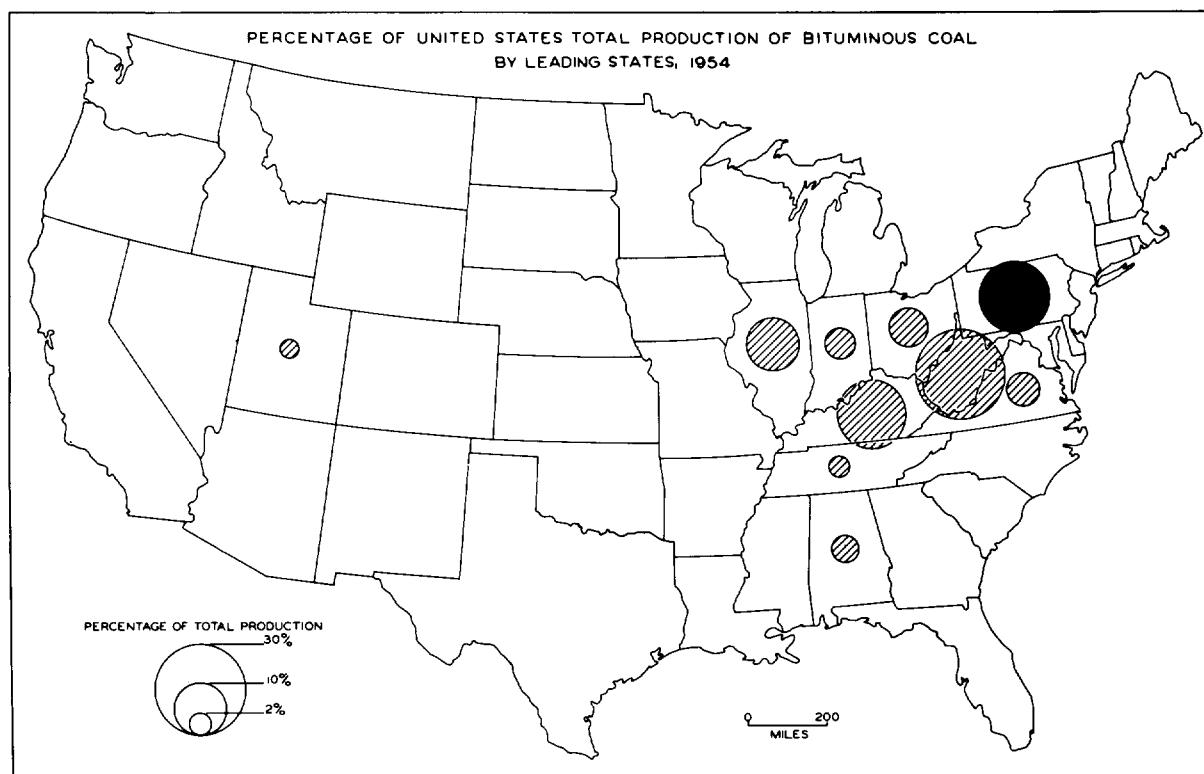
GEORGE F. DEASY
PHYLLIS R. GRIESS

University Park, Pa.
December, 1959

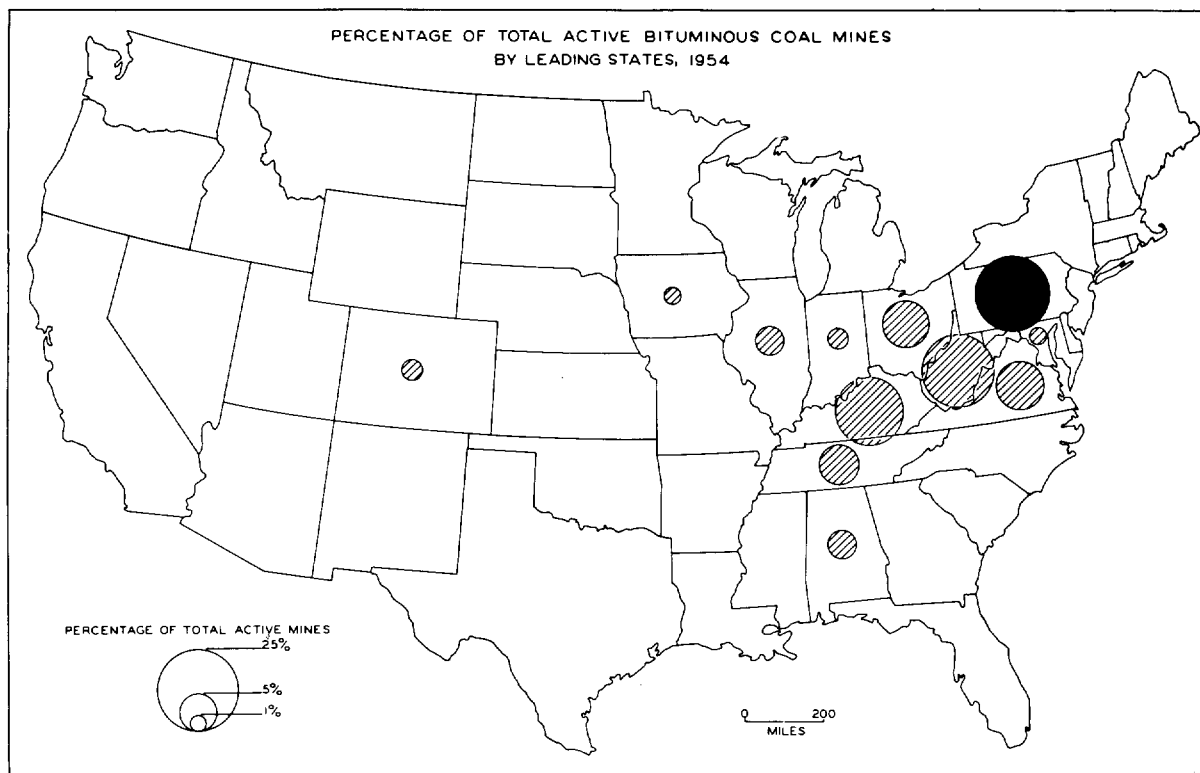
Pennsylvania's Position
in the
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and
Coal Industry



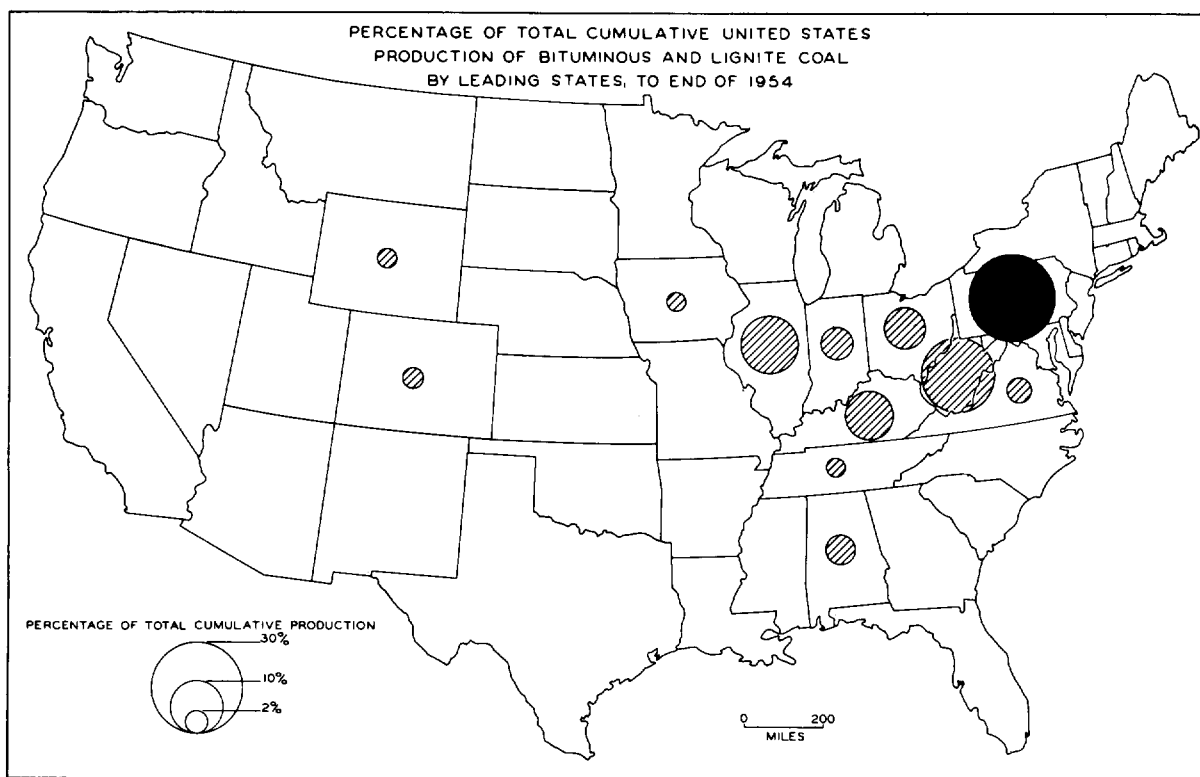
Appendix: Notes 2, 3, and 11.



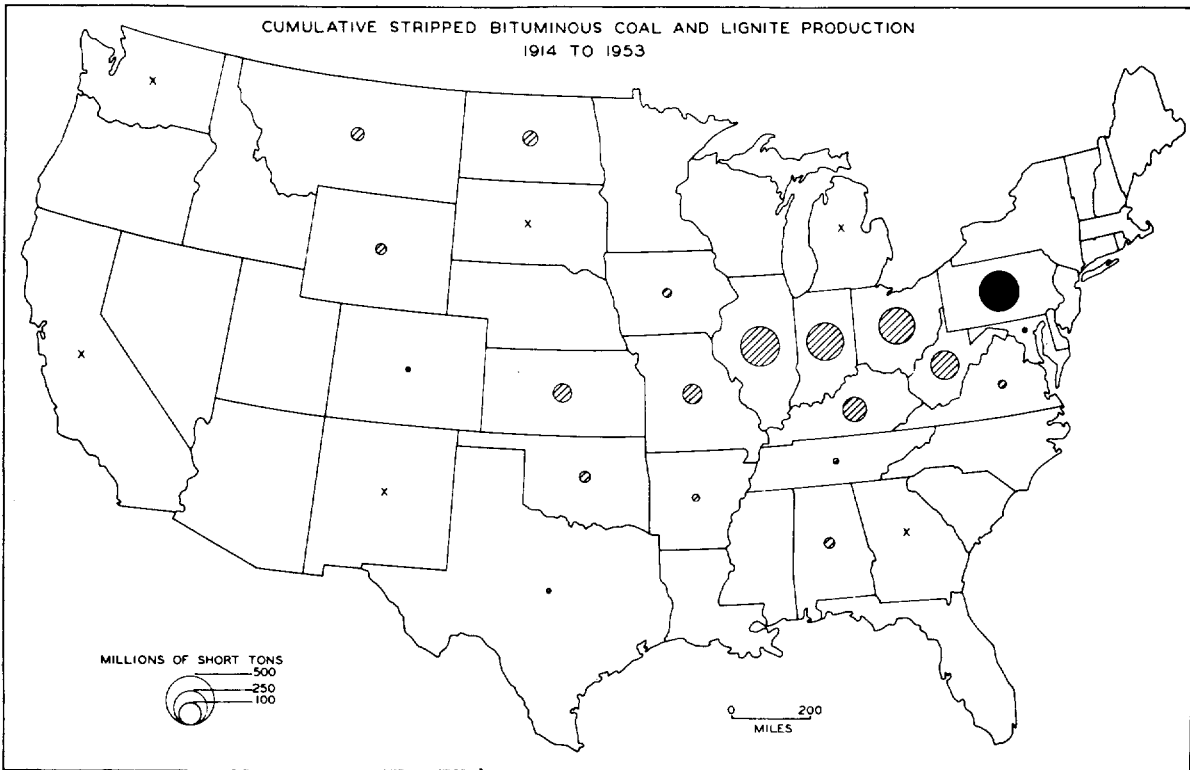
Appendix: Notes 3, 4, 5, and 6.



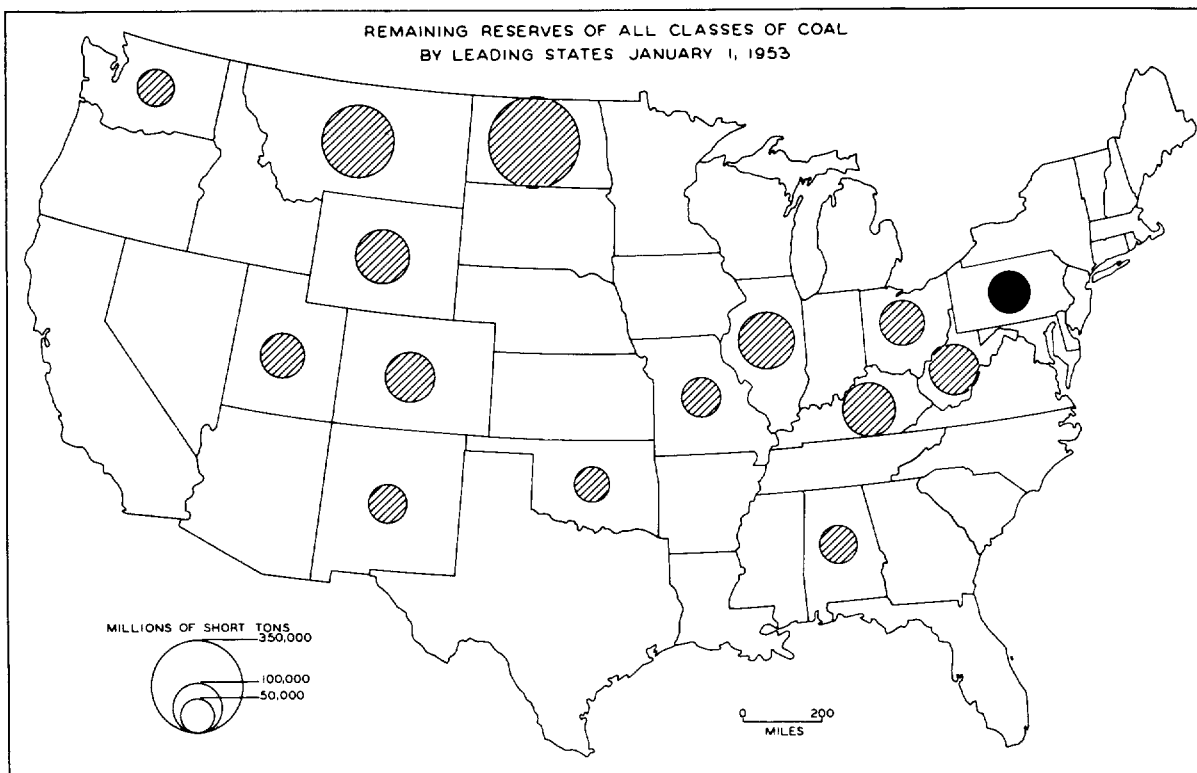
Appendix: Notes 3, 4, and 5.



Appendix: Notes 3, 5, and 7.

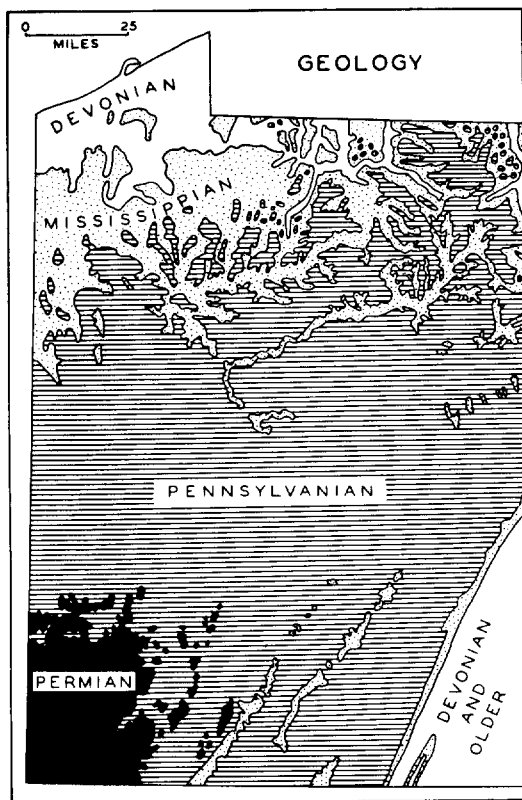


Appendix: Notes 40 and 41.



Appendix: Notes 3, 8, and 9.

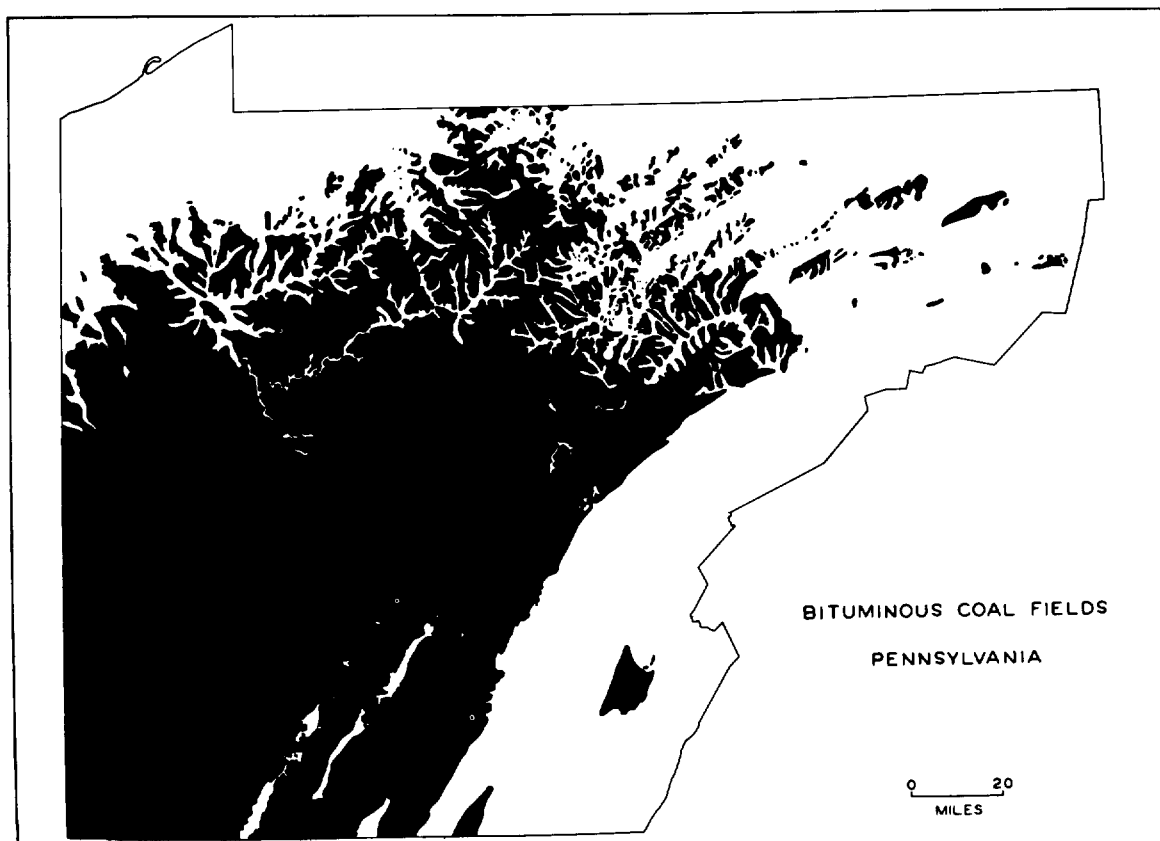
Bituminous Coal Fields
and
Selected Seams
of
Pennsylvania



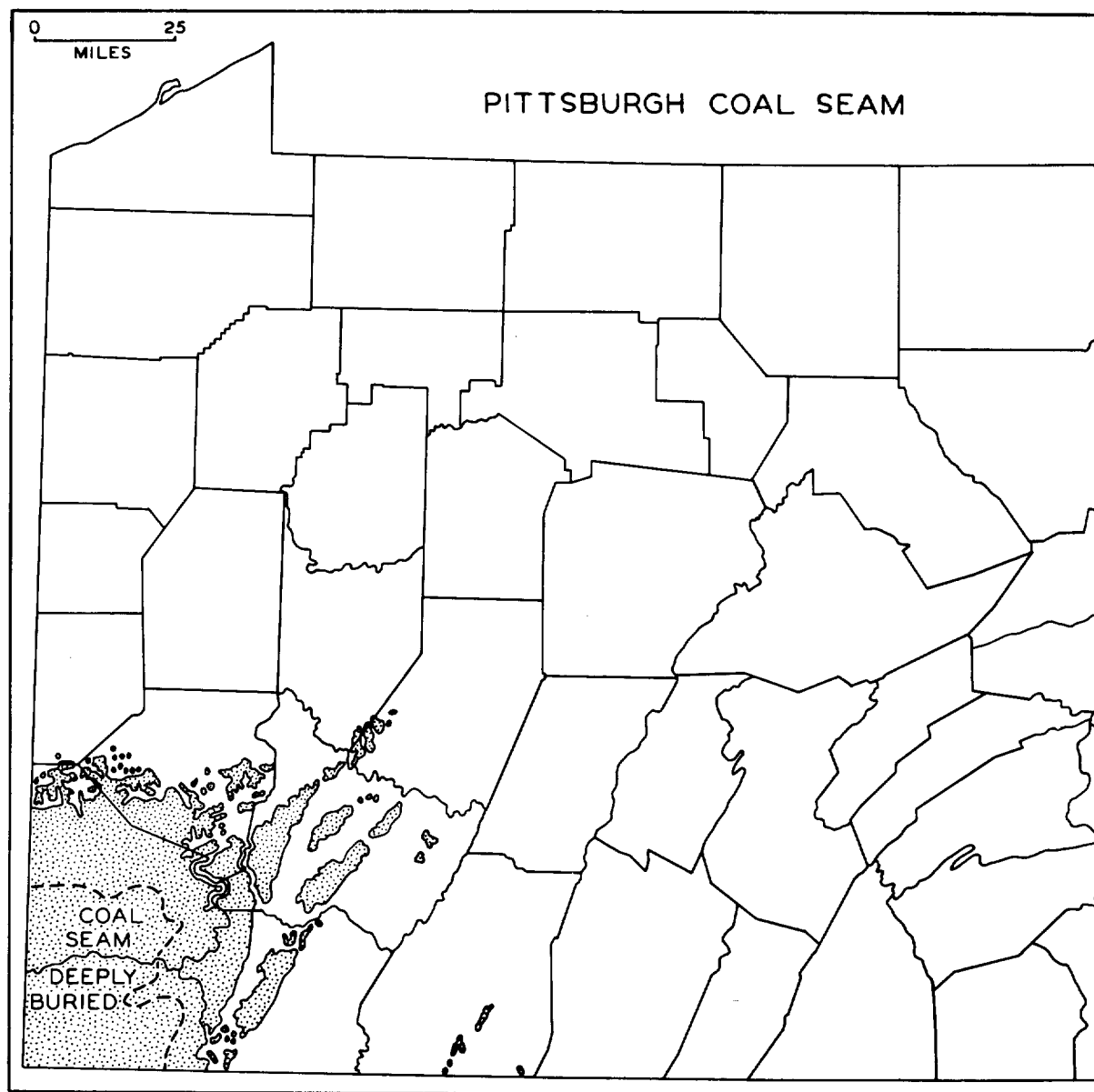
Appendix: Note 47.

BITUMINOUS COAL FIELDS

All rocks underlying western Pennsylvania, except surficial materials such as recent stream and glacial deposits, consist of sedimentary layers formed during the Paleozoic era on the geologic time scale. The most recent of the subdivisions comprising that era is the Permian period (from 185 to 210 million years ago). Successively older subdivisions are the Pennsylvanian (from 210 to 240 million years ago), the Mississippian (from 240 to 265 million years ago), the Devonian (from 265 to 320 million years ago), and the Silurian, Ordovician, and Cambrian. The youngest strata of western Pennsylvania outcrop in the southwestern corner of the State; successively older rocks appear at the surface toward the north and east. Most of Pennsylvania's bituminous coal seams are of Pennsylvanian age, the so-called "Coal Measures." A few seams are of Mississippian and Permian age.



Appendix: Note 48.



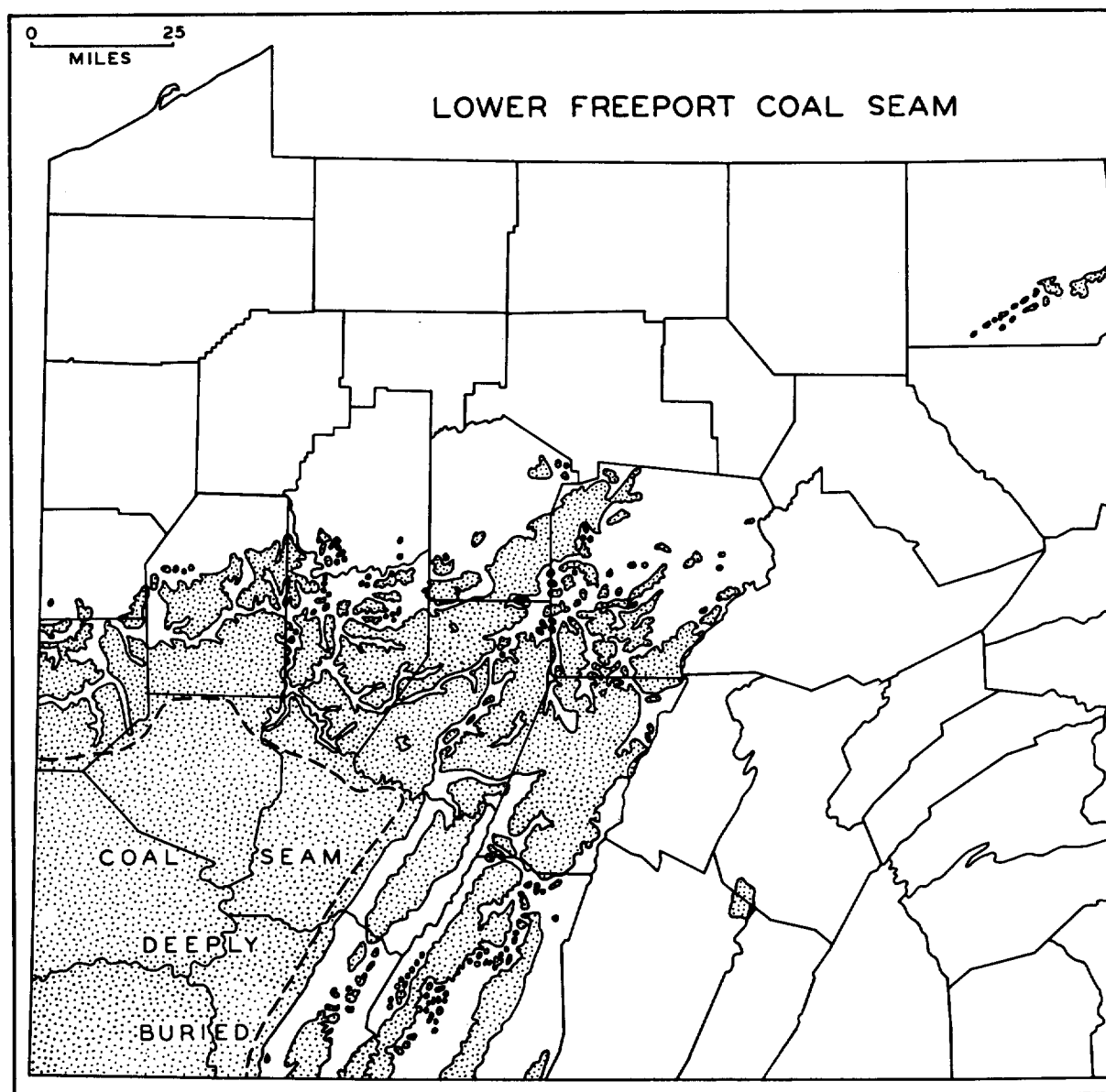
Appendix: Note 50.

INDIVIDUAL COAL SEAMS

Numerous coal seams are incorporated within the 2,500 to 3,000 feet of rock that comprise the coal measures of western Pennsylvania. The entire sequence of seams is not found at any one site, for many of the beds have only limited horizontal extent. Since the rock strata of western Pennsylvania dip gently southwestward, the number of coal seams is greatest in the southwestern counties, where the entire stratigraphic sequence of coal-bearing rocks from the Mississippian

up through the lower Permian is present. The number of coal seams gradually decreases northward and eastward as successively older strata outcrop at the surface, until in the northernmost and easternmost coal-producing counties only a few of the older seams remain. In general, the lower the stratigraphic position of a seam, the more widespread is its areal extent in western Pennsylvania.

[Continued on next page.]



Appendix: Note 50.

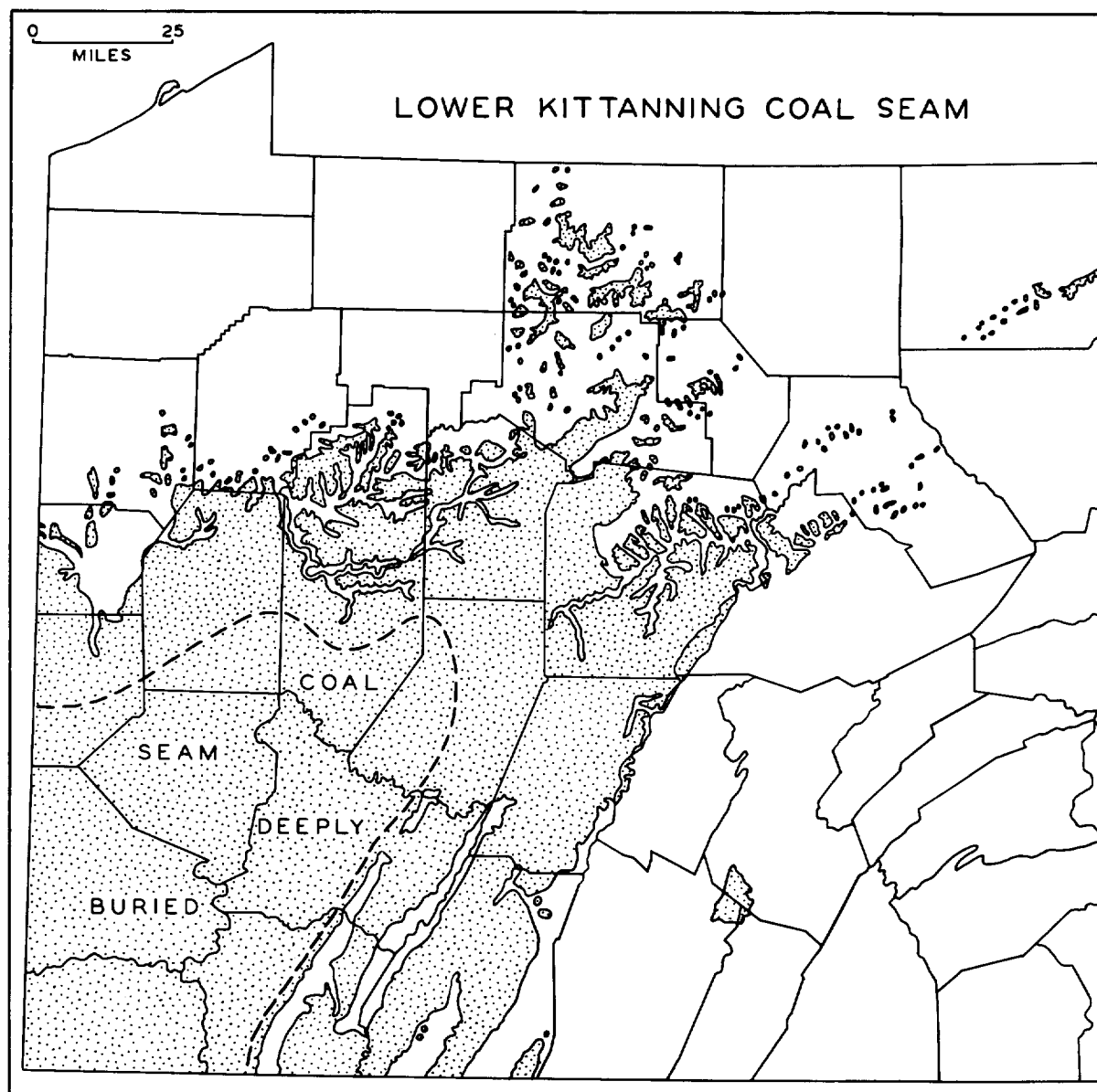
LOWER FREEPORT COAL SEAM

Only a few of the coal seams are currently being mined. The most important seams include the Upper and Lower Freeport, the Pittsburgh, the three Kittanning (Upper, Middle, and Lower), and the Clarion (Upper and Lower). Smaller amounts of coal are mined from the Tionesta or Brookville, Bakerstown, Brushcreek, Little Pittsburgh, Mahoning, Mercer, Pittsburgh Rider, Redstone, Sewickley, and Wellersburg seams.

The pre-mining areal extent of three important coal seams is indicated on the above set of maps. The Pittsburgh seam (page 7), situated high on the strati-

graphic scale of western Pennsylvania, is of relatively limited extent. It is confined to Washington and Greene counties, the southern half of Allegheny County, and the western parts of Fayette and Westmoreland counties. In addition, it occurs in small sections of Beaver, Armstrong, Indiana, and Somerset counties. The Pittsburgh seam lies near the surface, or outcrops at the surface, in its northern and eastern parts. It is buried many hundreds of feet below the surface in southern Washington and most of Greene counties.

[Continued on next page.]



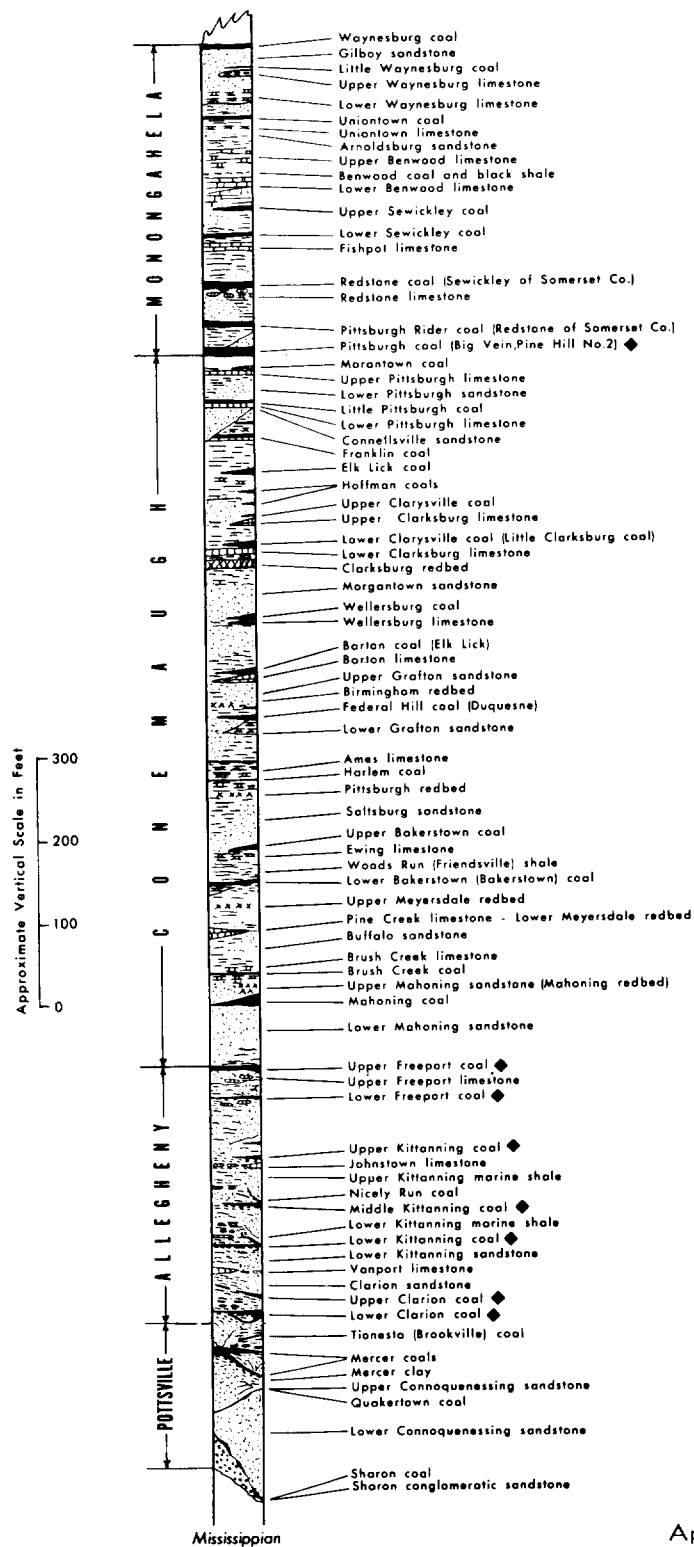
Appendix: Note 50.

LOWER KITTANNING COAL SEAM

The Lower Freeport (page 8) has considerably greater areal expanse than the Pittsburgh, due to its stratigraphically lower position in the coal measures. It extends as far north as southern Lawrence and Clarion counties, and northern Butler and Jefferson counties; and as far east as western Centre and Blair counties, and eastern Somerset County. Additionally, small outlying areas underlain by the Lower Freeport seam are located at the junction of Bedford, Huntingdon, and Fulton counties (the Broad Top Field), and in Tioga and Bradford counties. This coal seam is buried many hundreds of feet below the surface in Greene, Allegheny, Washington, and western Fayette and Westmoreland

counties. Elsewhere it lies near the surface or outcrops.

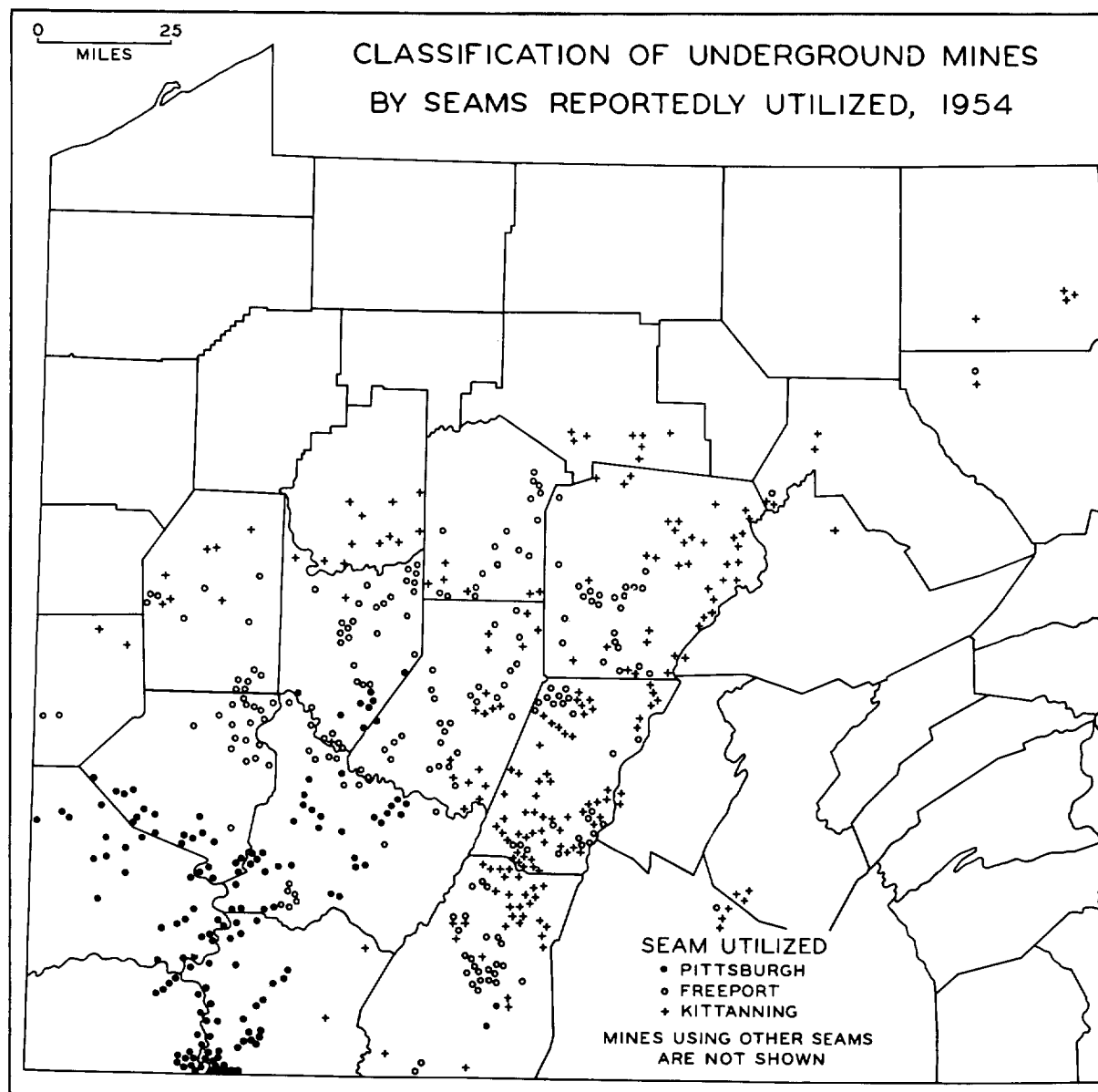
The Lower Kittanning seam (page 9), situated stratigraphically below the Lower Freeport seam, has the greatest areal extent of any of the three seams mapped. In fact it is exceeded in this respect, among the important seams of western Pennsylvania, only by the Clarion beds. It projects northward in McKean County to the New York state boundary, and eastward into the Broad Top Field and Bradford County. Its deeply buried portion underlies not only Greene, Washington, Allegheny, and western Fayette and Westmoreland counties, but also southern Beaver, Butler, and Armstrong counties, and western Indiana County.



Appendix: Note 55.

GENERALIZED COLUMNAR SECTION OF PENNSYLVANIAN AGE STRATA IN WESTERN PENNSYLVANIA

The more important producing coal seams are indicated by black symbols following their names.



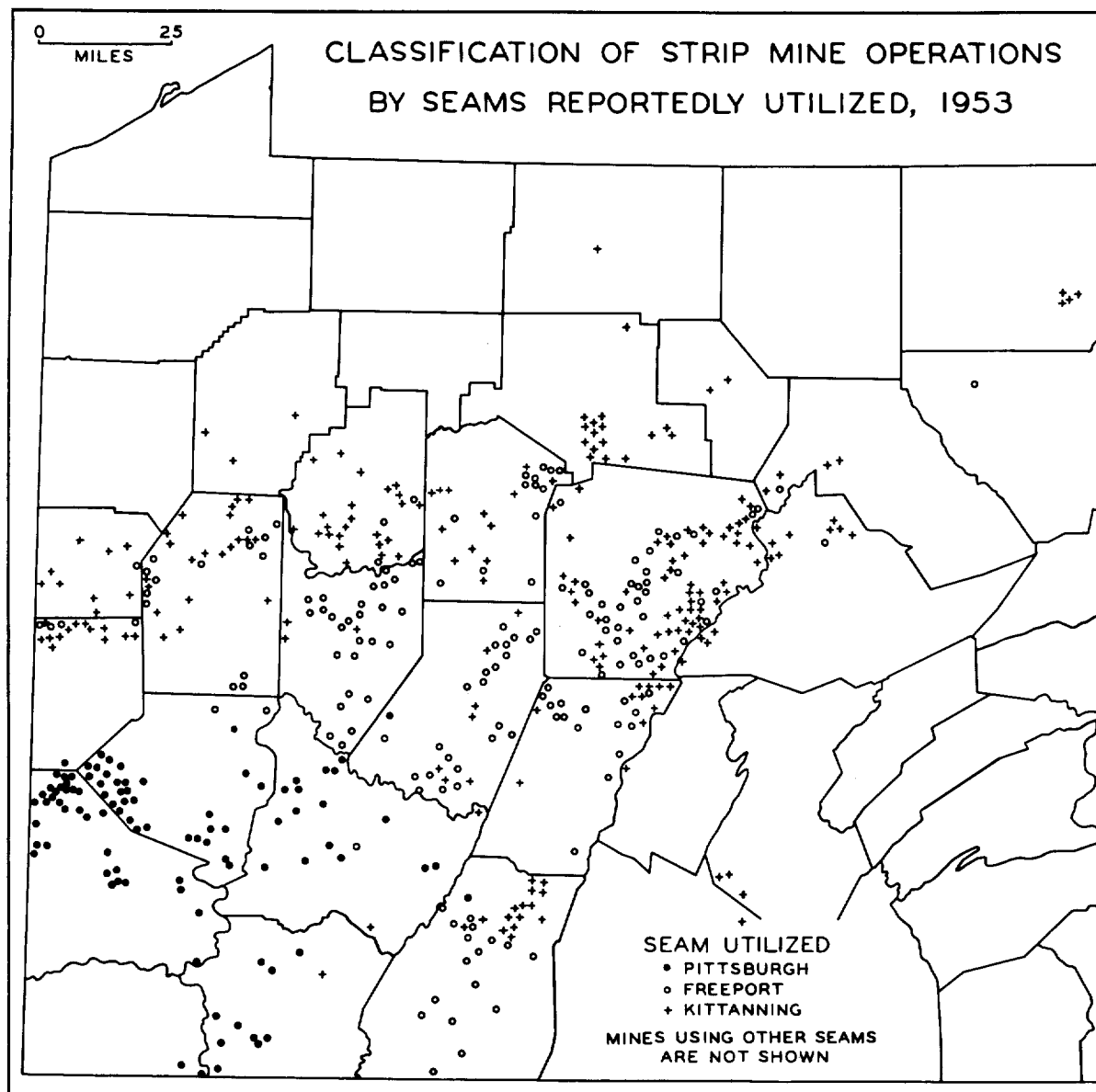
Appendix: Notes 22, 28, and 32.

SEAMS UTILIZED

Underground mines in western Pennsylvania primarily work six seams: the Pittsburgh, the two Freeport, and the three Kittanning seams. The 143 deep mines utilizing the Pittsburgh seam, stratigraphically highest of the six, are localized in a relatively restricted zone in the southwest, including Greene County (17 mines), Washington (24 mines), Allegheny (21 mines), Fayette (37 mines), Westmoreland (33 mines), Armstrong (8 mines), Indiana (1 mine), and Somerset (2 mines). There is a western, as well as a northern and an eastern,

border to the area in which the Pittsburgh seam is being mined, the western border coinciding essentially with the margin of the area in which the seam is deeply buried.

The 211 deep mines utilizing the stratigraphically lower Freeport seams are located in general to the north and east of mines utilizing the Pittsburgh seam; and the 203 deep mines tapping the even lower Kittanning seams are found primarily in a belt that lies still farther to the north and east.



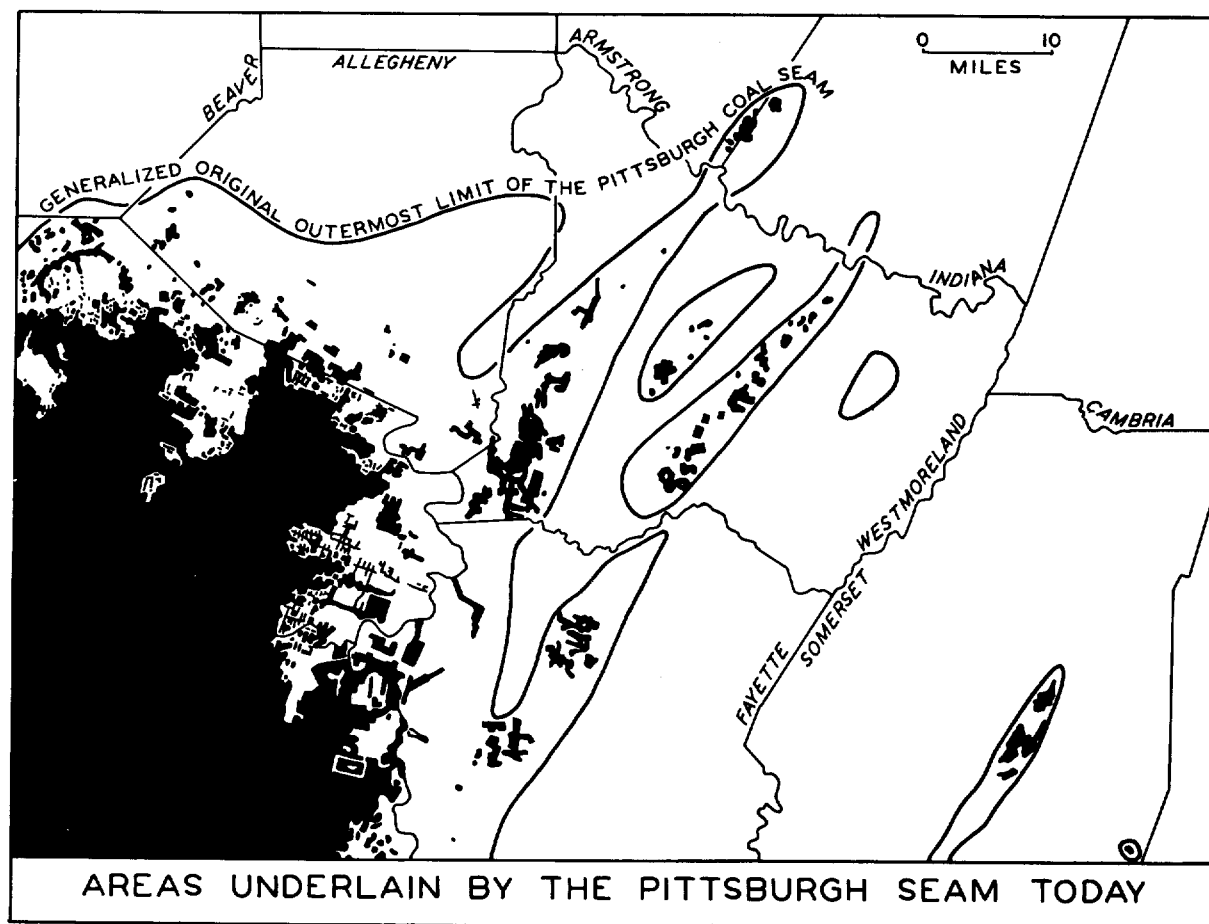
Appendix: Notes 28, 32, 42, and 43.

SEAMS UTILIZED

Strip mines, like underground mines, utilize a variety of seams in Pennsylvania's bituminous coal fields. Pits employing the Pittsburgh seam number 97, those using the two Freeport seams number 169, and those tapping the three Kittanning seams number 230. Several score additional pits utilize seams not plotted on the above map, including especially the Brookville and Clarion

in the north and the Redstone in the south.

The general geographical distribution of strip pits employing the various seams closely resembles the pattern of underground mines using the same seams. Stripping is employed to mine the outcrops, and deep mining is used to obtain the more deeply buried portions, of a seam in a given locality.



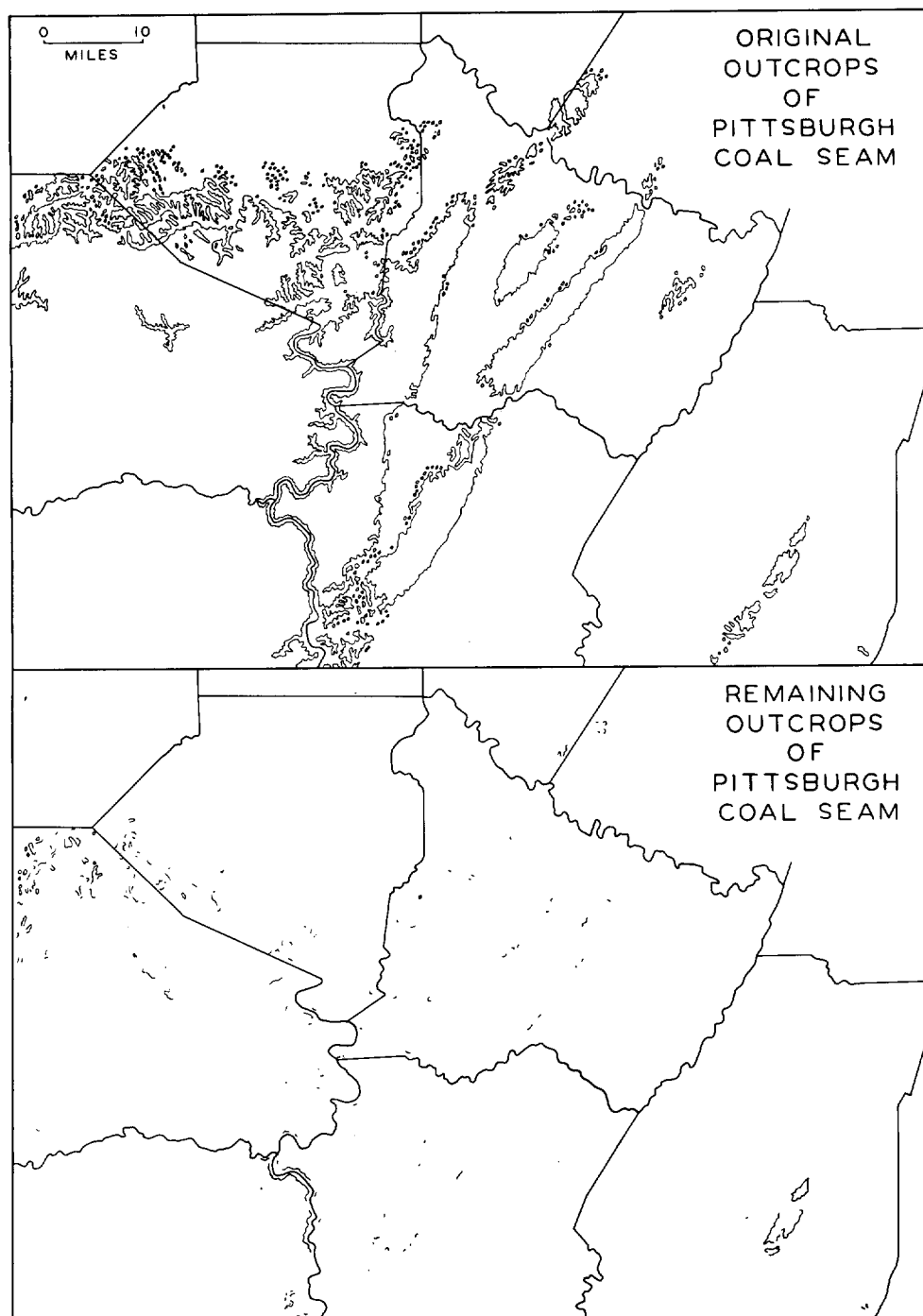
Appendix: Note 30.

THE PITTSBURGH SEAM

The bituminous coal mining industry of Pennsylvania has been dominated from its inception by the Pittsburgh seam, because of its thickness and quality and its early discovery and development in parallel with the growing steel industry. From 1759, the earliest known year in which coal was mined in the Commonwealth, until 1804, the total bituminous coal output was derived from this single seam; and until nearly the end of the 19th century it typically supplied some two-thirds or more of the output. Since 1940, however, less than one-half of Pennsylvania's bituminous coal has come from the Pittsburgh seam; and today it supplies only about 40 per cent of the annual State output. Almost all of the shallow, and hence readily accessible, portions of the

Pittsburgh seam have been mined out. Only scattered remnants now remain of the once extensive deposits in Allegheny, Fayette, and Westmoreland counties; and considerable tracts in northern and eastern Washington County, and in eastern Greene County, have been depleted. Mostly deeply buried portions of the seam remain, chiefly in Washington and Greene counties.

The map above represents, in black, those areas still possessing Pittsburgh coal. White areas, within the lines representing the original limits of the seam, have been mined out. The map is based on individual county surveys made by the U. S. Bureau of Mines between December 1950 and August 1955.



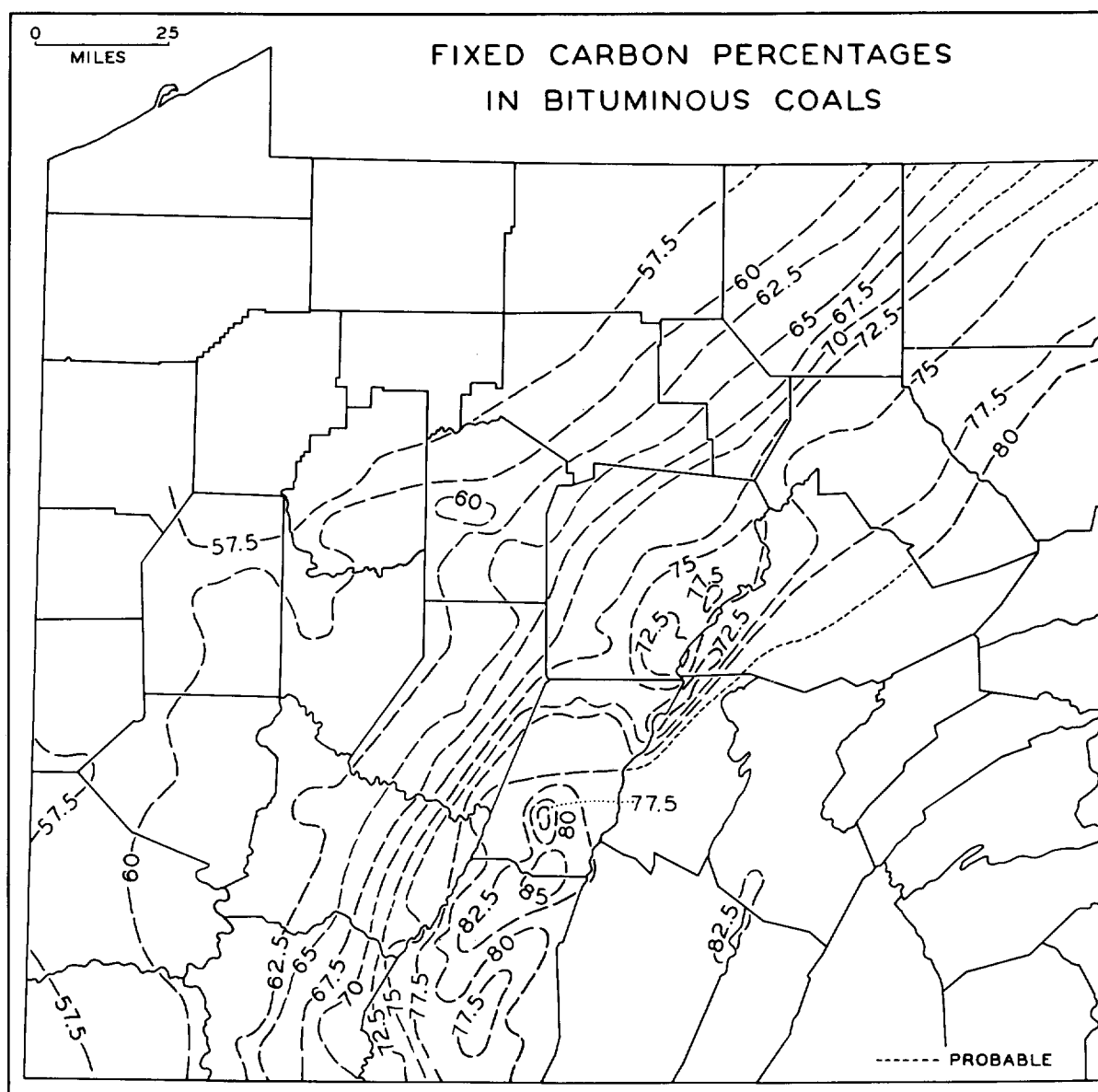
OUTCROPS OF THE PITTSBURGH SEAM

From the beginnings of significant bituminous coal stripping in Pennsylvania during the early 1930's until the late 1940's, the industry was largely concentrated in four southwestern counties: Allegheny, Fayette, Washington, and Westmoreland. Most stripped coal during that era came from extensive outcrops of the Pittsburgh seam, the one closest to the great industrial markets of Pittsburgh and its satellite towns. Today, most strippable Pittsburgh seam coal has been mined,

and significant remaining outcrops are limited to scattered tracts in southwestern Allegheny and northwestern Washington counties, to sections along the Monongahela River in Greene and Fayette counties, and to areas in central Somerset County.

The above maps are based on detailed individual county surveys made by the U. S. Bureau of Mines between December 1950 and August 1955.

Composition and Heat Value
of
Pennsylvania's
Bituminous Coal



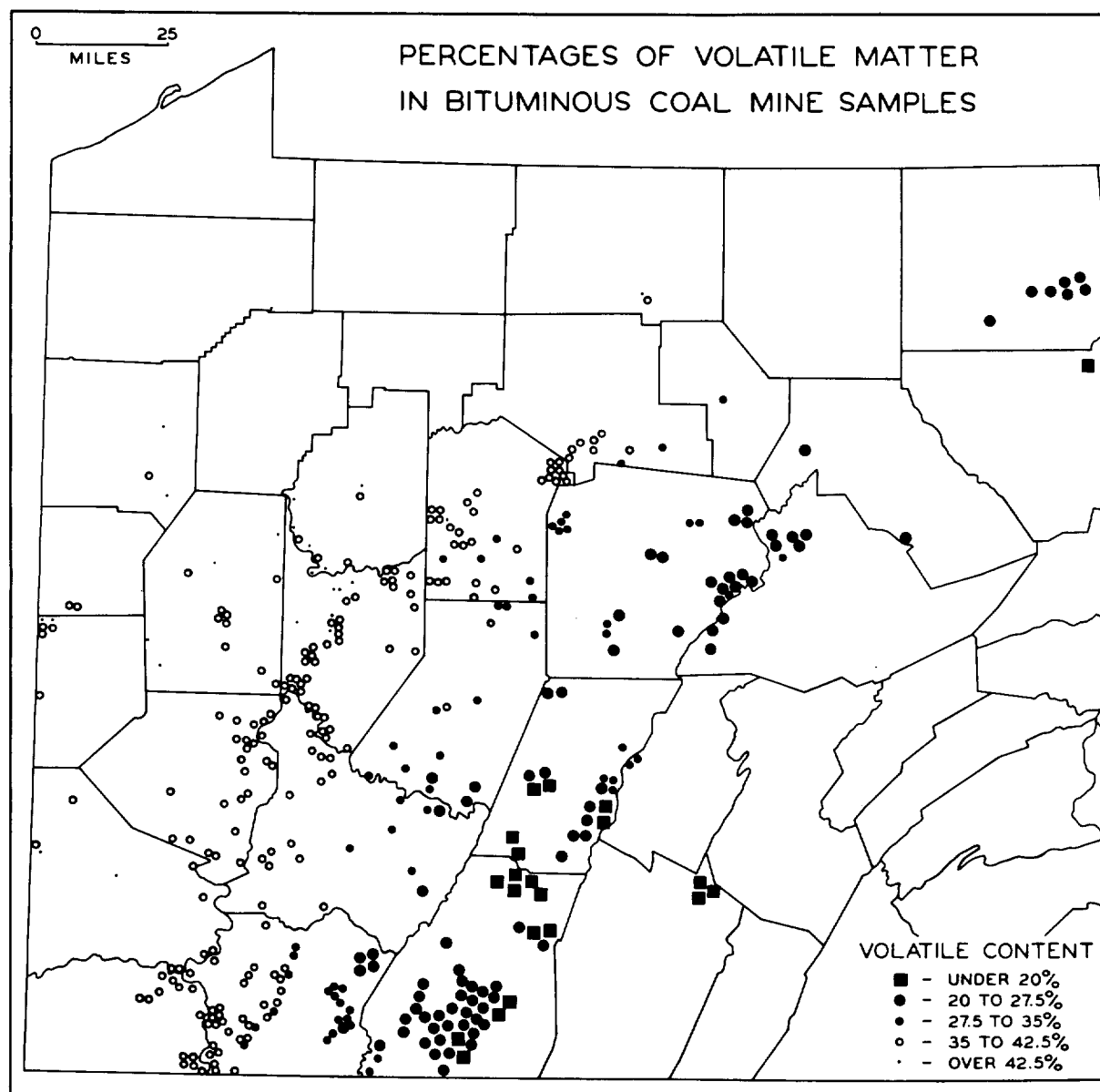
Appendix: Notes 14 and 49.

FIXED CARBON

Pennsylvania bituminous coal, like all bituminous coal, is of complex composition, consisting of fixed carbon, volatile matter, moisture, and ash. The relative percentages of these various constituents differ from place to place in western Pennsylvania. In general, the southeastern part of the coal fields is characterized by relatively high percentages of fixed carbon, and there is a progressive decrease toward the northwest. This

relationship holds true regardless of the individual coal seam considered, and appears to be related to regional differences in the intensity of heat and pressure to which the coal seams were subjected during earlier geologic time.

Local variations in the gradual transition from southeast to northwest are shown by the isocarbs on the map above.



Appendix: Notes 14, 51, and 52.

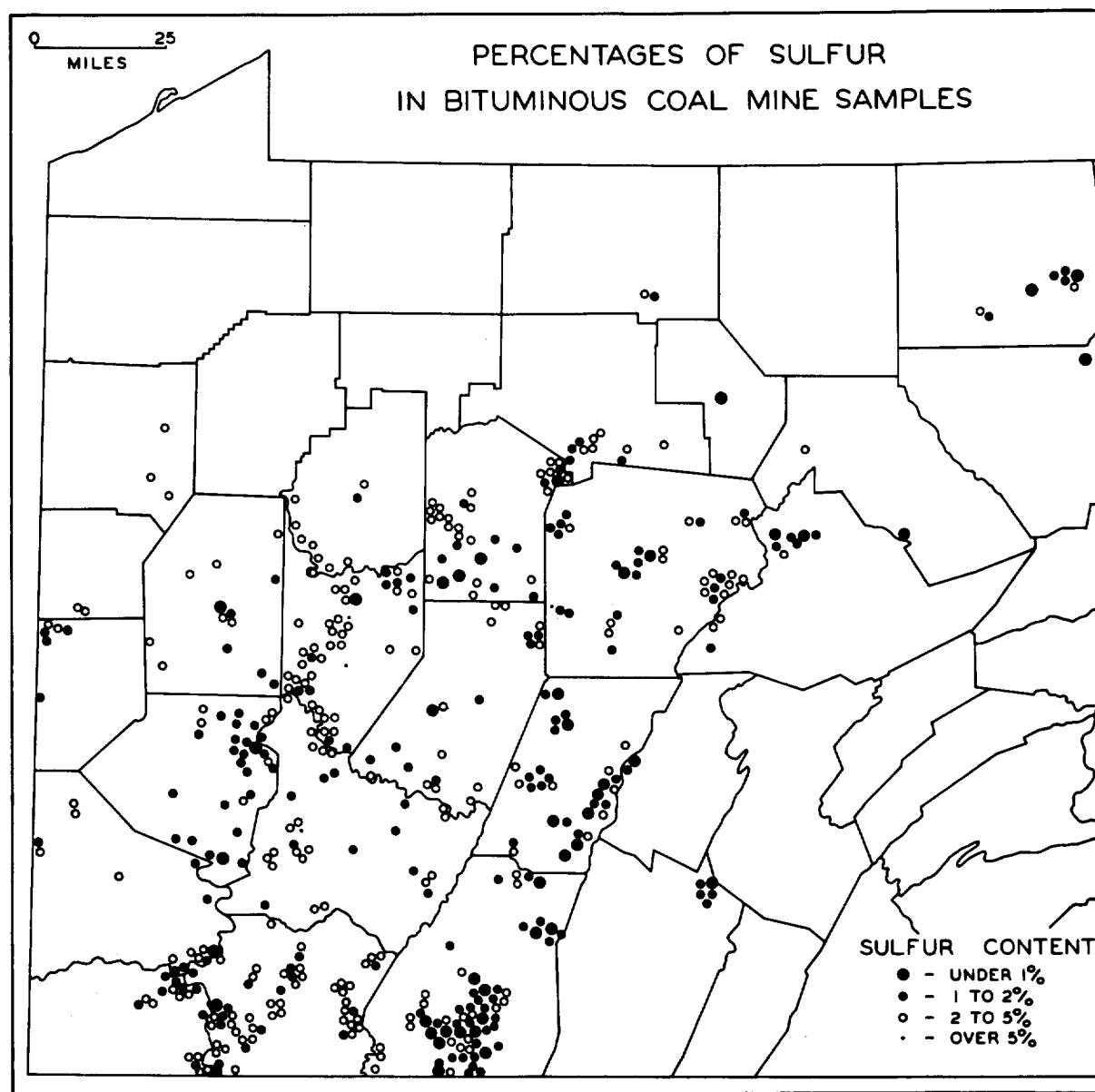
VOLATILE MATTER

Volatile matter in bituminous coal consists mainly of carbon, hydrogen, and oxygen compounds that will burn if ignited. It also includes some non-combustible matter, for example, small amounts of ammonia.

The heat value of bituminous coal, when burned, depends in large measure upon the relative percentages of fixed carbon and volatile matter it contains (the fuel ratio, i.e., fixed carbon divided by volatile matter). Very low (under 20 per cent) and low (20 to 27.5 per cent) volatile coals yield more B.T.U.s per pound than do medium (27.5 to 35 per cent) and high (35 to 42.5 per cent) or very high (over 42.5 per cent) volatile coals. Hence, market prices commonly are quoted in

terms of volatile content in addition to sizes and grades of coal.

As in the case of fixed carbon percentages, volatile matter percentages tend to change progressively from the southeastern to the northwestern portions of Pennsylvania's bituminous coal fields, and this progression is characteristic of all coal seams. In the case of volatile matter, however, percentages *increase* north-westward. Thus, as the above map illustrates, lowest percentages are found in the Broad Top Field and in eastern Somerset and southern Cambria counties; whereas highest percentages characterize Clarion, Butler, Mercer, and associated counties.



Appendix: Notes 51, 52, and 53.

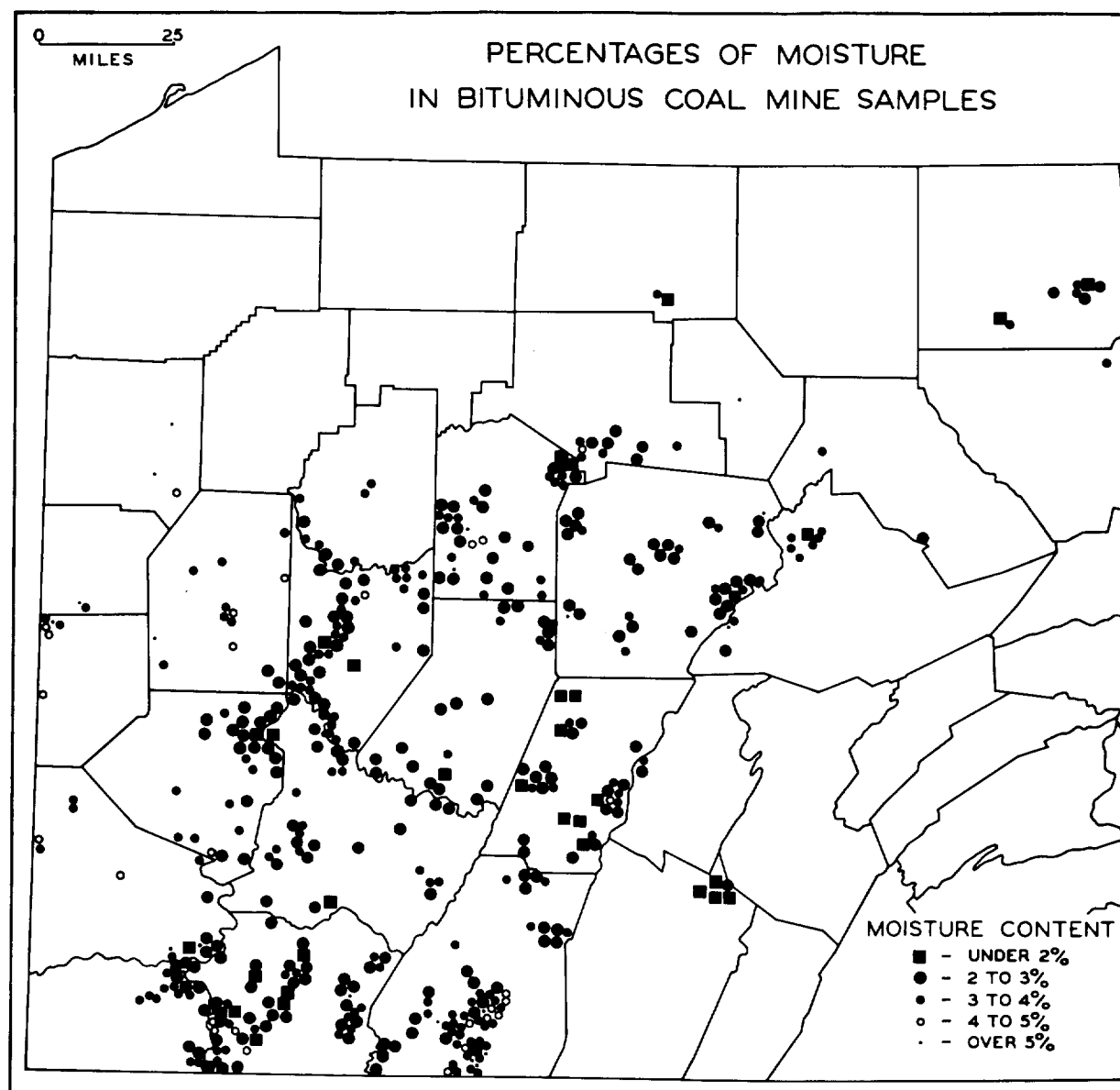
SULFUR

Most of the sulfur in coal is inorganic in origin and exists in the form of sulfides, sulfates, and free sulfur. Particularly common are two sulfides, pyrite (FeS_2 , isometric) and marcasite (FeS_2 , orthorhombic), which produce the familiar "brasses" of the coal mines. These occur either in the coal bed or in the roof rock, as solid partings, irregular crevice fillings, balls, crystals, nodules of various shapes and sizes, or occasionally as microscopic particles dispersed throughout the coal. Other sulfur compounds associated with coal are calcium sulfate, and sulfates of iron, copper, and manganese.

Sulfur is a detrimental constituent of coal. Excessive

amounts in metallurgical coke adversely affect the quality of iron. In steam coals, sulfur corrodes boilers and increases clinkering. Under some conditions, sulfur may produce spontaneous combustion of stored coal.

The sulfur content of Pennsylvania bituminous coals ranges from less than 1 per cent to more than 7 per cent. As the above map illustrates, there is a lack of progressive change in the sulfur content of western Pennsylvania coals. Certain areas on the map, however, stand out as regions of relatively low-sulfur coals (2 per cent or under), including most of Allegheny, much of Cambria, and parts of Somerset counties, as well as the Broad Top Field in Bedford County.



Appendix: Notes 51, 52, and 53.

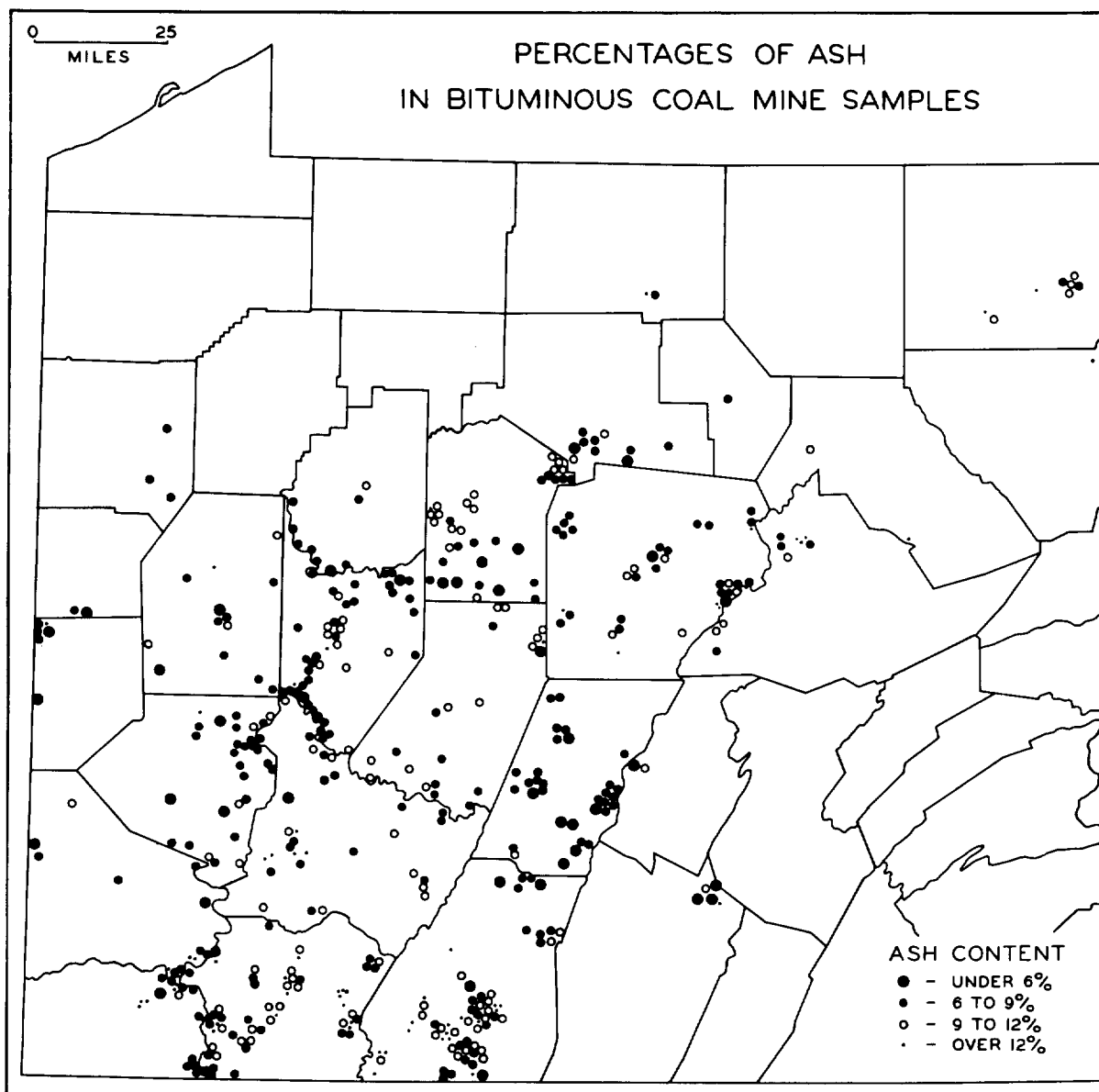
PERCENTAGES OF MOISTURE

Pennsylvania bituminous coal averages about 3 per cent moisture, except cannel coal which may have less than 1 per cent. Most of the samples represented on the above map have between 2 and 4 per cent moisture. At a few sample sites the moisture content is from 4 to 7 per cent, due in part at least to infiltration of ground water into seams under shallow cover or to partial weathering of the coal.

There is little pattern to the distribution of coal moisture in the producing area of the Commonwealth

other than a tendency toward high moisture content in coal from the western counties, particularly Beaver, Butler, Lawrence, and Mercer. South central Somerset County likewise has considerable coal of high moisture content. Coal from the Broad Top Field in Bedford County is notably low in moisture.

Moisture is an undesirable constituent of coal. It does not contribute to the production of heat, and its transportation and storage entail expense.



Appendix: Notes 51, 52, and 53.

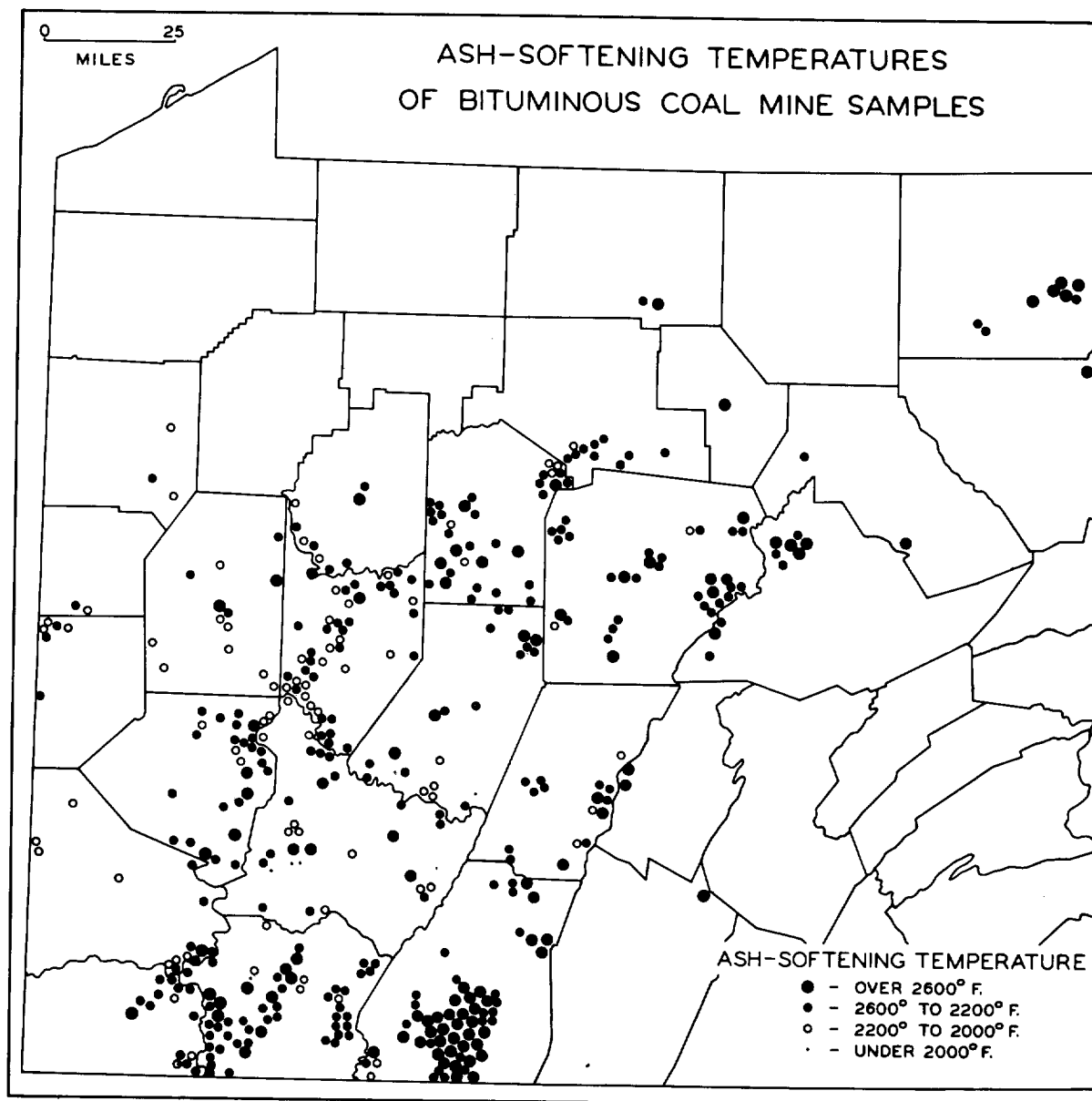
ASH CONTENT

Ash is the unconsumed residue remaining after the combustion of coal, a residue which is derived from inorganic constituents of the original coal swamp vegetation plus interlayered shale and intermixed sand, clay, carbonates, sulfates and sulfides.

Ash is an economically undesirable constituent of coal since it lowers the percentage of combustible matter, and its transportation, storage, and disposal involve financial costs.

As the map above indicates, there is no progressive change in the ash content of Pennsylvania bituminous

coals from southeast to northwest. Percentages differ locally depending upon specific sedimentation conditions at individual sample sites during the time of deposition of coal-forming vegetation. In addition, the various vegetation types themselves undoubtedly differed in percentage of ash content. There is apparent on the map, however, a concentration of high ash content coal samples (over 12 per cent ash) in the southern producing counties; and a majority of the very low ash content coal samples (under 6 per cent ash) are found in the eastern, northern, and western producing counties.



Appendix: Notes 51, 53, and 54.

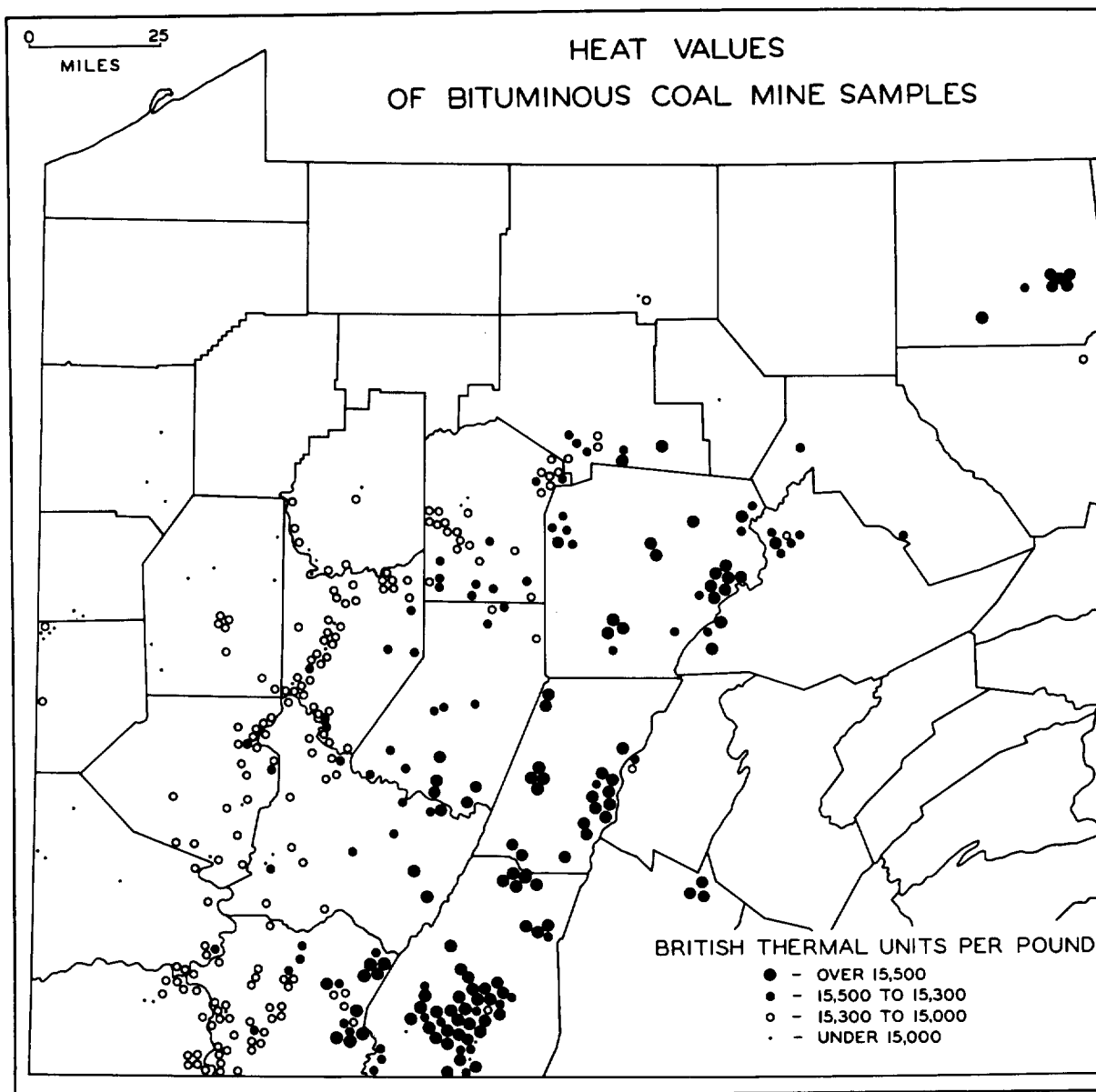
ASH-SOFTENING TEMPERATURES

The temperature of softening by partial fusion of coal ash is an important factor in determining the clinkering properties of coal and therefore is of interest to coal users. Other factors are the temperature of initial deformation, the fluid temperature and the viscosity of the resultant fluids. In some types of firing equipment the ash is fused and tapped off as a liquid; in more common types of equipment, a refractory ash is desired.

The softening temperature of coal ash is that temperature at which a cone of ash, when heated in a test furnace under prescribed conditions, fuses down to a spherical lump.

The ash in Pennsylvania bituminous coals has a wide

range of fusibility, from highly fusible to very refractory. As the above map indicates, there is a general tendency for coal ash to become progressively more fusible from the southeastern to the northwestern borders of the Commonwealth's producing region. Thus, refractory ash characterizes many of the coal mine samples in Somerset, eastern Cambria, Blair, Clearfield, Centre, and Tioga counties; whereas ash of medium or easy fusibility is more typical of Washington, Allegheny, Butler, Armstrong, and Clarion counties as well as areas farther to the northwest. The intermixture of fusibility ranks among coal samples within a given county is in part due to marked variations in the fusibility of ash from various coal seams.



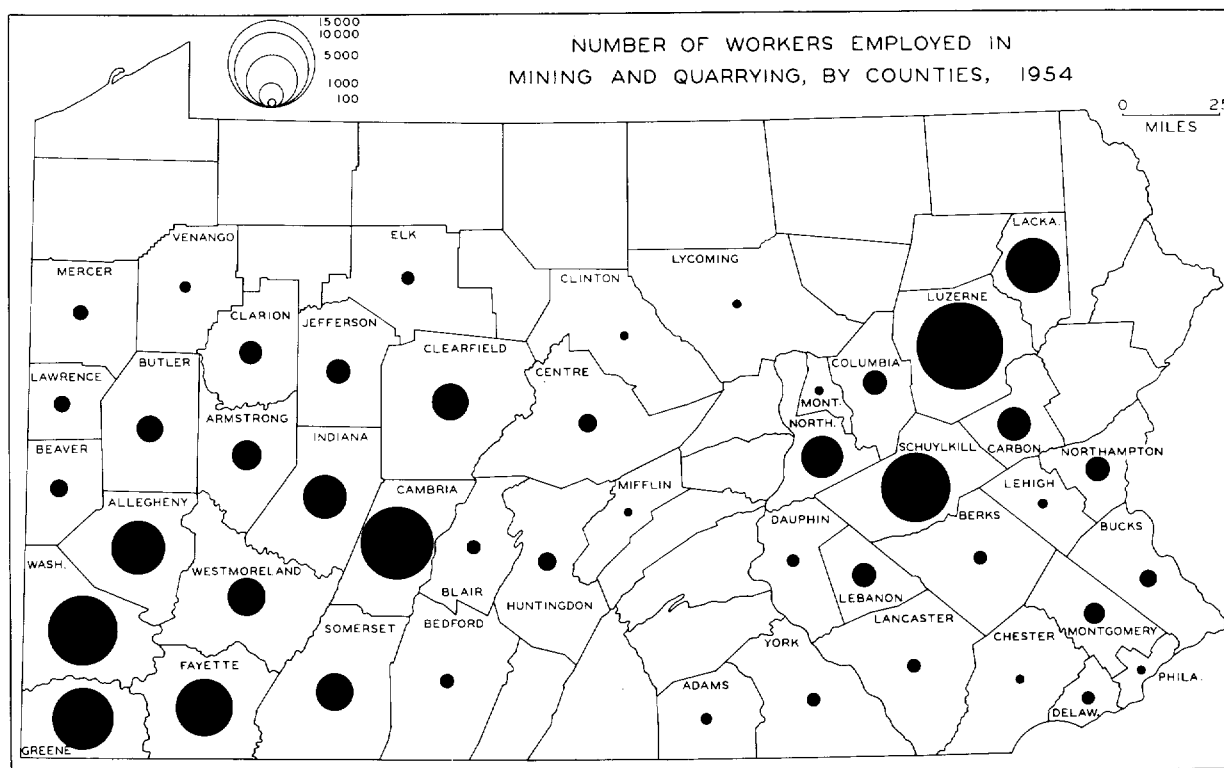
Appendix: Notes 14, 51, and 52.

HEAT VALUES

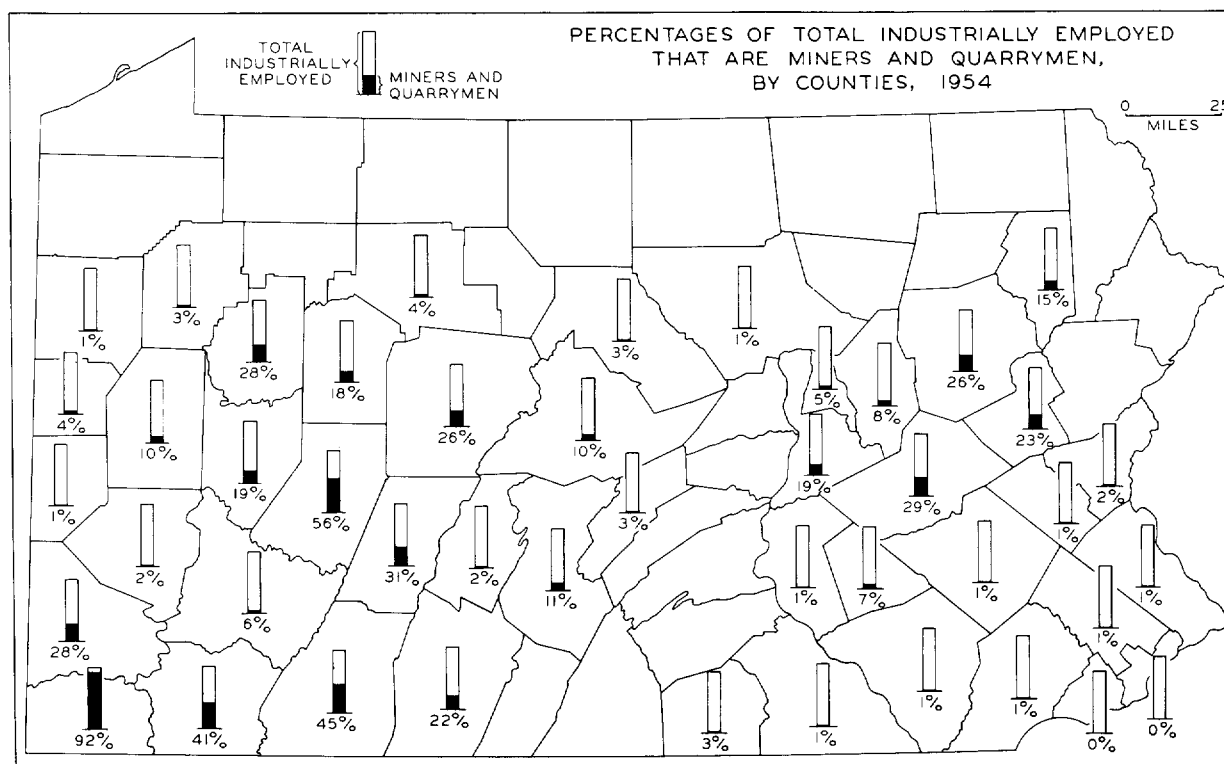
There is a close relation between the percentage of fixed carbon (see map on page 16) and the heat value of Pennsylvania coals. In general, the higher the fixed carbon the higher the B.T.U. content. There is a difference of 1,500 B.T.U.s per pound between Commonwealth bituminous coals of lowest and highest rank, with values ranging from extremes of approximately 14,300 to 15,800 on a dry ash-free basis.

The map above indicates a generally progressive decrease in heat values from the southeastern to the northwestern borders of the Commonwealth's producing area. Coals with a high heat value characterize Bedford, Somerset, Cambria, Clearfield, Centre, Clinton, Tioga, eastern Fayette, eastern Westmoreland, Indiana, southern Jefferson, and southern Elk counties. Farther northwest, most coals have a lower heat value.

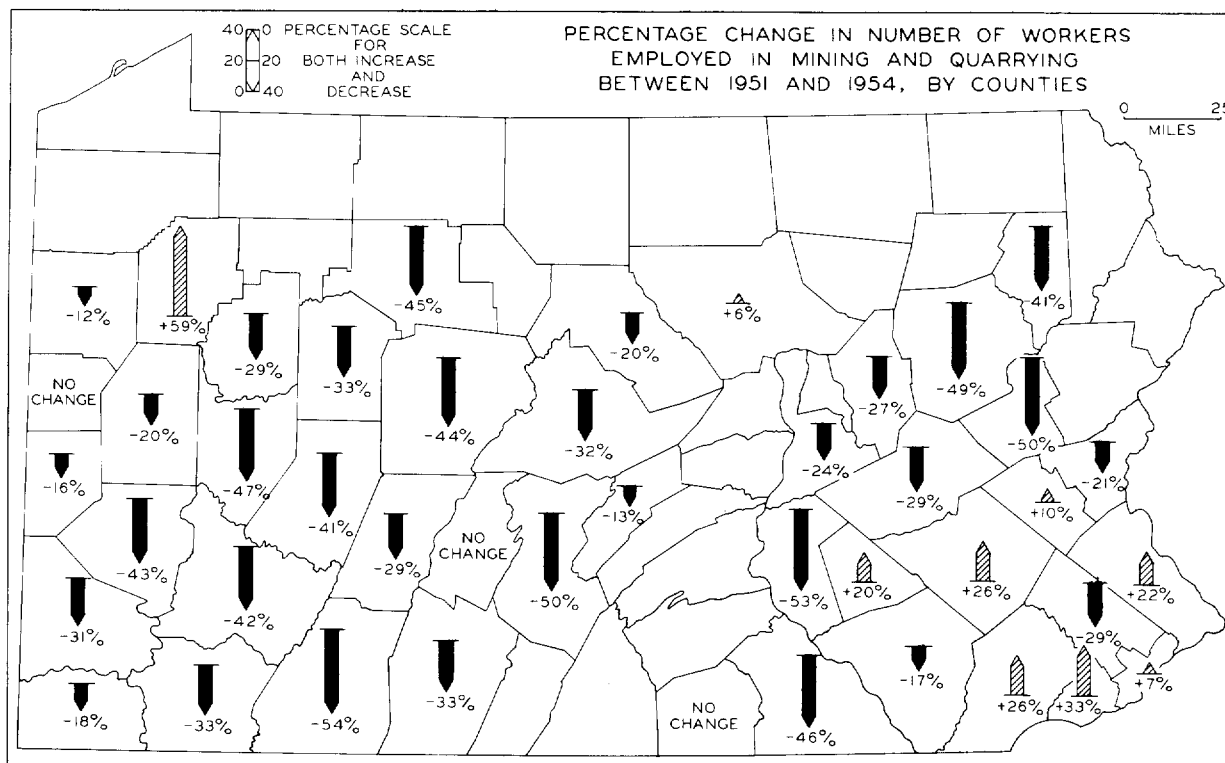
Employment and Labor
in Pennsylvania's
Bituminous Coal Mining Industry



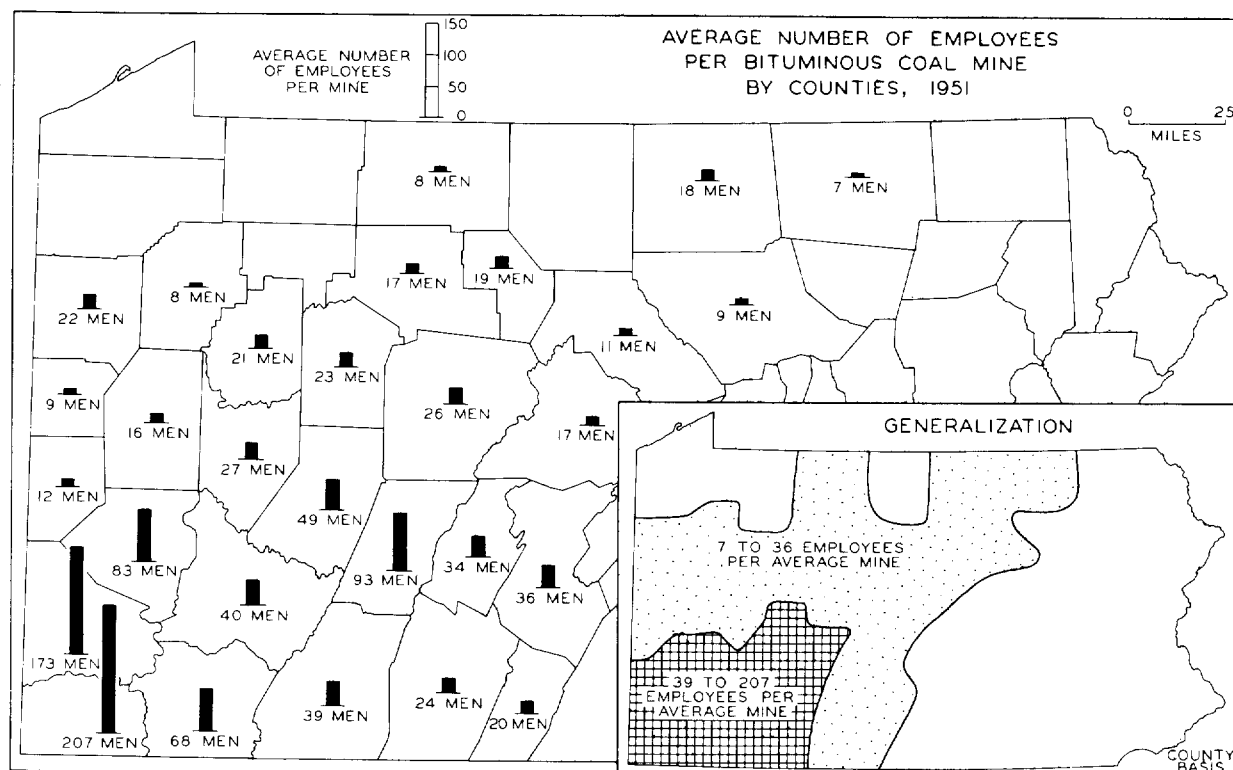
Appendix: Notes 10 and 12.



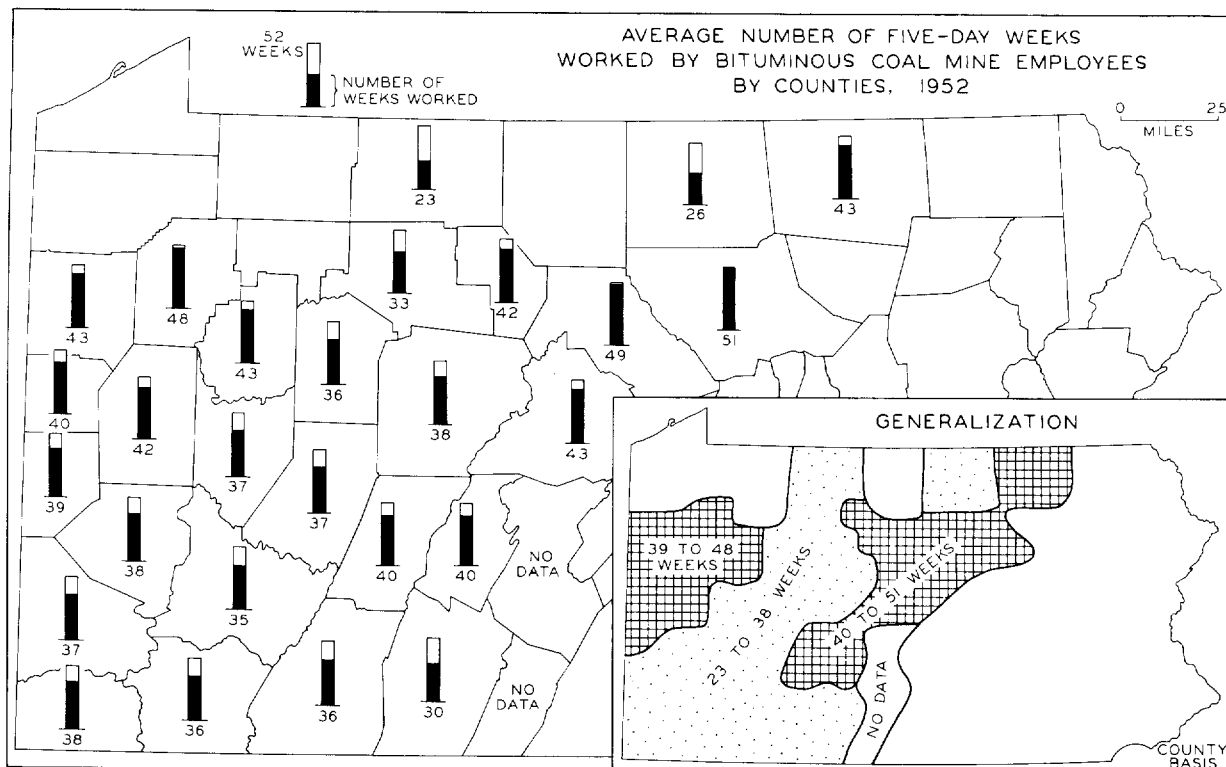
Appendix: Notes 10, 12, and 13.



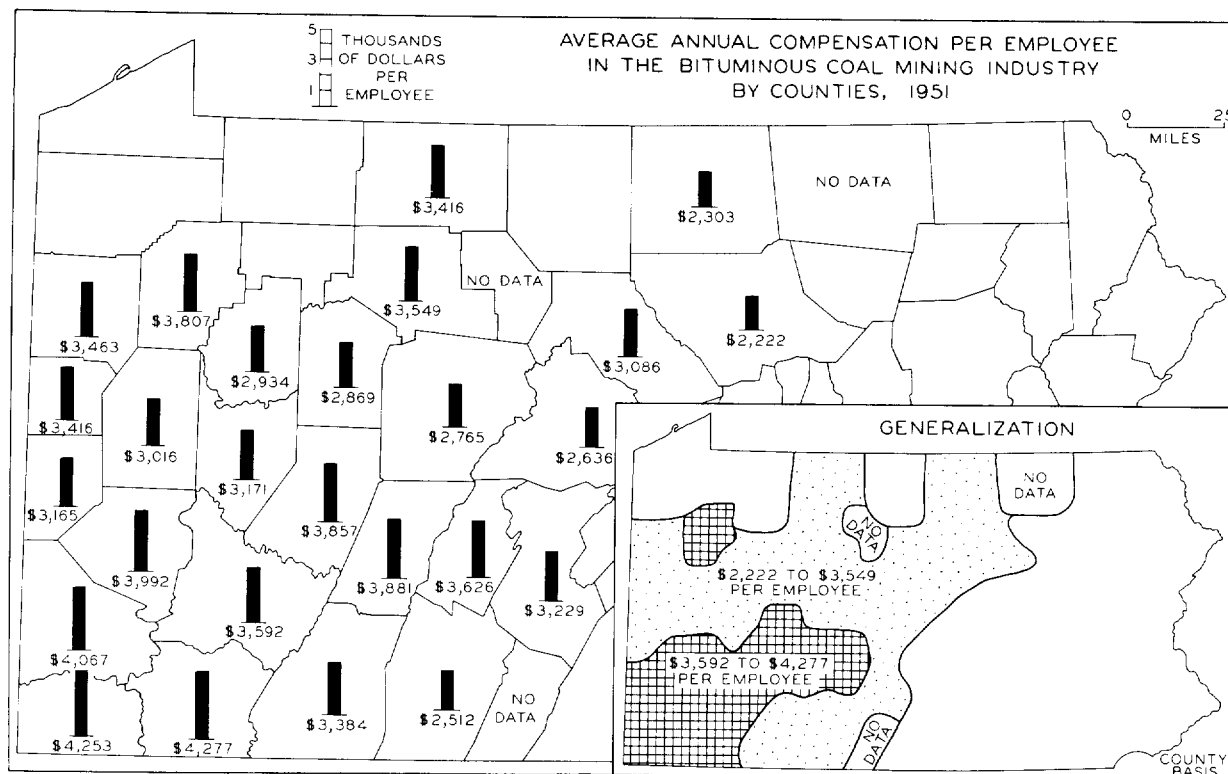
Appendix: Notes 10, 12, and 13.



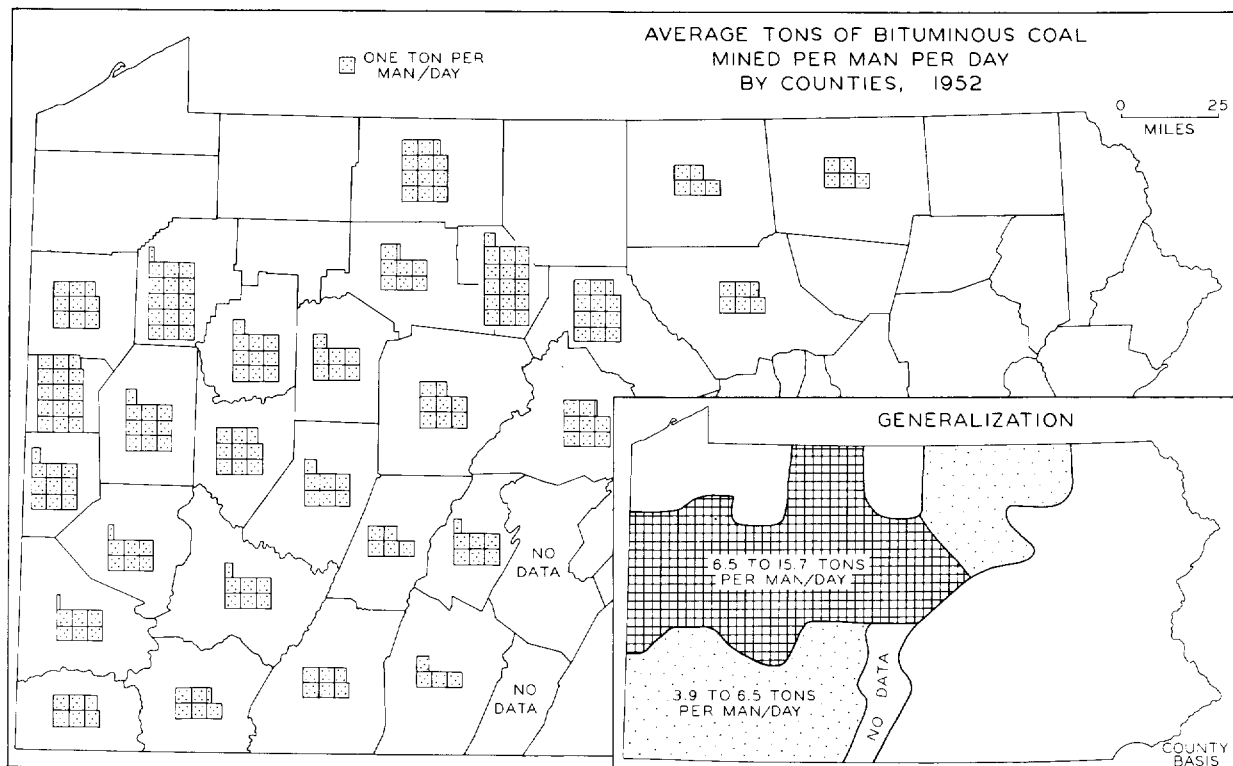
Appendix: Notes 17 and 22.



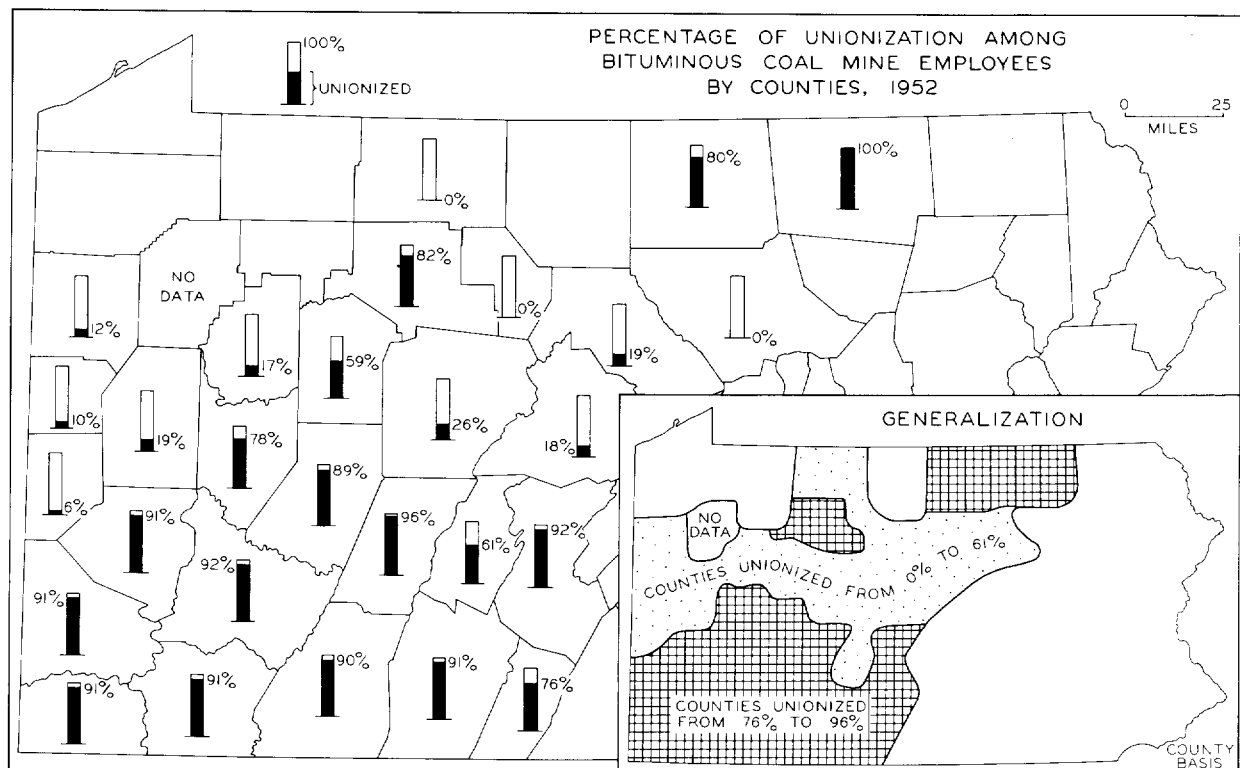
Appendix: Notes 5, 17, and 23.



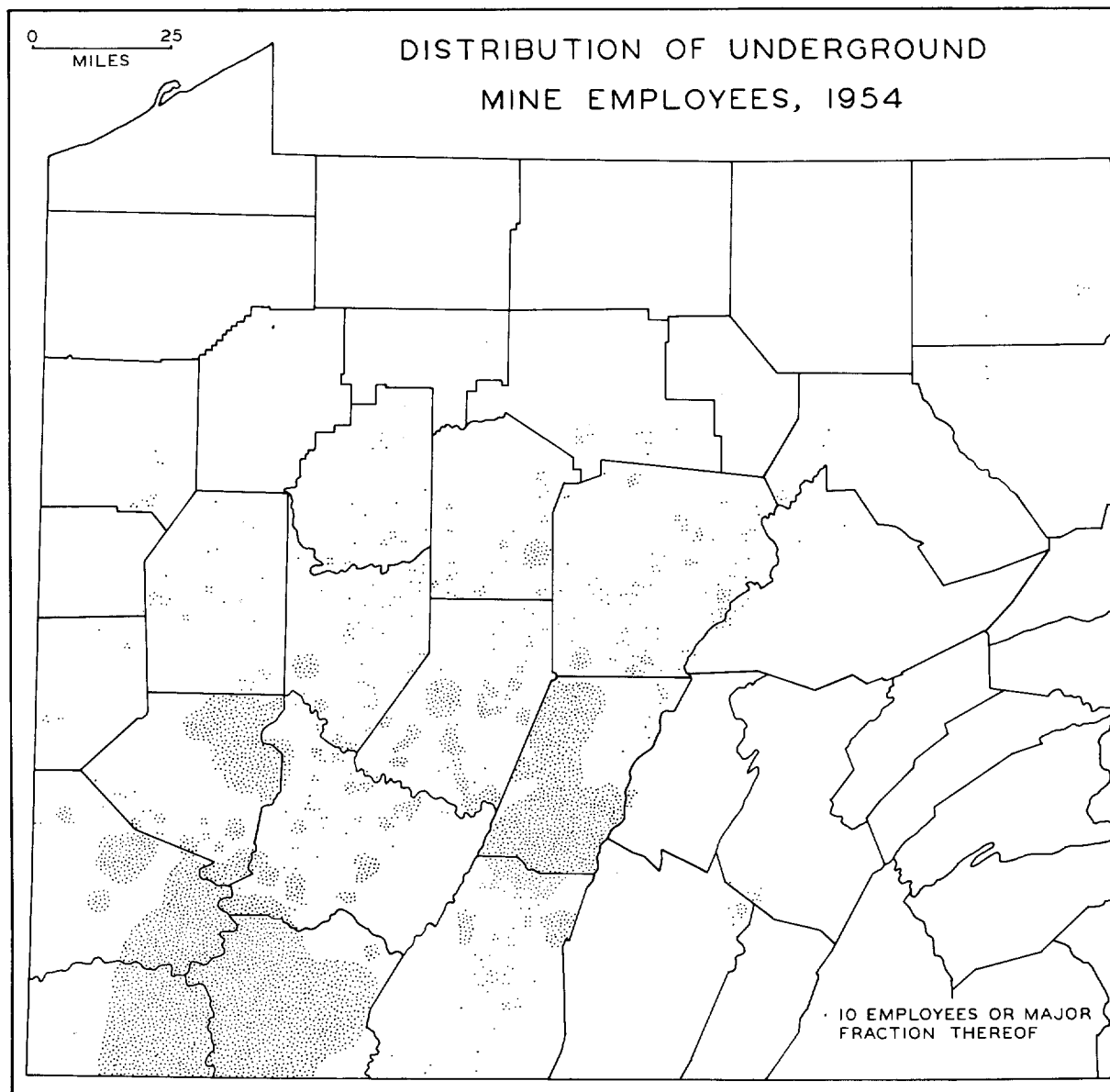
Appendix: Note 17.



Appendix: Notes 5 and 17.



Appendix: Notes 13 and 17.



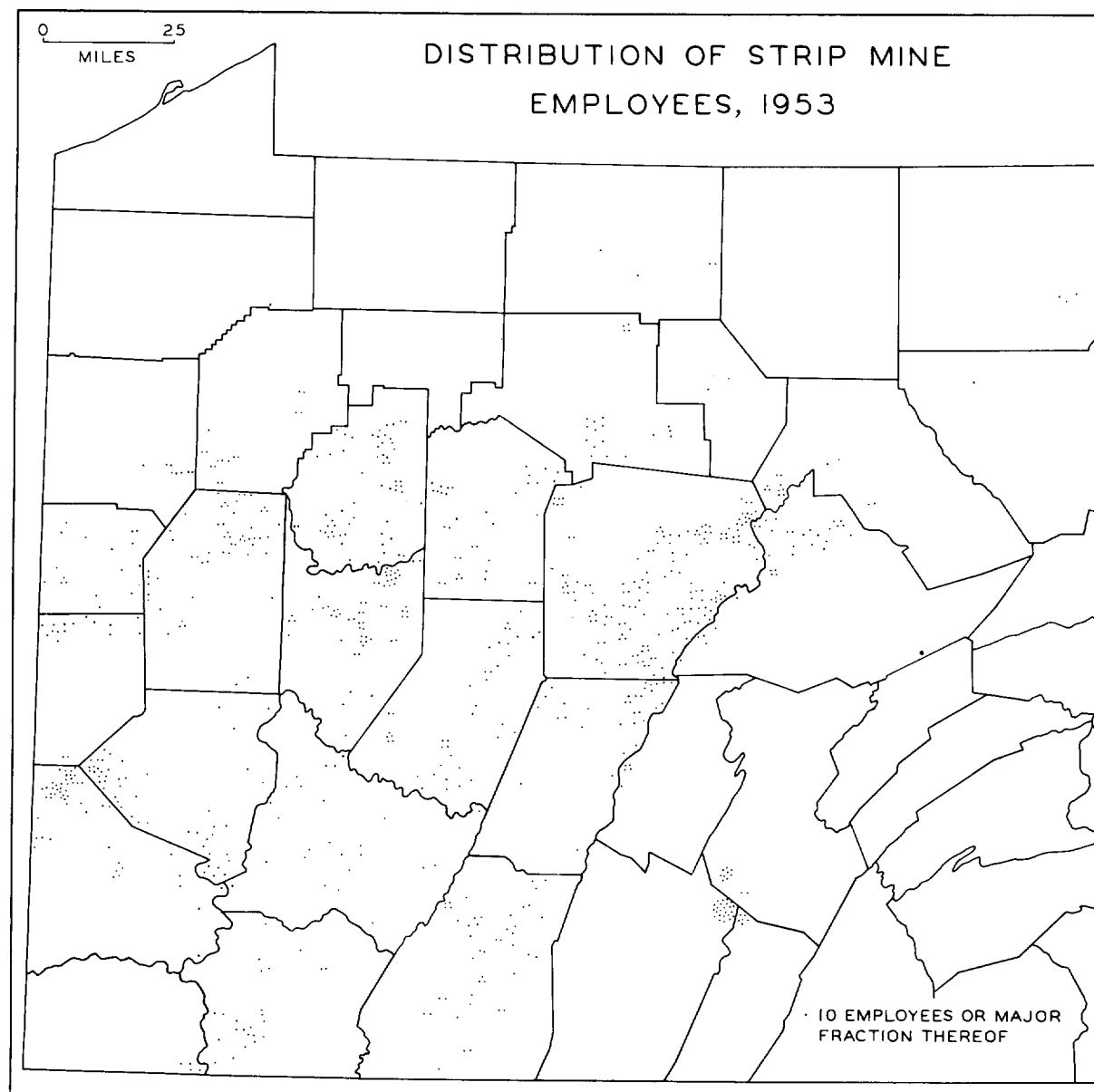
Appendix: Notes 22, 28, 32, 33, and 38.

UNDERGROUND MINE EMPLOYEES

Although the number of underground mine employees in the bituminous coal fields of Pennsylvania has declined to less than one-half that of a decade ago, there are nevertheless tens of thousands of people presently engaged in the underground mining industry. Their occupations range from shot firers, cutting machine runners, and fire bosses, to clerks, mine foremen, and superintendents.

The map above represents the distribution of all

such employees. Greatest concentrations are found in eastern Greene and Washington, western and central Fayette, northeastern Allegheny, and western and southern Cambria counties. Underground mining employment is a major factor in the economy of such regions. Elsewhere in the producing territory there are only scattered clusters of underground mine employees, and the importance of such employment in the economy of these areas generally is limited.



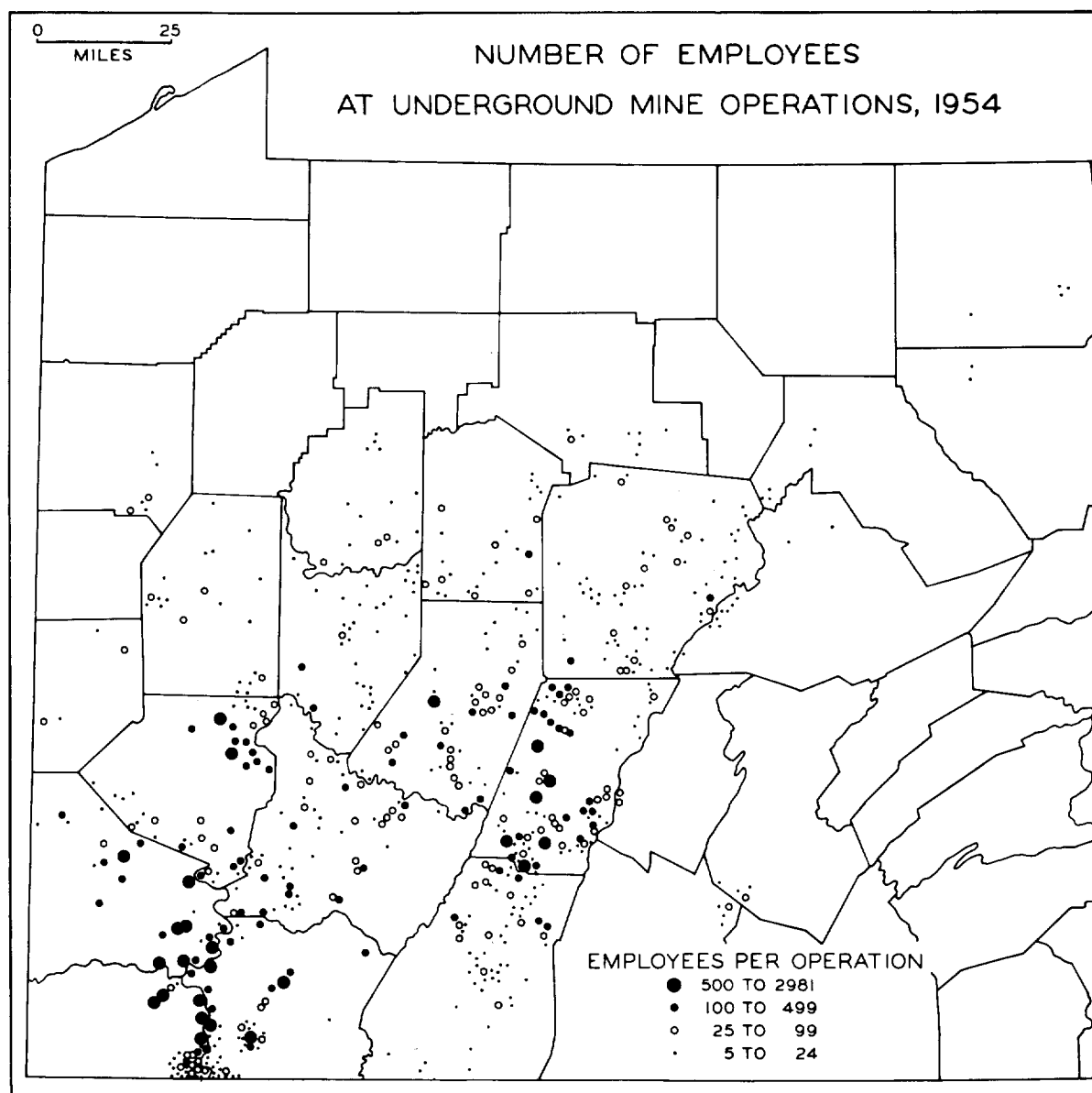
Appendix: Notes 28, 32, 33, 38, and 45.

STRIP MINE EMPLOYEES

Strip mine employees constitute only a minor percentage of total bituminous coal mine employees in Pennsylvania, averaging approximately one-sixth to one-eighth of those in the underground industry during recent years. But strip mine employees have decreased less drastically in numbers during the past decade than their counterparts in deep mine operations. Today, more than 7,000 persons are engaged in stripping.

The map above represents the distribution of bituminous coal strip mine employees in Pennsylvania.

Greatest concentrations occur in eastern Clearfield County, in Armstrong, Butler, and Clarion counties, and in southwestern Allegheny and northwestern Washington counties. Small numbers of workers also are scattered almost everywhere throughout the bituminous coal fields of the State. Because of their limited numbers and widespread distribution, bituminous coal strip mine employees play only a minor role in the employment situation in any part of western Pennsylvania.



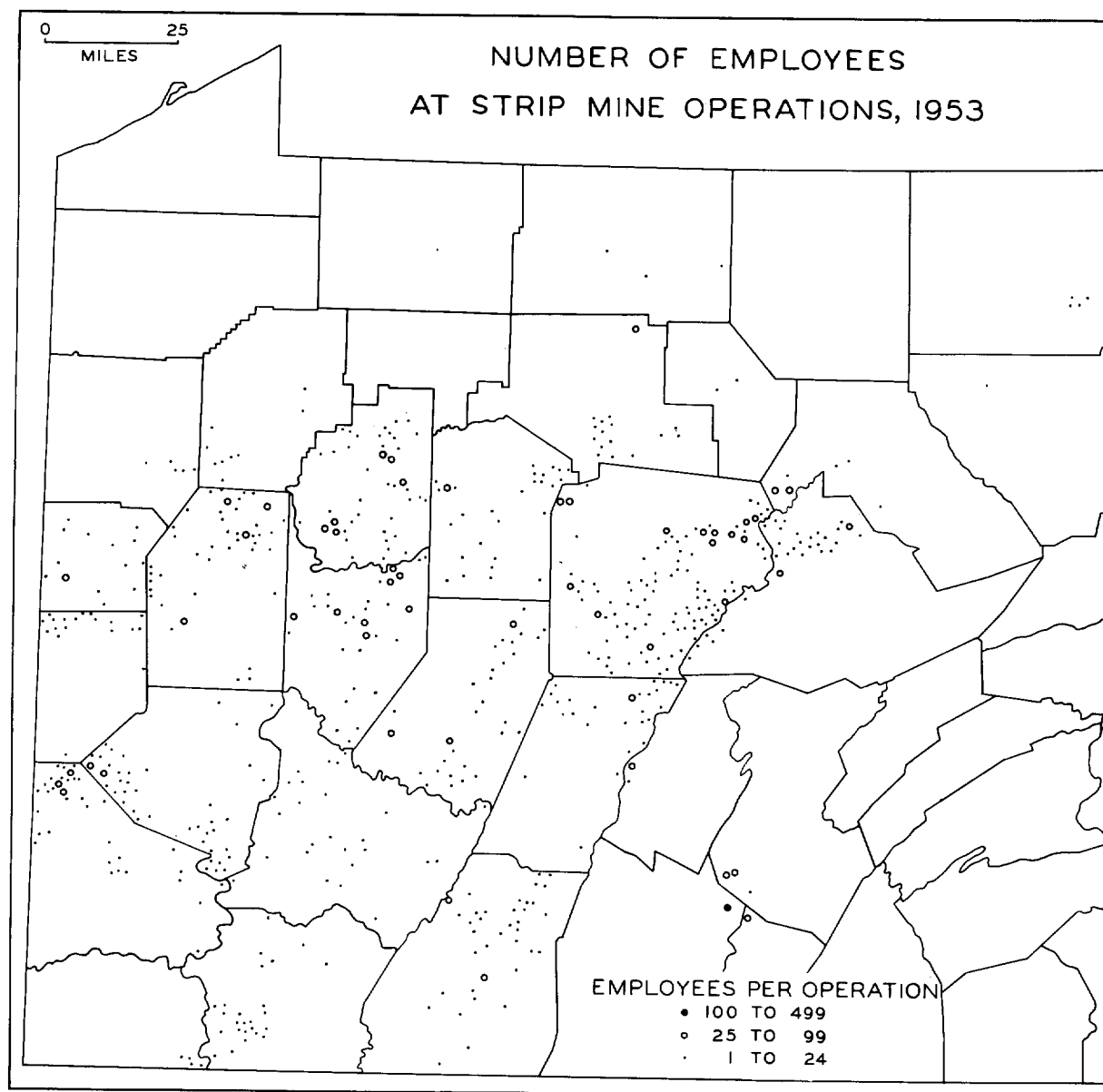
Appendix: Notes 22, 28, 32, and 33.

NUMBER OF EMPLOYEES PER UNDERGROUND MINE

Most underground mining operations in the bituminous coal fields of Pennsylvania are conducted on a small scale. A majority of the mines employ fewer than 25 people, and many have only a half-dozen or so employees. Only 105 of the 607 mines employ 100 or more, only 25 of these employ 500 or more, only 2 employ 1,000 or more, and the largest operation employs 2,981.

All but a few of the large-scale operations (500 or more employees) are concentrated in four southern counties—Cambria (6 such mines), Fayette (4 such

mines), Greene (5 such mines), and Washington (7 such mines). There is a somewhat similar concentration of medium-scale operations (100 to 499 employees) in the southern half of the producing area. Almost without exception, underground mines in the northern half are of limited size. Concentration of the larger mines in the south is largely a result of the demand for great quantities of uniform quality coal by the industrial complexes of the Pittsburgh and associated districts of southwestern Pennsylvania, a demand that can be met on a reliable basis only by large-scale producers.



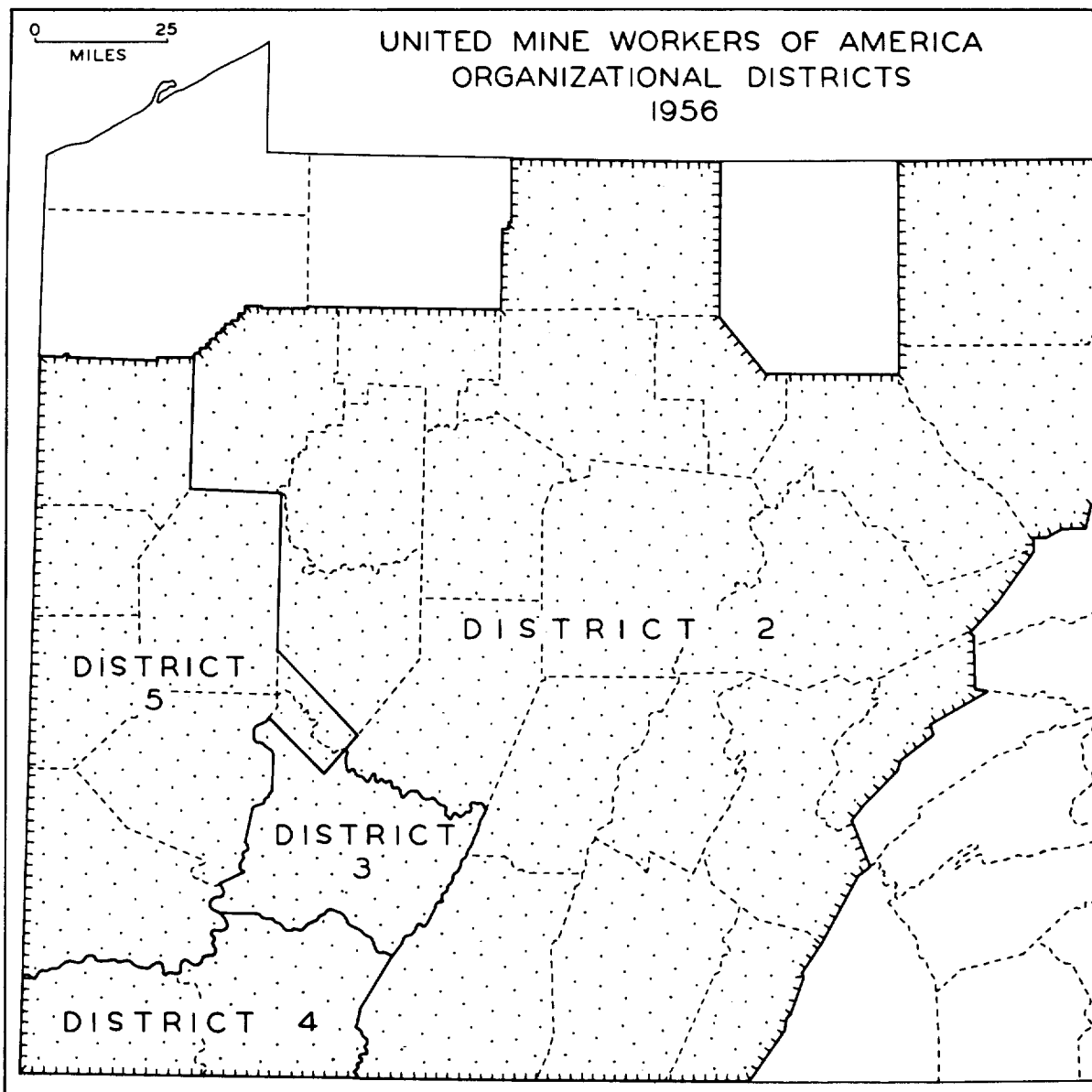
Appendix: Notes 28, 32, 33, and 42.

NUMBER OF EMPLOYEES PER STRIP MINE

Bituminous coal strip mining operations in Pennsylvania are invariably conducted on a small scale in terms of employment. Only one of the approximately 500 pits employs more than 100 workers, and only 55 pits employ between 25 and 99 workers. The remaining approximately ninety percent of the pits have fewer than 25 employees each, and many use only two or three people.

As the map above indicates, almost all stripping

operations employing 25 or more workers are located in the northern half of the producing area, where large reserves of strippable coal foster relatively sizeable operations. Strip pits in the southern half, other than in the southwestern Allegheny—northwestern Washington counties region and in the Broad Top Field, almost without exception have few employees. This situation is in contrast to the one prevailing in the deep mine industry, in which most of the larger mines are situated in the south.



Appendix: Note 28.

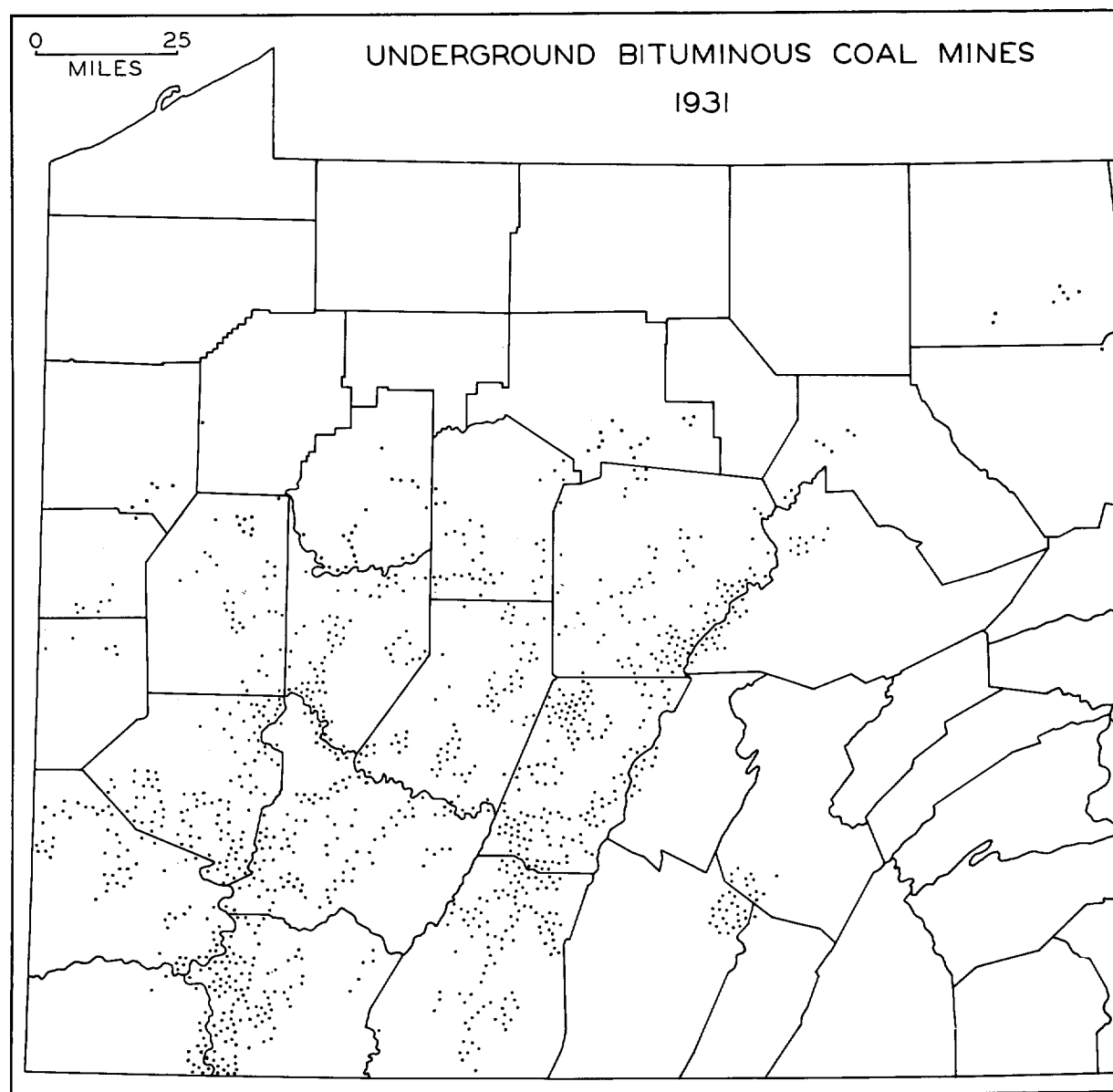
UNITED MINE WORKERS

The United Mine Workers of America plays an important role in the bituminous coal mining industry of Pennsylvania. The union lists among its members almost all of the mine employees of the southern producing counties, but enrolls a considerably smaller percentage of employees in most northern producing counties (refer to map at bottom of page 27).

The UMWA is organized into four districts in the bituminous coal region of Pennsylvania. District 2, with headquarters at Ebensburg, comprises more than

half of the producing area, and includes all or major portions of 22 counties in the central and eastern parts of the producing area. District 3, with headquarters at Greensburg, is restricted to Westmoreland County; District 4, with headquarters at Uniontown, comprises Fayette and Greene counties; and District 5, with headquarters at Pittsburgh, includes 6 western counties as well as small parts of two additional counties. The smaller districts, in general, comprise the areas of most intensive mining at present or in the recent past.

Mines, Mining Methods, and Accidents
in Pennsylvania's
Bituminous Coal Mining Industry



Appendix: Notes 22 and 28.

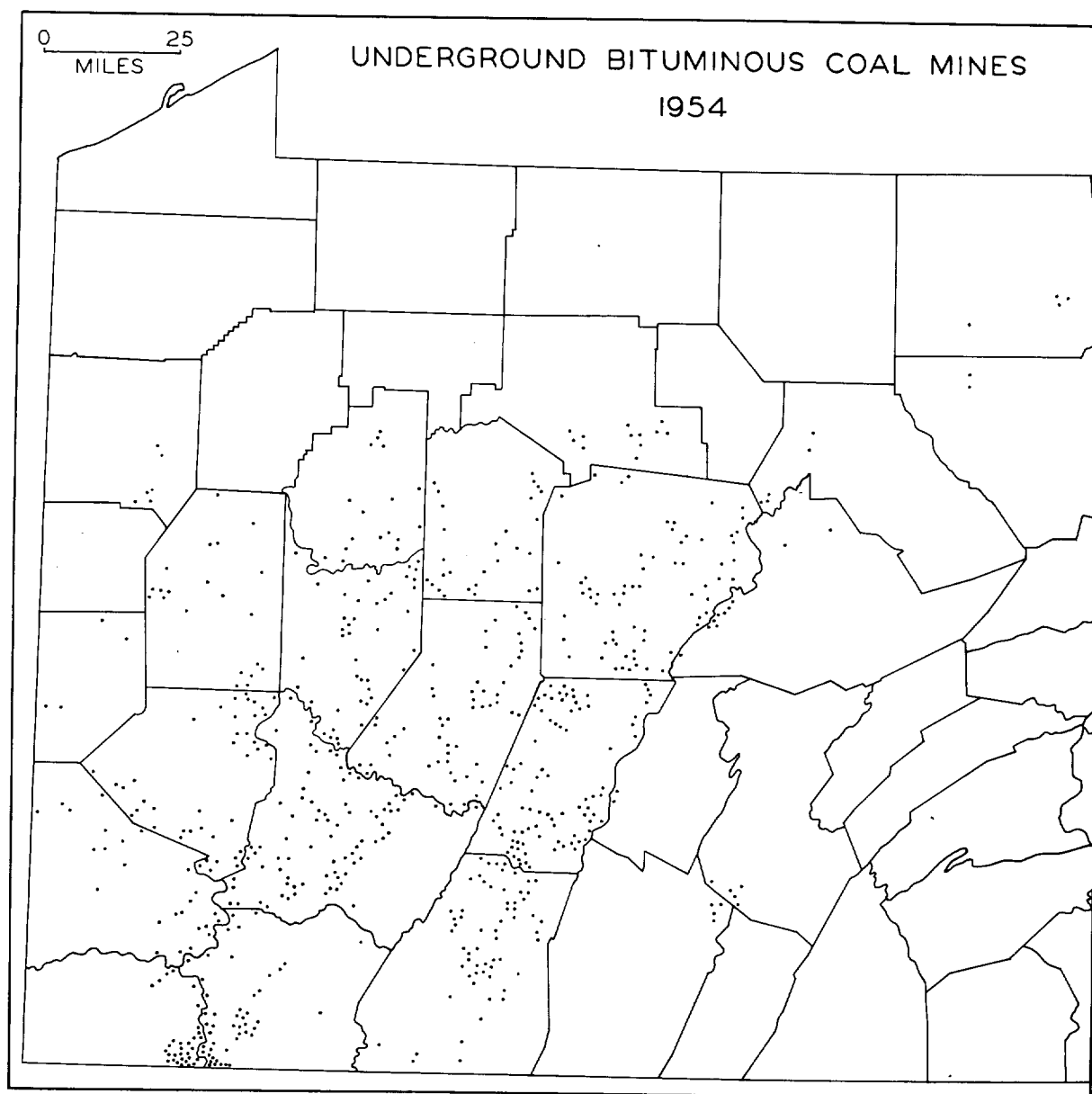
DISTRIBUTION OF UNDERGROUND MINES, 1931 AND 1954

Comparison of the map on this page with the one on the facing page indicates changes that have taken place during approximately a quarter of a century in the number and distribution of underground bituminous coal mines in Pennsylvania. The number of mines decreased appreciably between 1931 and 1954, with 1,130 active mines in the earlier year and only 653 in the later year. The broad pattern of mine distribution,

however, has remained remarkably stable. With rare exceptions, the same counties that had underground coal mines in 1931 had them in 1954; and the same general northern and eastern limits to mines are found on both maps.

Obviously the coal areas being exploited have neither expanded nor contracted appreciably.

[Continued on next page.]



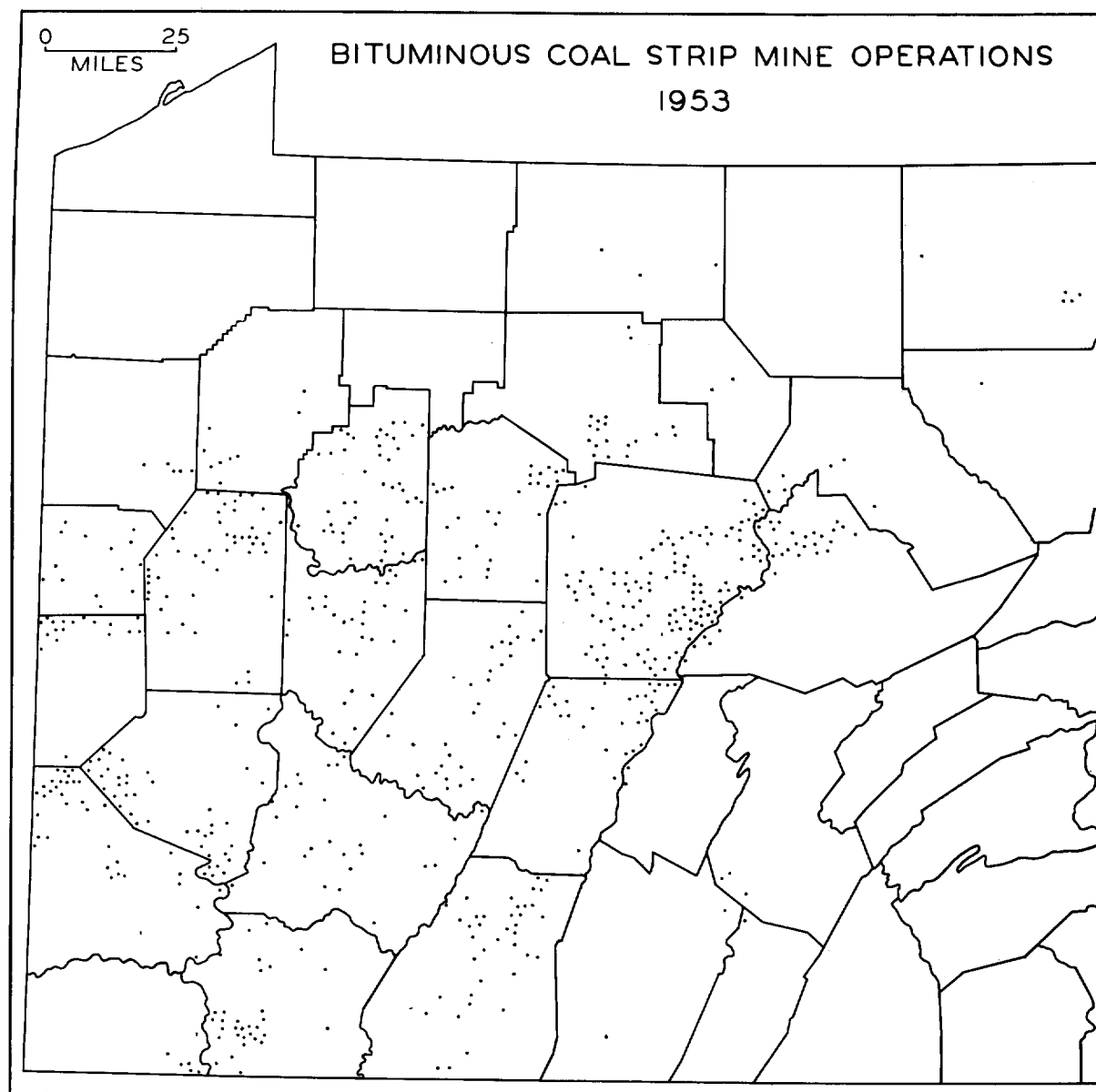
Appendix: Notes 22, 28, and 32.

UNDERGROUND BITUMINOUS COAL MINES

Examination of the *internal* distribution pattern of underground coal mines, within the broad regional framework of western Pennsylvania, reveals significant changes.

Certain areas with numerous deep mines in 1931 now have few, whereas some formerly insignificant regions now have a considerable number of mines. Among the more noteworthy changes, on a county basis, are the following: Allegheny—the disappearance of mines from the interior and the marked reduction in number

of peripheral mines; Armstrong—the shift of mines from the western to the eastern half; Butler—the decline of deep mining in the east; Cambria—the marked reduction in number of mines; Clearfield—the disappearance of deep mines from much of the southeast; Fayette—the disappearance of deep mines from much of the northwest; Greene—the unique increase in the number of underground mines; Somerset—the decline in number of deep mines in the south; Washington—the great reduction in number of mines; Westmoreland—the disappearance of deep mines from the east.



Appendix: Notes 28 and 42.

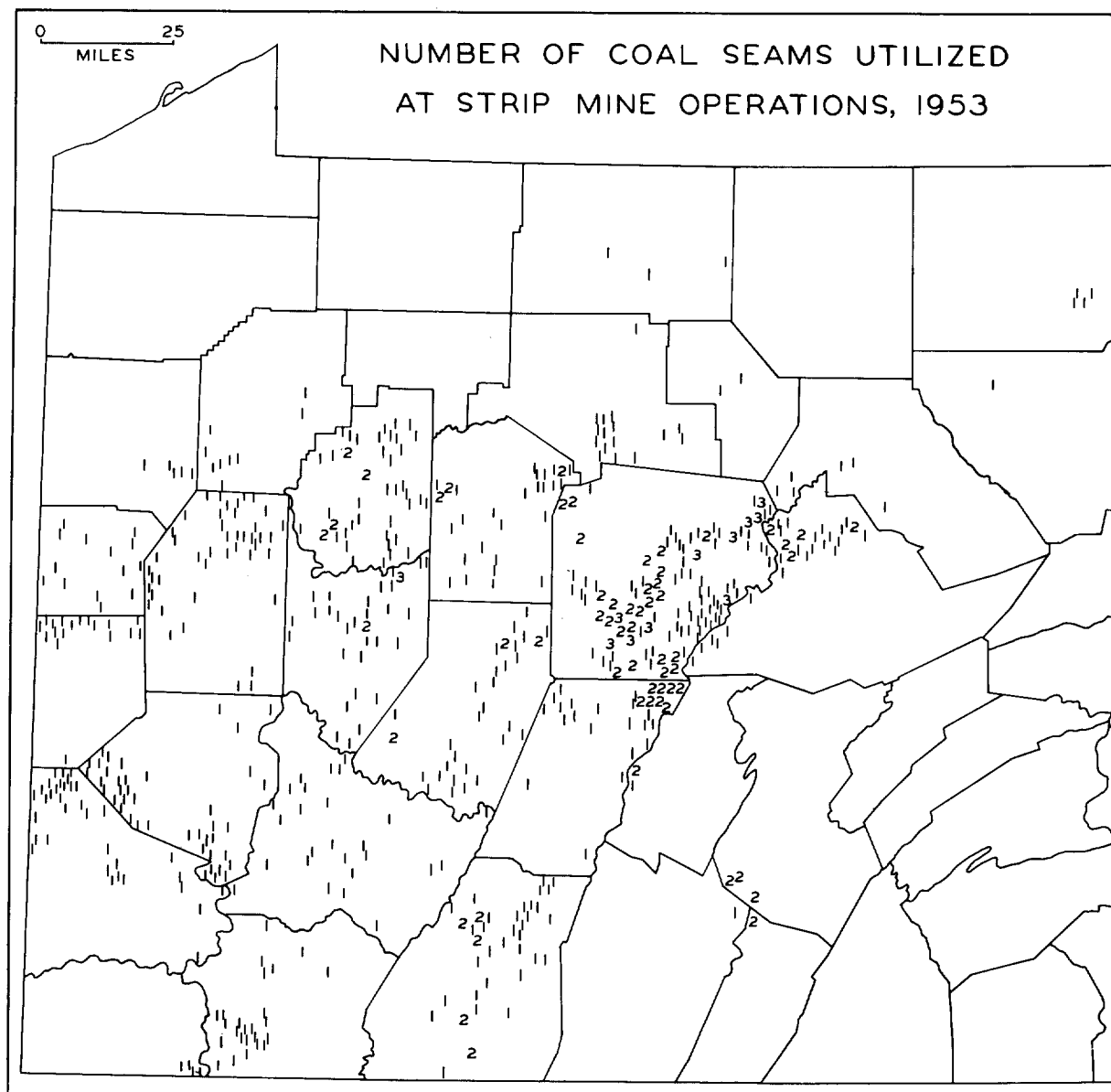
BITUMINOUS COAL STRIP MINE OPERATIONS

Stripping of bituminous coal is an important segment of the soft coal mining industry of Pennsylvania. Over one-fourth of the total annual bituminous coal output of the Commonwealth comes from strip pits, and Pennsylvania ranks first among the states in cumulative production of stripped bituminous coal for the period 1914 to 1953 (see map at the top of page 4).

Stripping operations are widely distributed throughout the bituminous coal producing area of the State, but specific regions of strip mine concentration differ in many instances from those of deep mines. For example, comparison of the distributional pattern on

the above map with that of deep mines on the preceding page indicates considerable concentration of strip mine operations along the western periphery of the producing area in northern Washington, western Allegheny, northern Beaver, and Lawrence counties, whereas there are few deep mines there. Conversely, Cambria County has far more deep than strip mines. Many other comparable instances are apparent on the two maps.

The largest number of strip mine operations in Pennsylvania is in Clearfield County. Only one bituminous coal producing county in the State (Forest), is without at least one strip pit.



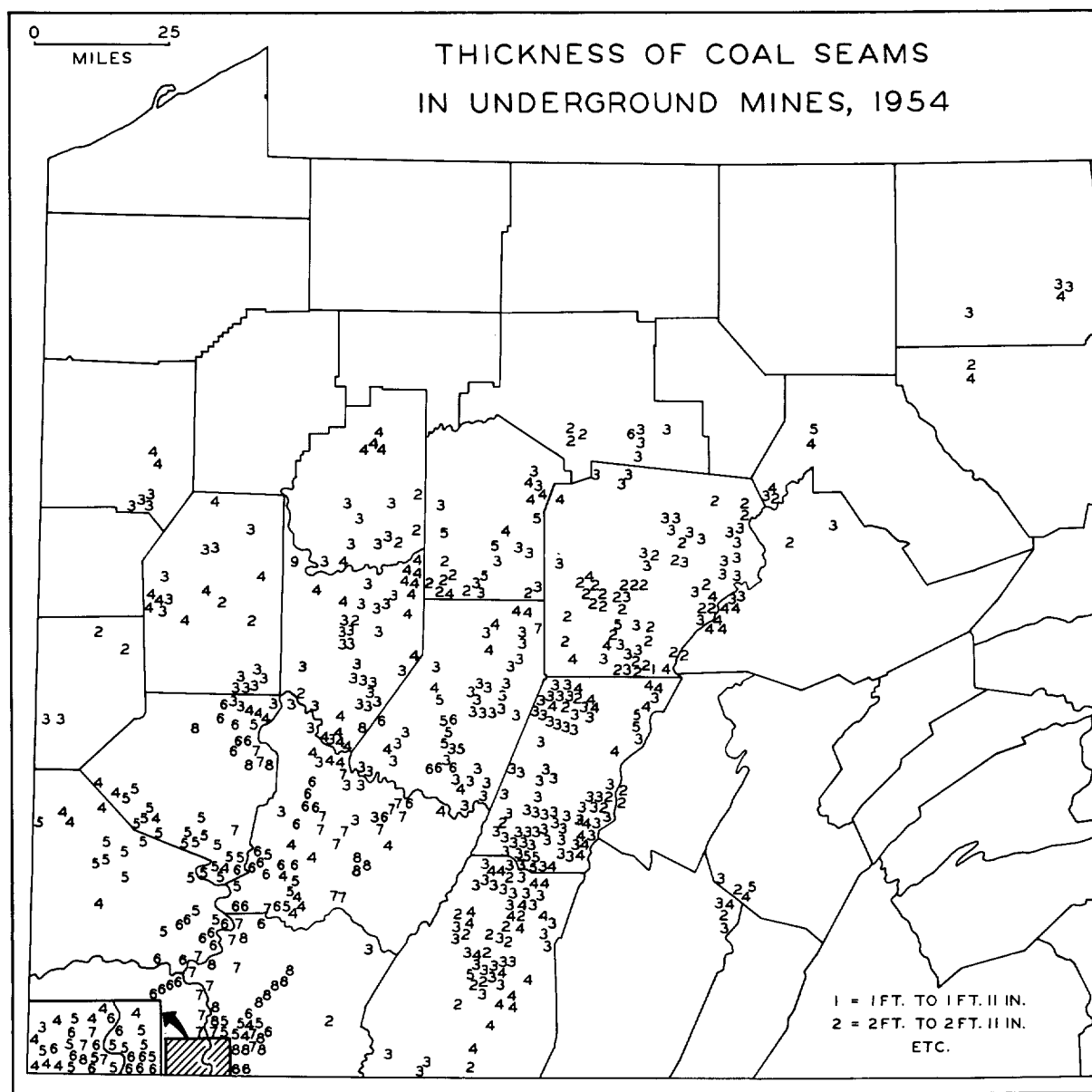
Appendix: Notes 28, 32, and 42.

NUMBER OF SEAMS UTILIZED

Most bituminous coal strip mine operations in western Pennsylvania involve only one coal seam, since normally only one useable coal outcrop is present in a given locality. Other seams in the vicinity of a given operation, being situated stratigraphically higher or lower than the one being worked, either have been removed by erosion during former geologic times or lie buried beneath the level at which streams locally have incised their valleys into the relatively horizontal

rock strata.

Along the eastern and northern margins of the producing area, however, there are a number of pits utilizing two or even three seams simultaneously. In these places, close stratigraphic proximity of useable seams, combined with folding of the seams or unusually deep dissection by streams to make them accessible, has exposed parallel outcrops of two or three seams that can be worked simultaneously.



Appendix: Notes 22, 28, and 32.

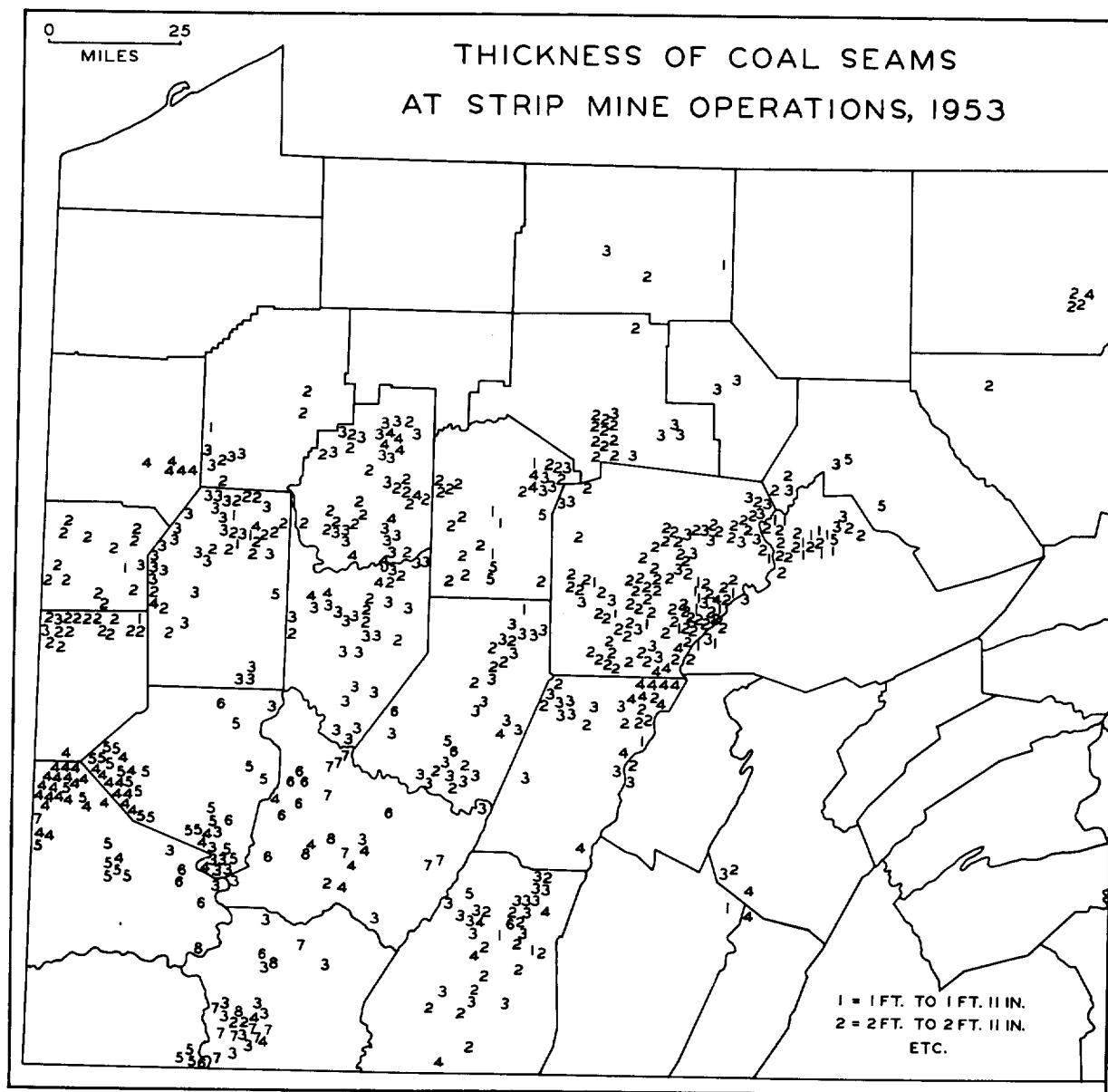
THICKNESS OF SEAMS

Pennsylvania's bituminous coal seams differ considerably from one another in thickness, and even the major seams are variable in thickness. The thicker the seam, and the greater the persistence of seam thickness, the lower are mining costs.

The above map shows, on a mine by mine basis, the thickness of the coal seams utilized in the Commonwealth's underground mines. Mines employing seams with a height of from 6 to over 8 feet number only 110 out of a total of 607, and they are limited almost exclusively to a small area in the southwestern corner of the State. Of these 110 thick-seam mines, 88 are operating in the Pittsburgh bed.

Mines operating in seams ranging from 4 feet to 5 feet 11 inches number 188, and tend to be found mainly in areas to the north and east of the thick-seam mines. Many such medium-seam mines are operating in the Freeport beds.

Mines utilizing seams ranging from 2 feet to 3 feet 11 inches number 309 and are exceedingly widespread in distribution, although tending to be concentrated in the northern and eastern margins of the coal fields. Most thin-seam mines are operating in the Kittanning beds, although fairly large numbers utilize the Freeport beds.



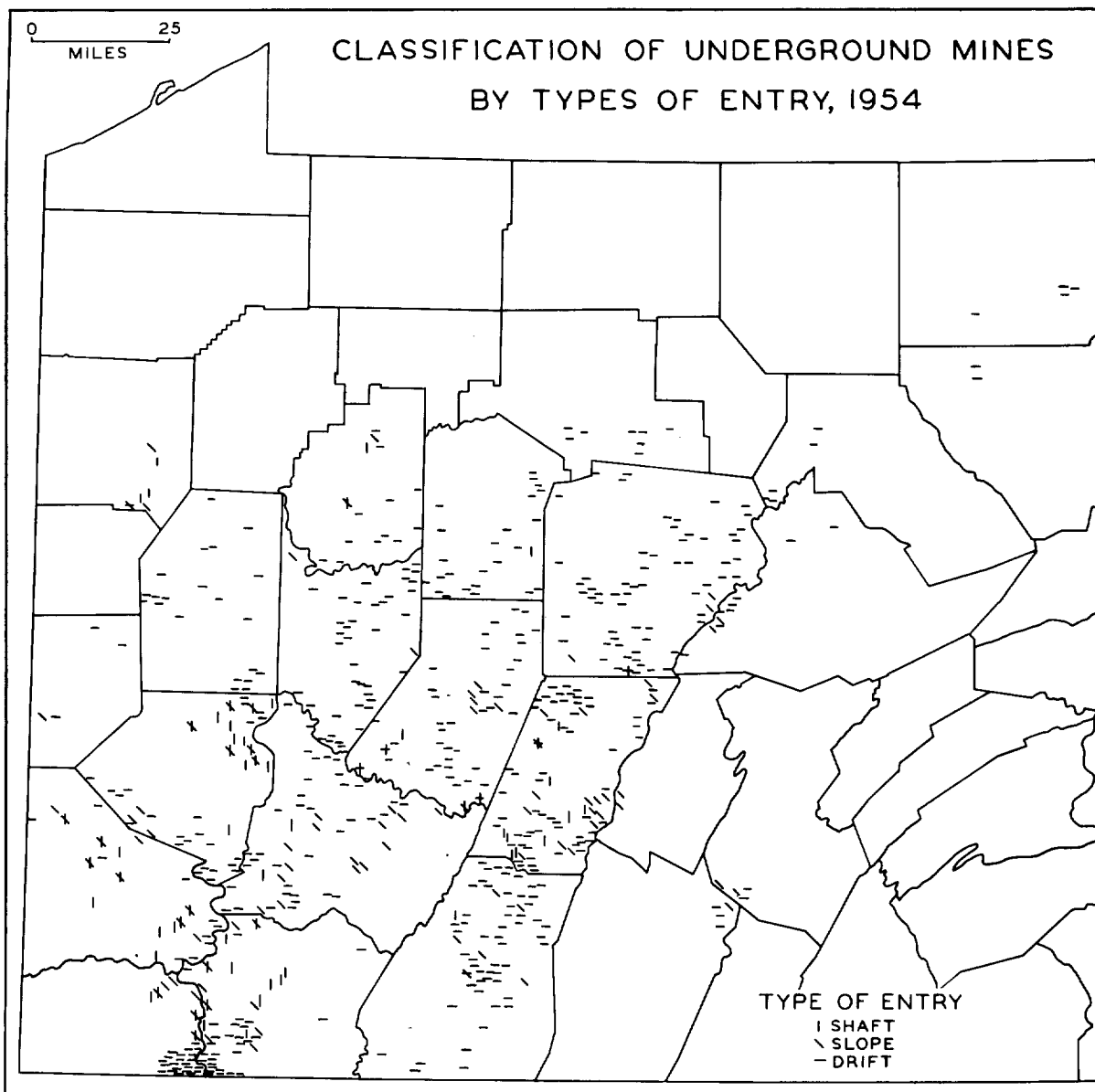
Appendix: Notes 28, 32, 42, and 44.

THICKNESS OF SEAMS

Strip mines, like deep mines, use coal seams differing greatly in thickness, but, in the case of stripping, seams as thin as one foot are mined. Thick seam stripping is mostly limited to the southwestern corner of the Commonwealth, in Allegheny, Fayette, Washington, and Westmoreland counties, where chiefly remnant outcrops of the Pittsburgh seam still are being mined

(compare the above map with that on page 12).

Elsewhere in western Pennsylvania strip pits are handicapped by having to utilize thinner seams, but outcrops of these seams are abundant and therefore production from them is large (compare the above map with that on page 55).



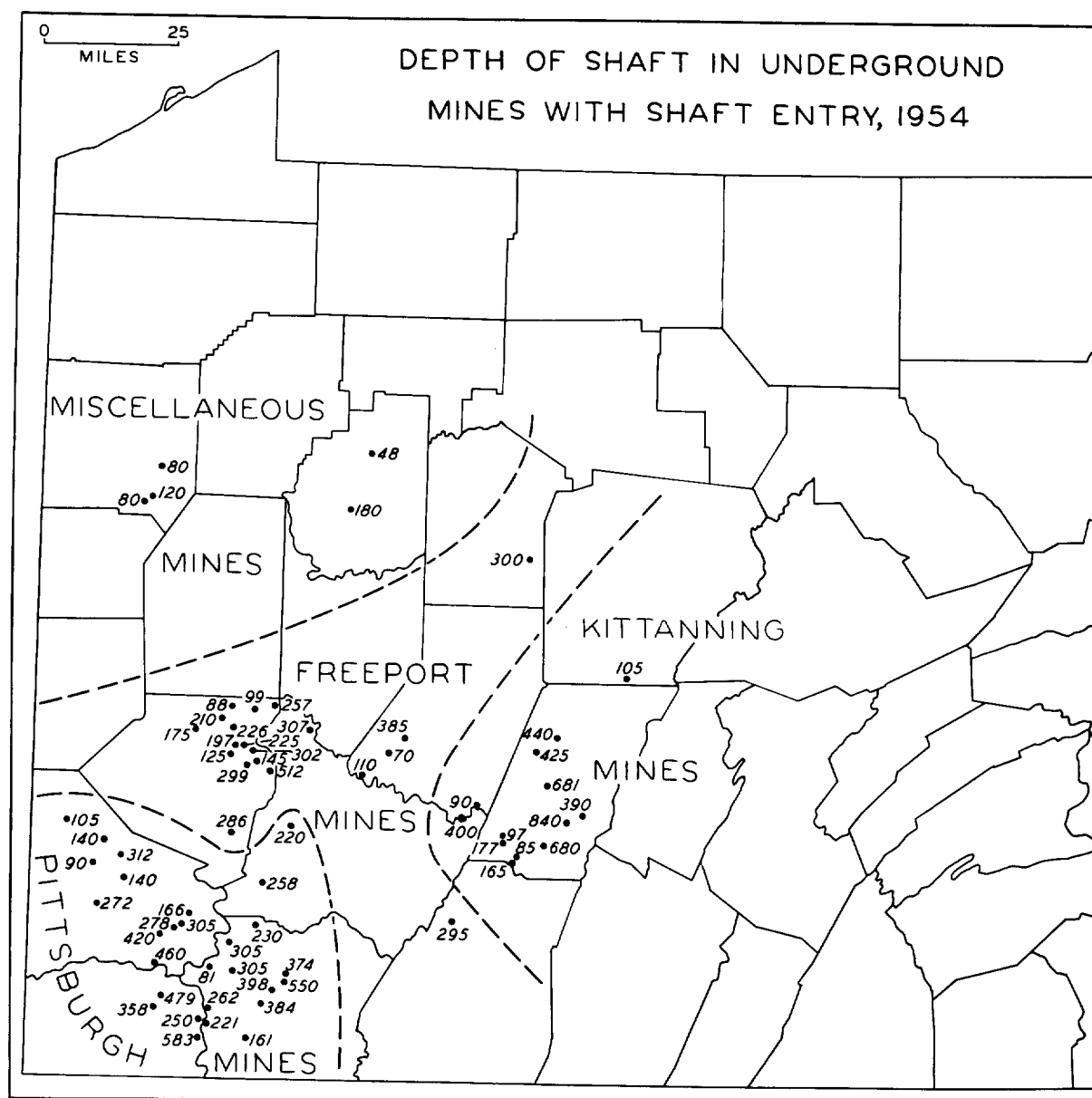
Appendix: Notes 22, 28, 32, 33, and 34.

TYPES OF ENTRY

The outcropping and essentially flat-lying coal beds of western Pennsylvania permit general use of horizontal or nearly horizontal deep mine entries termed "drifts." Slope and shaft entries, however, are by no means rare. As the map above illustrates, some 66 of 607 deep mines employ shaft entries, either alone or in combination with other types; and approximately 94 mines utilize slope entries, either alone or in combination.

Shaft and slope entries are most common in the southern part of the producing area, being especially

prevalent in Allegheny, Cambria, Fayette, Greene, Indiana, Somerset, Washington, and Westmoreland counties. Such entries are utilized primarily to obtain the more heavily capped remnants of a particularly desirable seam in areas where valley outcrops already have been worked out; or they are employed along the southwestern margin of the exploited portion of a seam, where it no longer outcrops but instead begins to dip beneath overlying strata. Because of the latter situation, few shaft and slope mines are found in the northern half of the coal producing area.

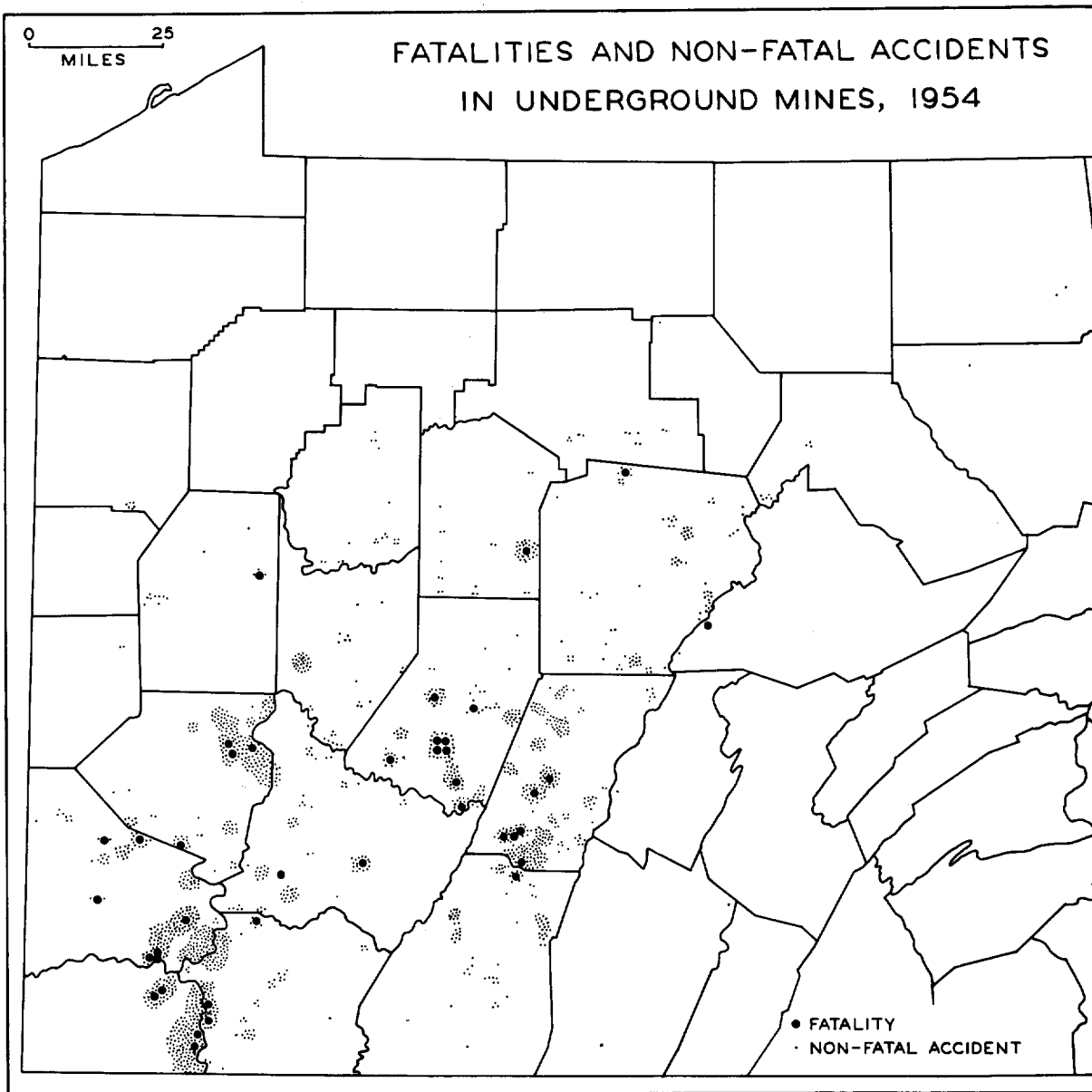


Appendix: Notes 22, 32, and 35.

DEPTH OF SHAFTS

Shafts of underground bituminous coal mines in western Pennsylvania range from 48 feet to 840 feet in depth. In Allegheny County, 8 shafts exceed 200 feet in depth, and one of these is 512 feet deep. Cambria County has one shaft with a depth of between 300 and 400 feet, two between 400 and 500 feet, two between 600 and 700 feet, and, deepest of all in the Commonwealth's bituminous coal fields, one shaft with a depth of 840

feet. Other counties with one or more shafts exceeding 200 feet are Fayette, Greene, Indiana, Jefferson, Somerset, Washington, and Westmoreland. Of course, the deeper the shaft the greater the expense of coal haulage to the surface and the more difficult it is to remove mine water and rock waste. As the above map indicates, there is a distinct regional pattern as to where the various seams are shaft mined.



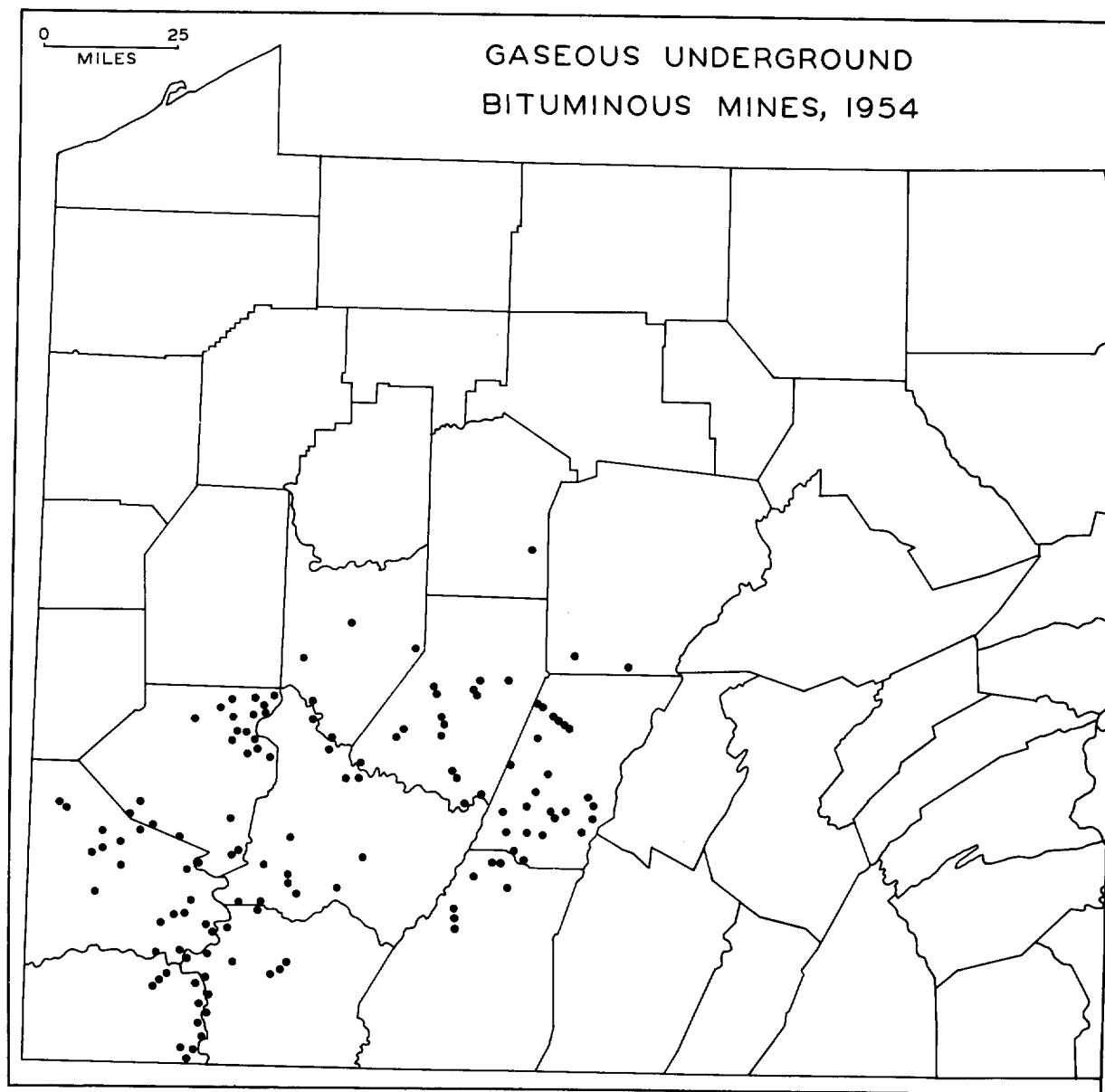
Appendix: Notes 22, 27, 28, 32, 33, and 39.

FATALITIES AND ACCIDENTS

Fatalities among underground bituminous coal mine employees of Pennsylvania have decreased remarkably during the past quarter century, due to advancements in knowledge concerning their cause and the consequent remedial measures that have been taken. Fatalities now number in the tens rather than the hundreds annually, and currently average less than one a year per 1,000 employees. Production approximates two million tons per fatality. Non-fatal accidents likewise have declined in numbers during recent years, averaging one per 30 employees.

Causes of fatal accidents are varied. Most common is the collapse of mine roofs, faces, and sides; but most spectacular is explosion caused by mine gases. Other fatalities generally are associated with mine machinery and electrical wiring.

All underground mines are subject to the hazards that cause fatalities and accidents; but most of these occur in the southern half of the Commonwealth's producing area, where mines are largest, employees most numerous, and gaseous mines most common.



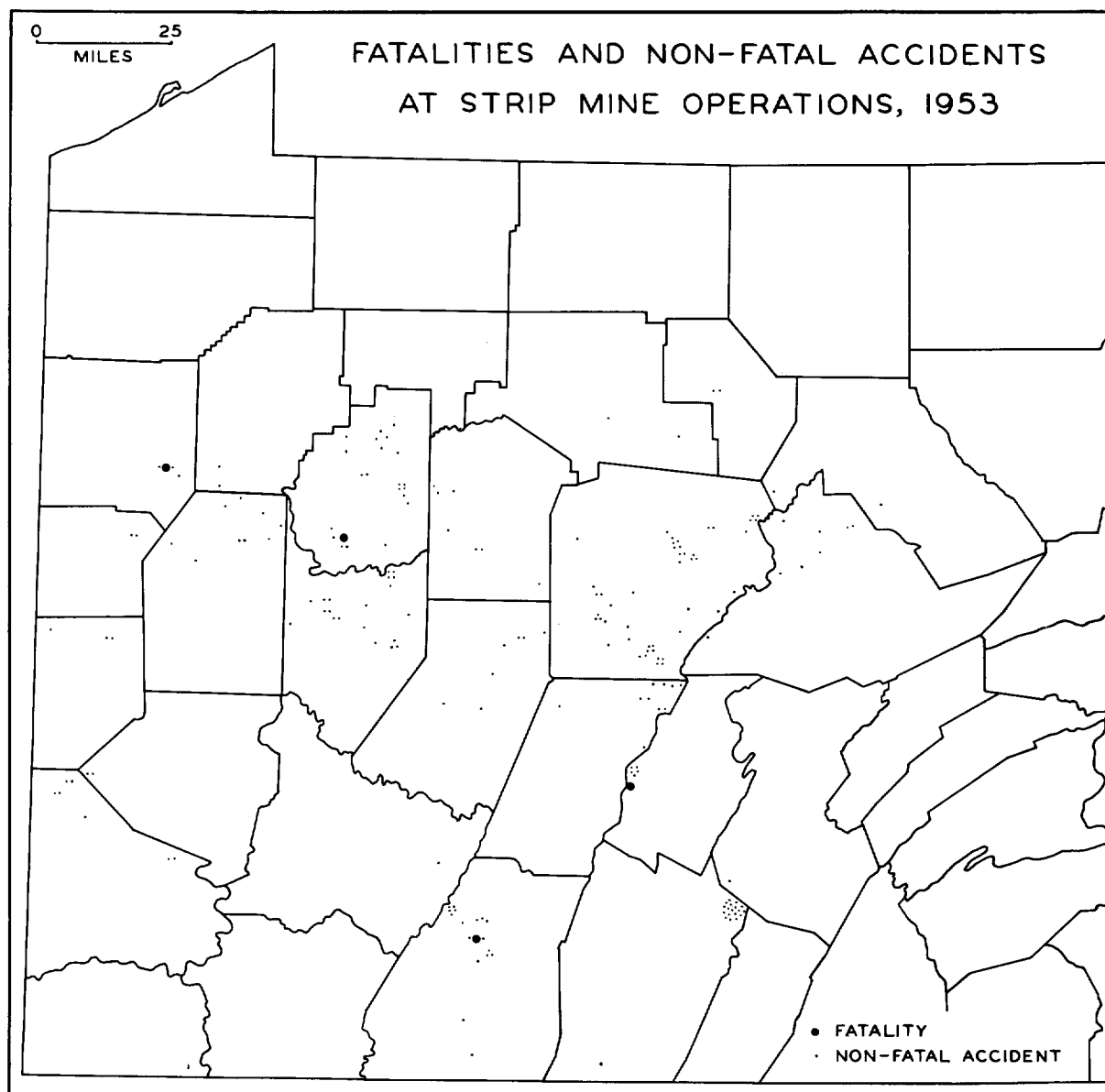
Appendix: Notes 22, 28, and 32.

GASEOUS MINES

Considerable progress has been made during recent decades in reducing the hazards to mining caused by the presence of explosive gas (mostly methane) in certain underground coal mines. Approved explosive and electrical equipment, compulsory inspection, and similar factors have removed much of the risk formerly associated with gaseous mines. Nevertheless, comparison of the map above with the one on the facing page shows a close spatial correlation between fatalities and non-fatal accidents on the one hand and gaseous mines on the other. The mines indicated as gaseous on the above map are so classified by the Bituminous Division of the Pennsylvania Department of Mines

and Mineral Industries.

Most of the gaseous mines in Pennsylvania's bituminous coal fields are located in the southern half of the producing area; the northern half is almost free from dangerous quantities of explosive gas. The gaseous mines of southern Allegheny, Fayette, Greene, Washington, and southwestern Westmoreland counties are largely in the Pittsburgh seam. Those of northeastern Allegheny, Armstrong, southwestern Indiana, and northwestern Westmoreland counties are mainly in the Freeport seams; and those of Cambria, southeastern Indiana, and Somerset counties are primarily in the Kittanning seams.



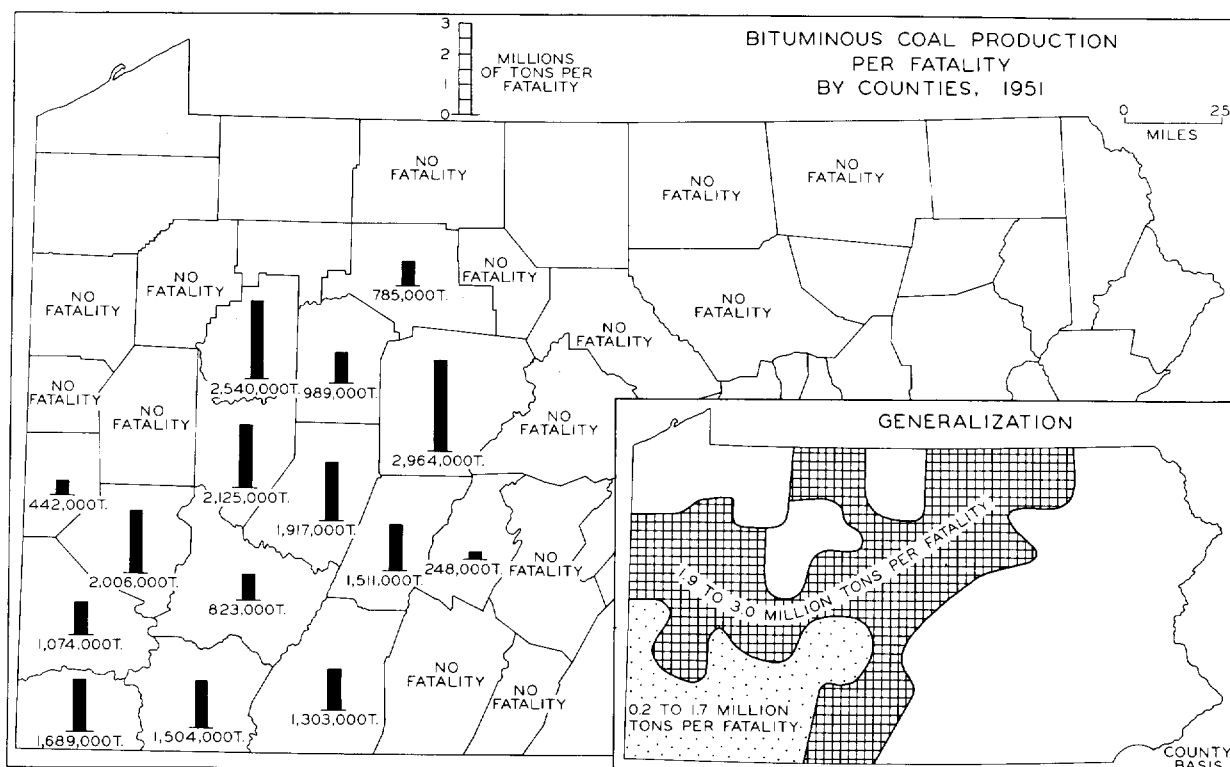
Appendix: Notes 27, 28, 32, 33, and 39.

FATALITIES AND ACCIDENTS

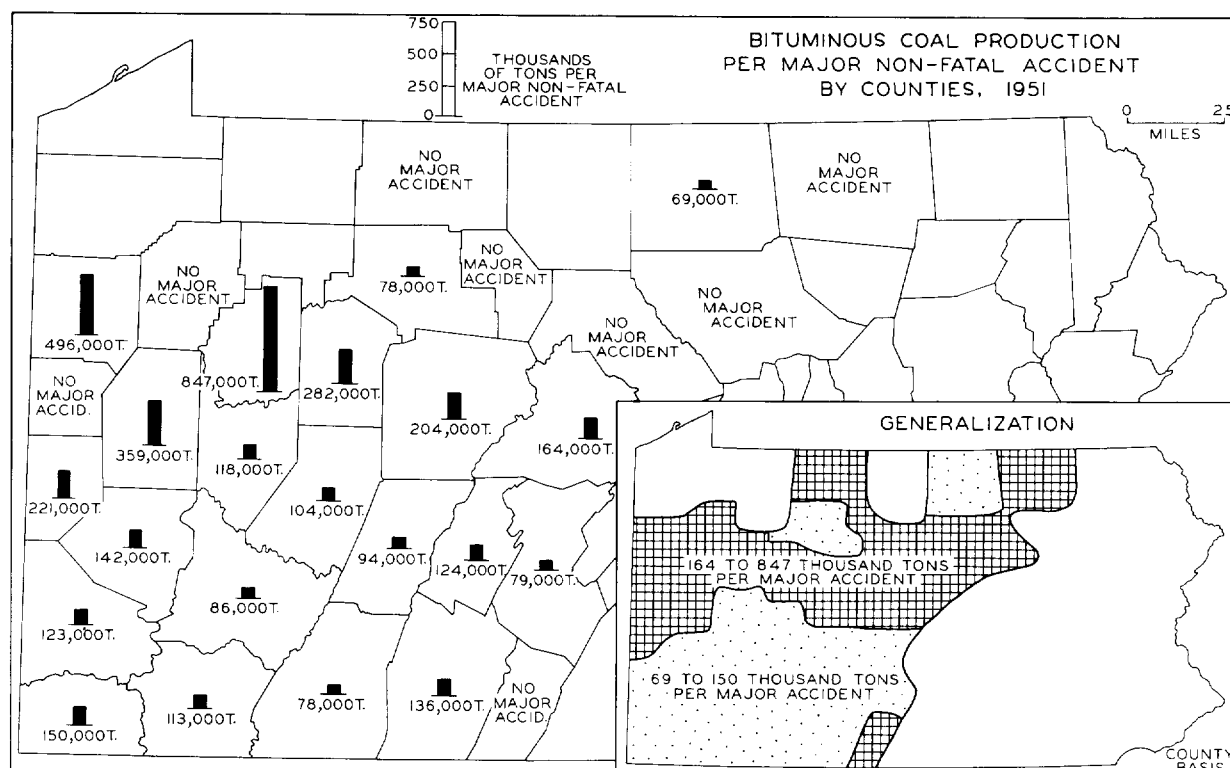
Fatalities and non-fatal accidents among Pennsylvania's bituminous coal strip mine employees are far fewer in number than those among the State's underground bituminous coal mine employees. In part such a situation reflects the smaller number of employees engaged in the stripping facet of the industry, but an additional factor is the greater degree of safety inherent in surface work as compared with underground work. Only some two to four strip mine fatalities occur each year in western Pennsylvania, the current average being about one a year per 2,000 to 4,000 employees. Strip production approximates 5 to 10 million tons per

fatality. Non-fatal accidents in the stripping industry average about one per 40 employees. Most strip mine accidents are of a character common to work around any type of heavy equipment, although some are caused by falls of rock from the highwall of the pit or by blasting.

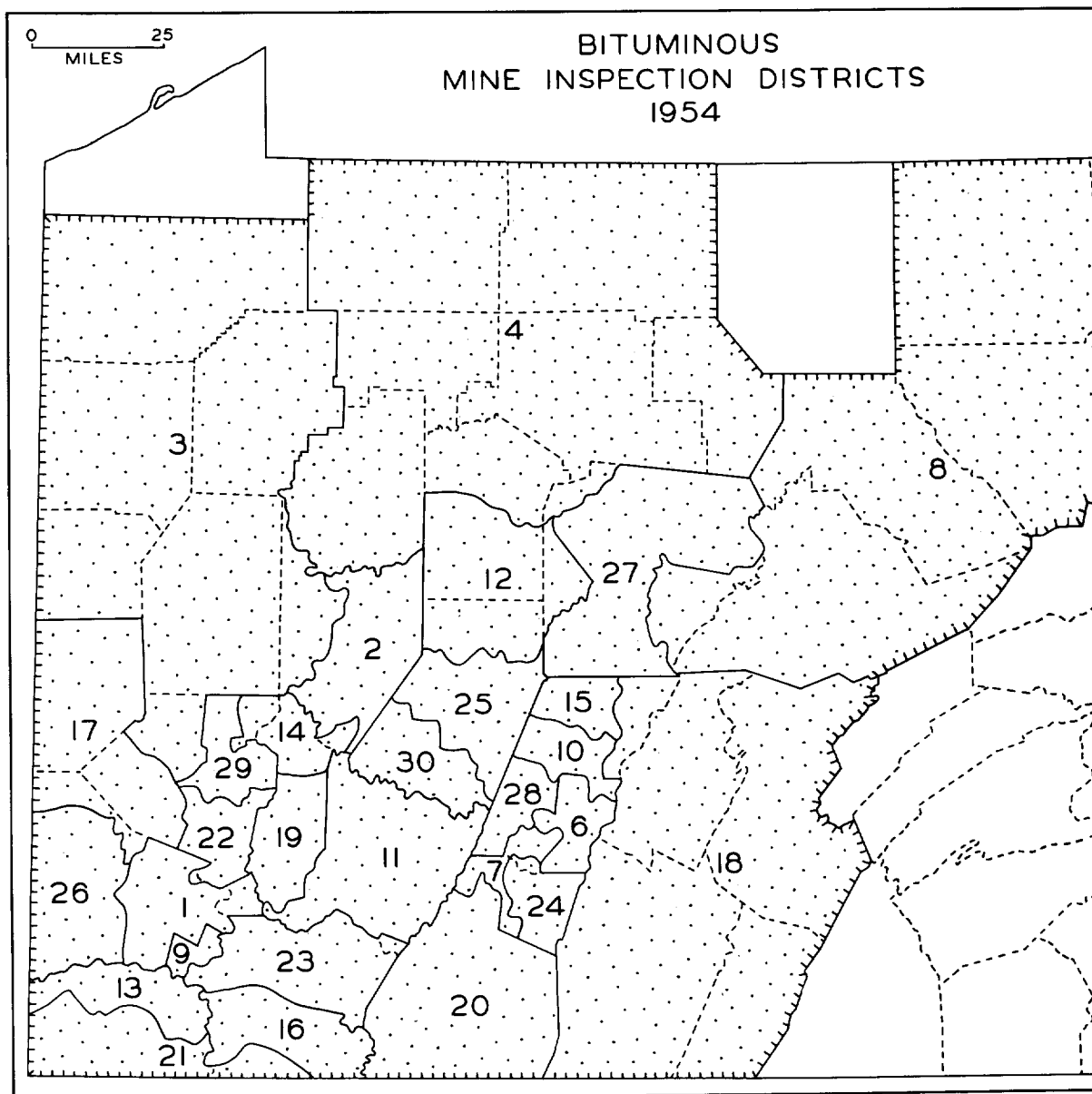
As the map above indicates, most non-fatal accidents in Pennsylvania's bituminous coal strip pits occur in the northern half of the producing area, where stripping activities are most concentrated and hence where exposure to possible accident is greatest.



Appendix: Notes 17 and 22.



Appendix: Notes 17, 22, and 27.



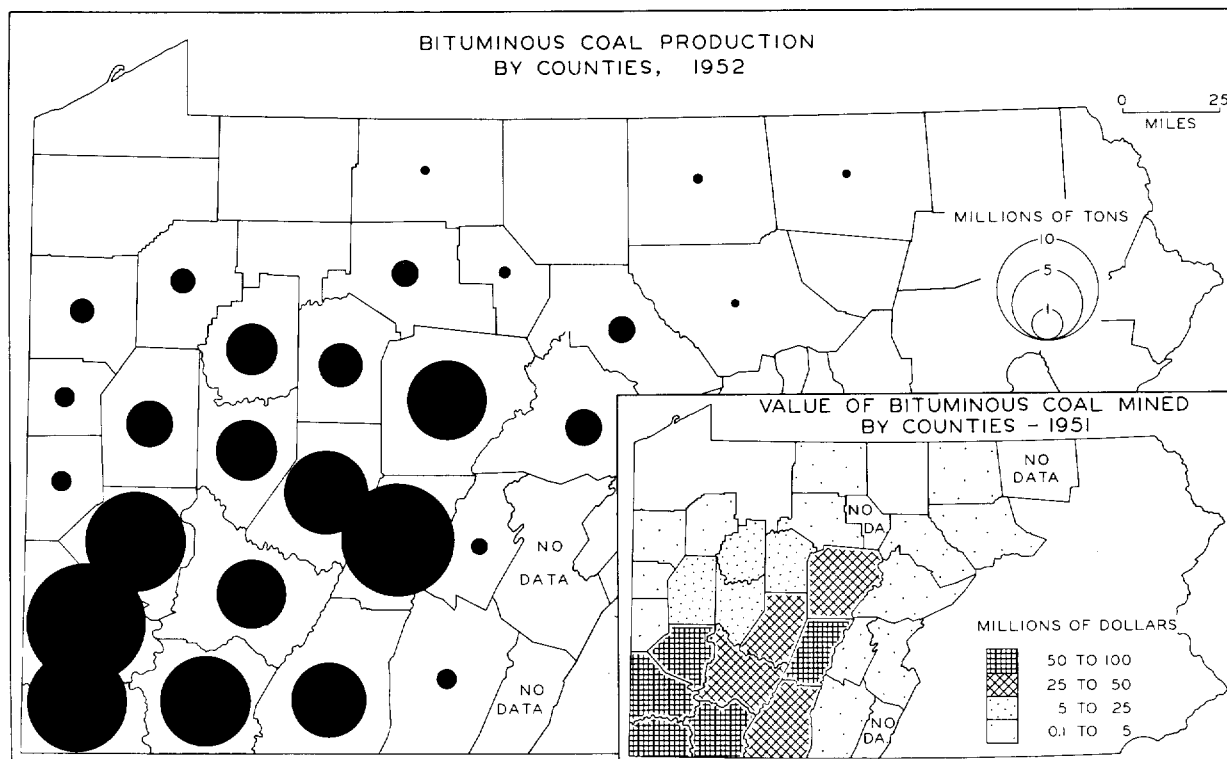
Appendix: Notes 28 and 31.

MINE INSPECTION DISTRICTS

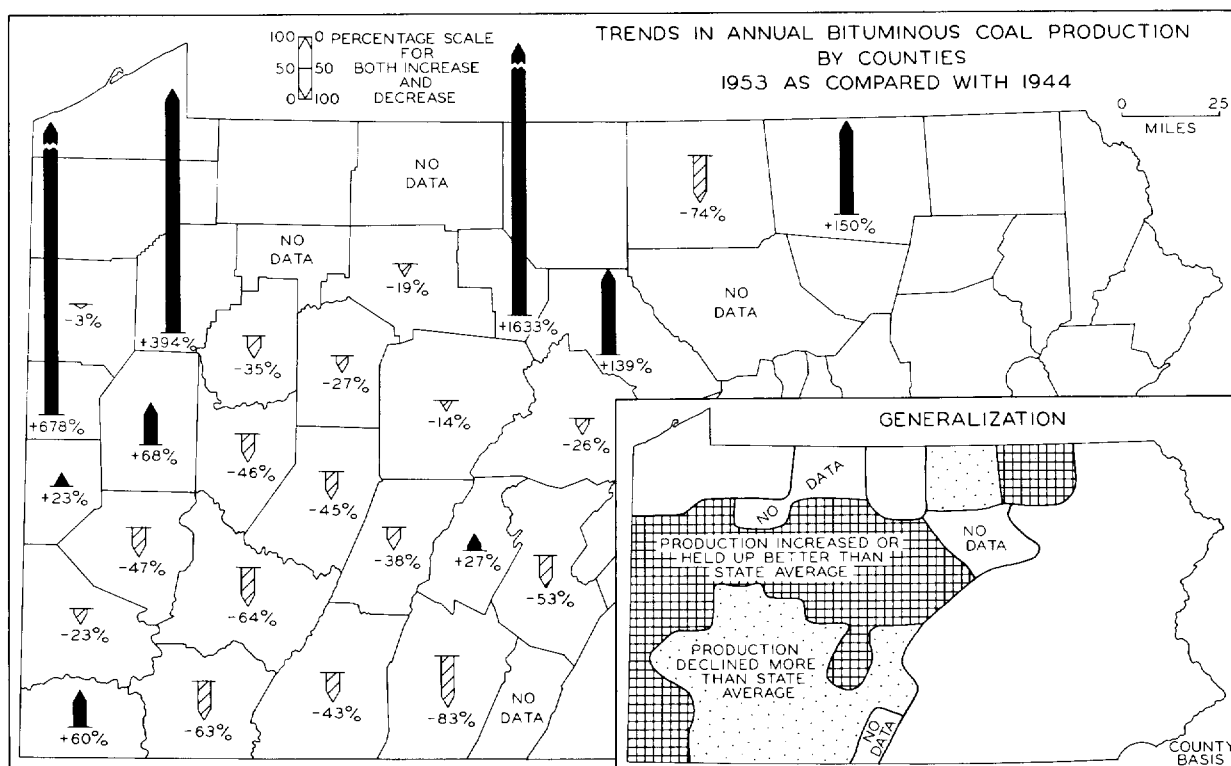
The Pennsylvania Department of Mines and Mineral Industries (formerly the Department of Mines) was established April 14, 1903, superseding the Bureau of Mines which was then in the Department of Internal Affairs. The Bituminous Coal Division of the Department is charged with supervising execution of laws of the Commonwealth relating to bituminous coal mining. The bituminous coal area of the State is divided into mine inspection districts (29 in 1954) each of which is under the jurisdiction of a mine inspector whose duties are to protect the health and promote the safety

of persons employed in and about the mines. Each mine in the State employing 5 or more men underground in any one 24-hour period is inspected at least once every four months, with special attention being given to gaseous mines and others where unusual dangers may exist. Inspections also are made of small underground mines that do not come under the mining laws, and of strip mines. As is evident from the above map, areas of individual mine inspection districts differ widely, due to regional variations in number of mines and prevalence of hazardous mining conditions.

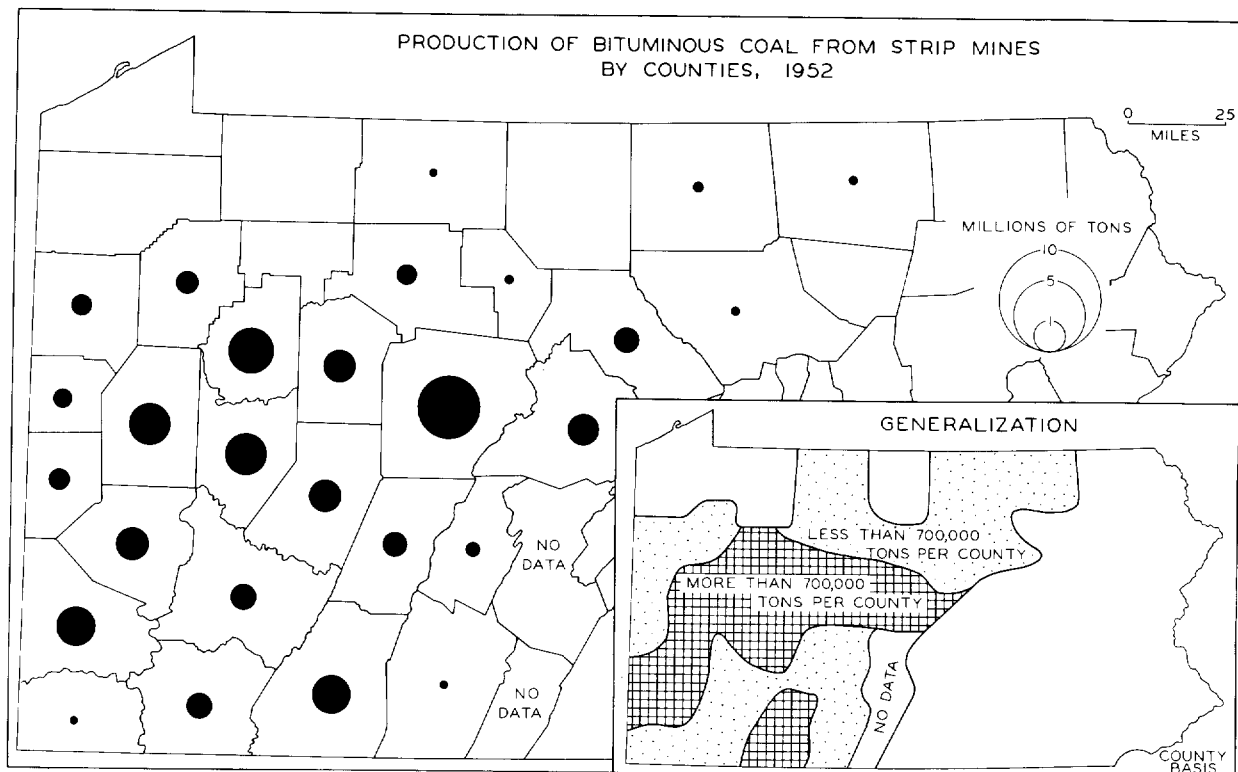
Production and Shipment
of Coal by
Pennsylvania's
Bituminous Coal Mining Industry



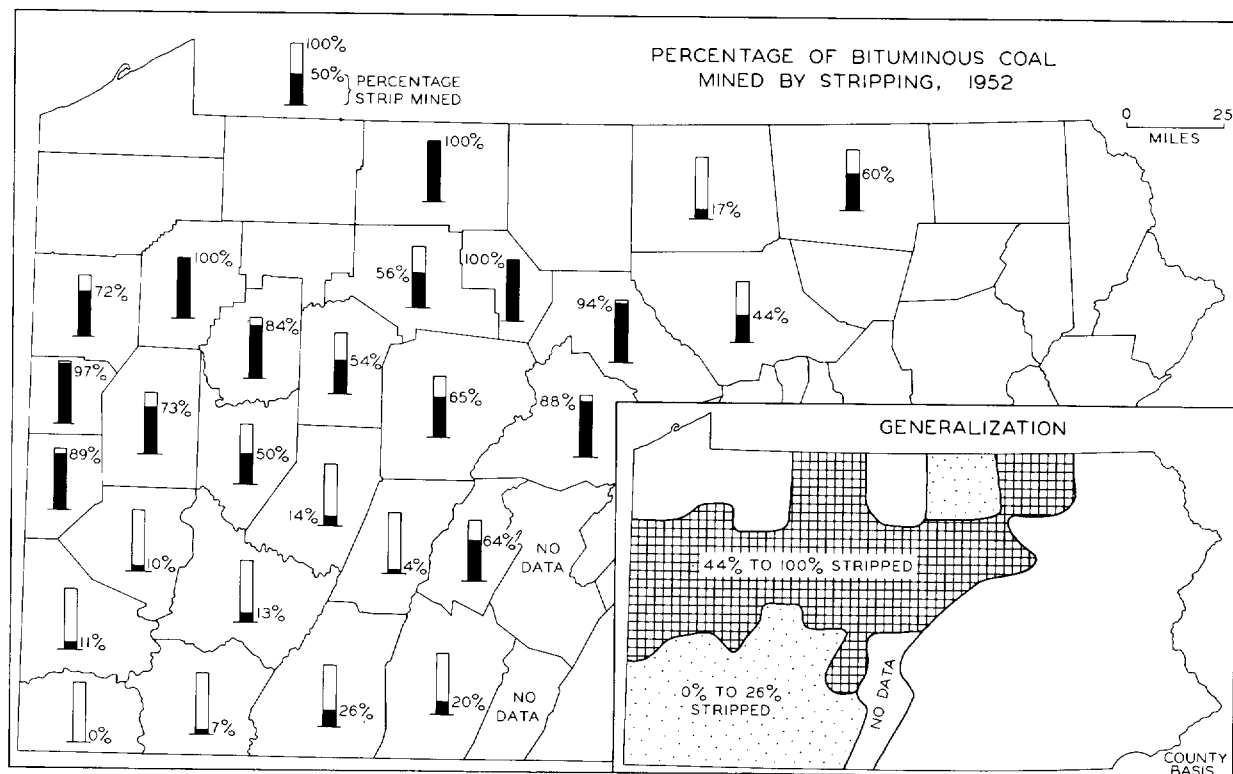
Appendix: Notes 5, 17, and 21.



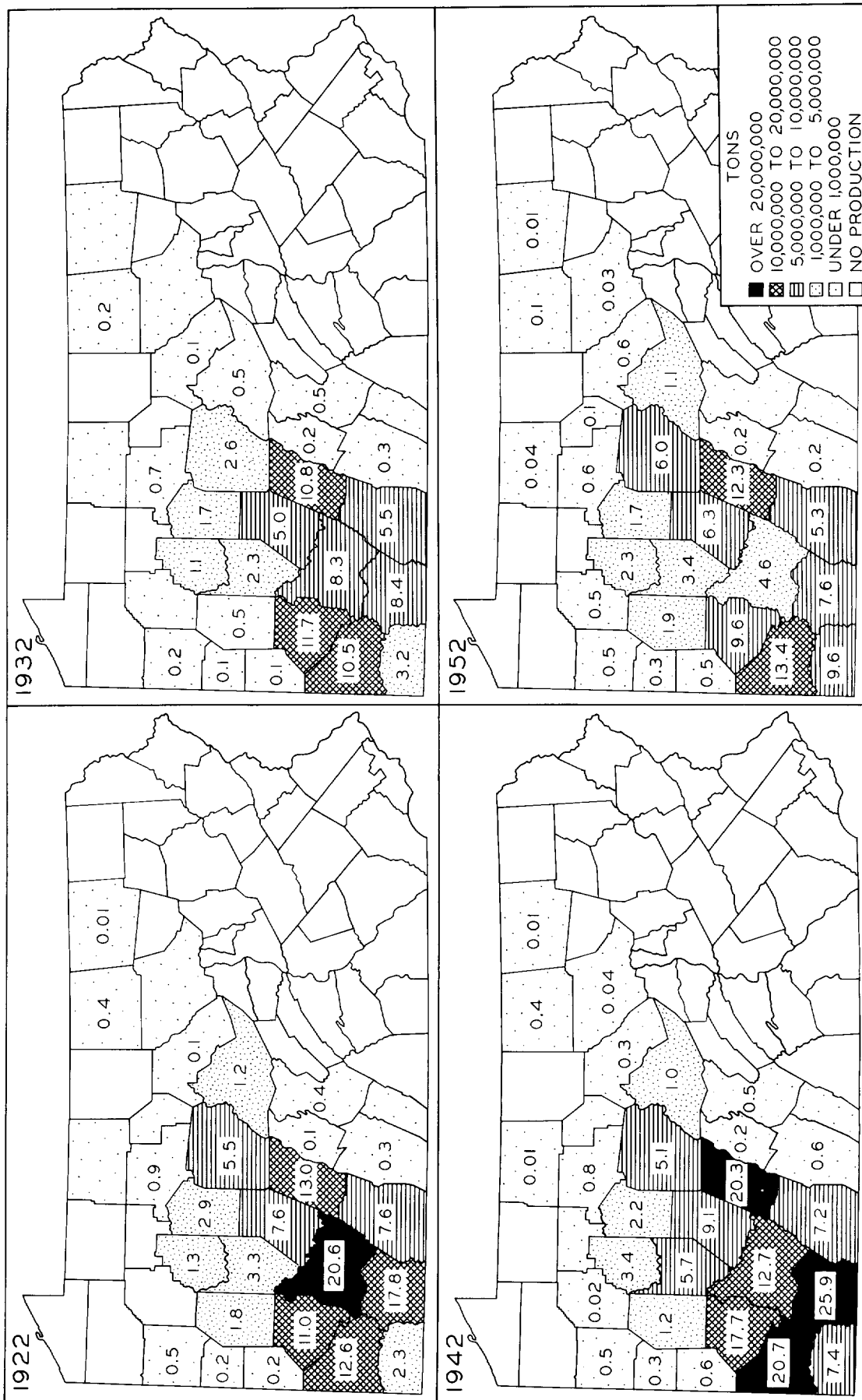
Appendix: Notes 5, 13, 17, and 21.



Appendix: Notes 5 and 21.

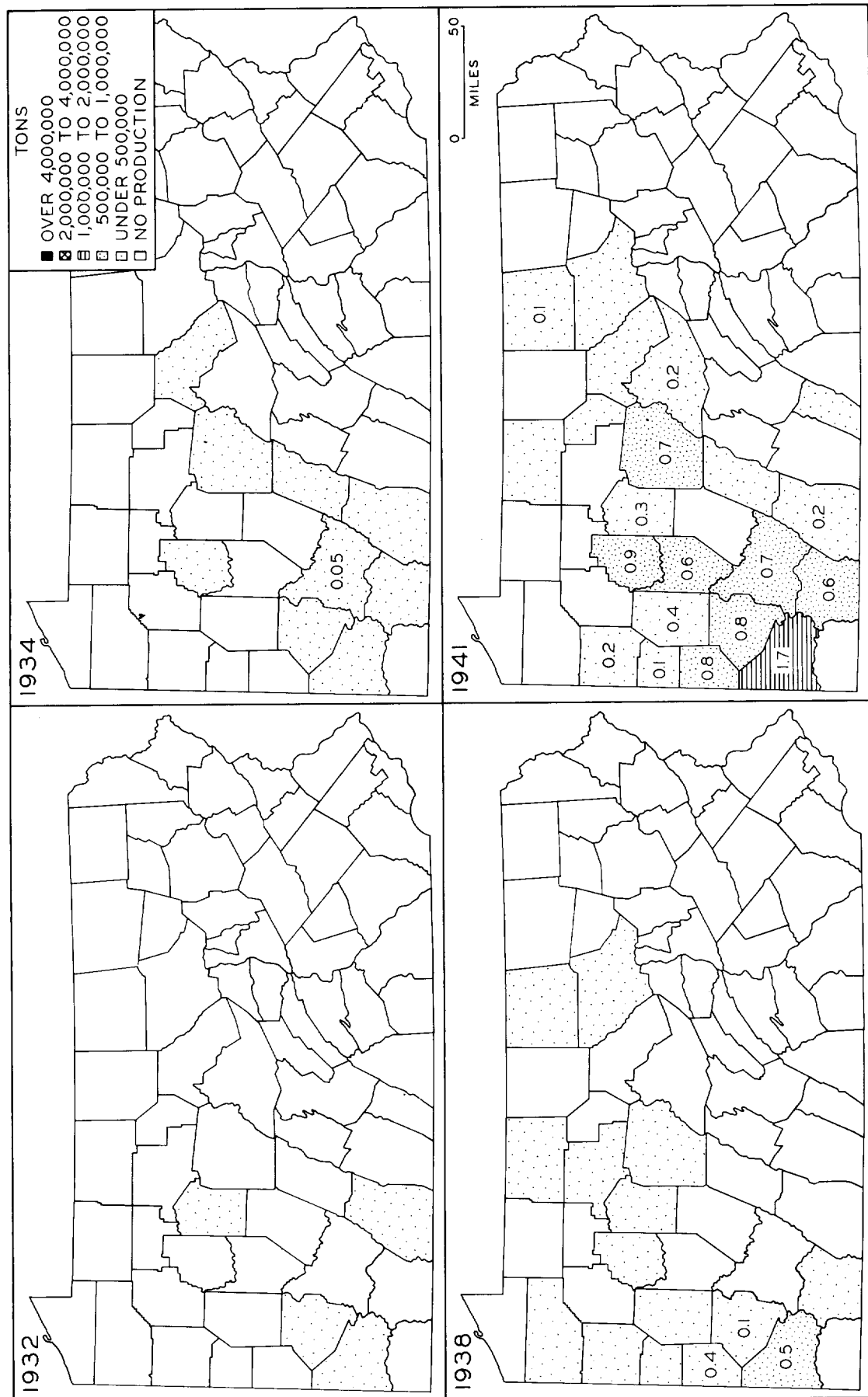


Appendix: Notes 5, 13, and 21.



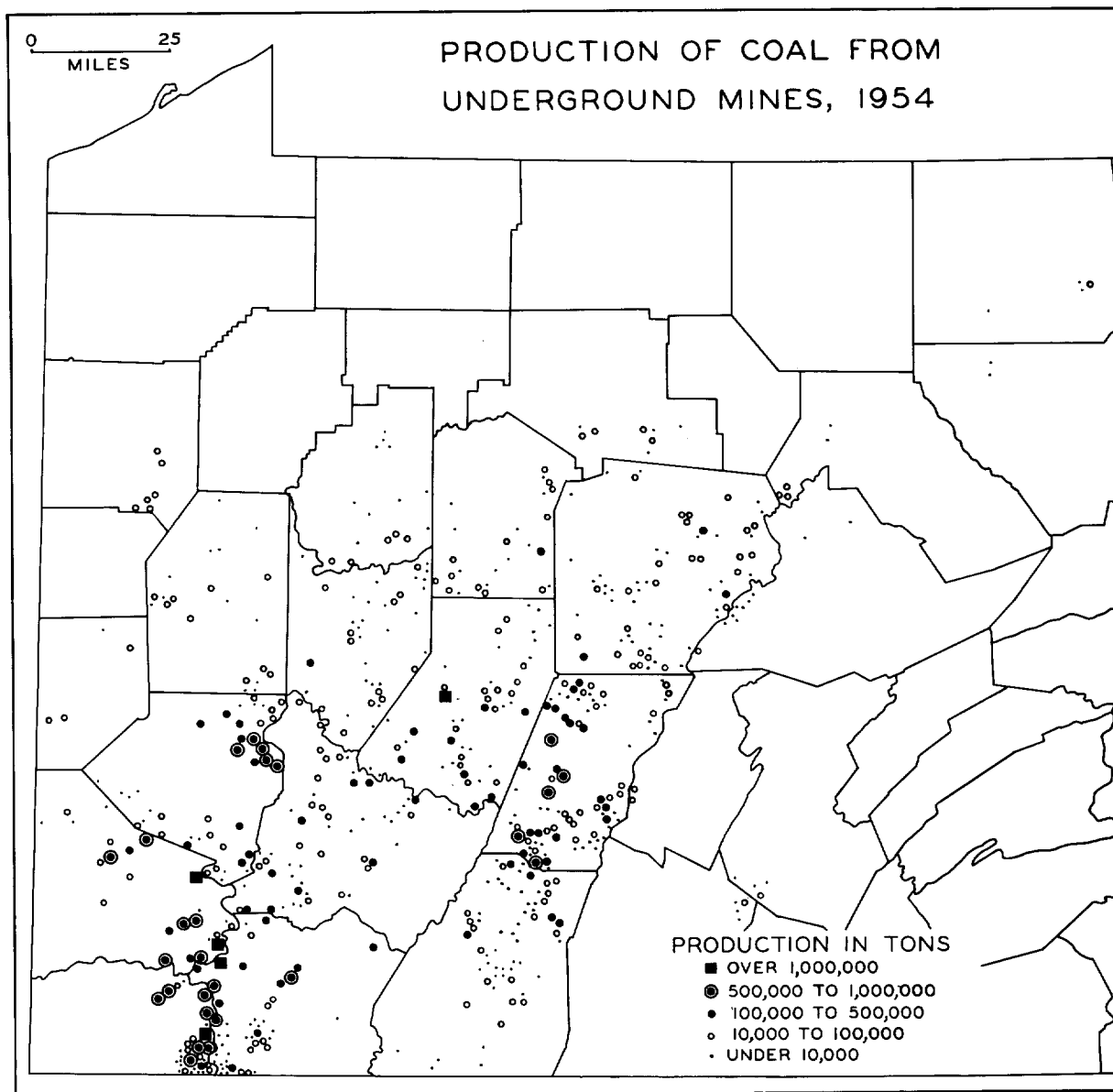
Appendix: Notes 15, 16, and 17. In addition, Note 20 applies to the 1922 map, and Note 5 to the remaining maps.

TOTAL BITUMINOUS COAL PRODUCTION, BY COUNTIES, 1922 TO 1952



Appendix: Notes 5, 15, and 16.

STRIP BITUMINOUS COAL PRODUCTION, BY COUNTIES, 1932 TO 1941



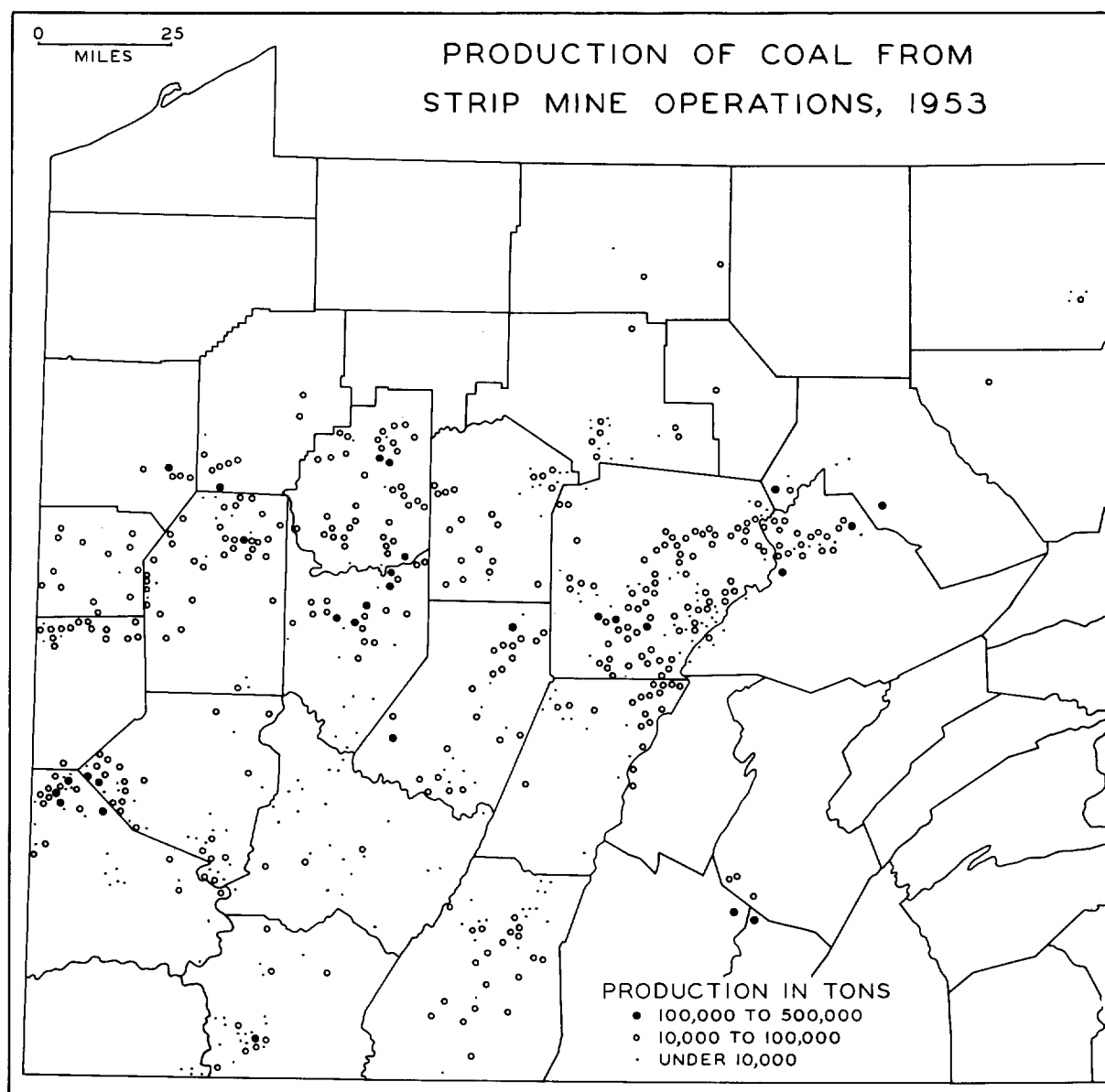
Appendix: Notes 22, 28, 32, and 33.

PRODUCTION

Pennsylvania's underground bituminous coal mining industry is organized chiefly around numerous small-scale producers. Of the 607 deep mines on the above map, only 5 have an annual output in excess of one million tons, and only 26 yield between one-half and one million tons. Sixty-four mines each yield from one-tenth to one-half million tons. All of the remaining 512 mines have yields of less than 100,000 tons a year; i.e., their daily output is on the average only a few tens to a few hundreds of tons. Maximum production from a single mine is somewhat over 4 million tons per year.

Almost all of the large- and medium-scale under-

ground bituminous coal mines of the Commonwealth are concentrated in the southern half of the producing area. Mines yielding over a million tons are limited to Fayette, Greene, Indiana, and Washington counties; and mines producing from one-half to one million tons are confined to the above three counties plus Allegheny and Cambria. Medium-scale mines (one-tenth to one-half million tons) are restricted to eleven counties, a majority of which are in the south. Many of the large- and medium-scale mines are so-called "captive mines," owned and operated by such large coal consuming firms as iron and steel companies and public utilities.



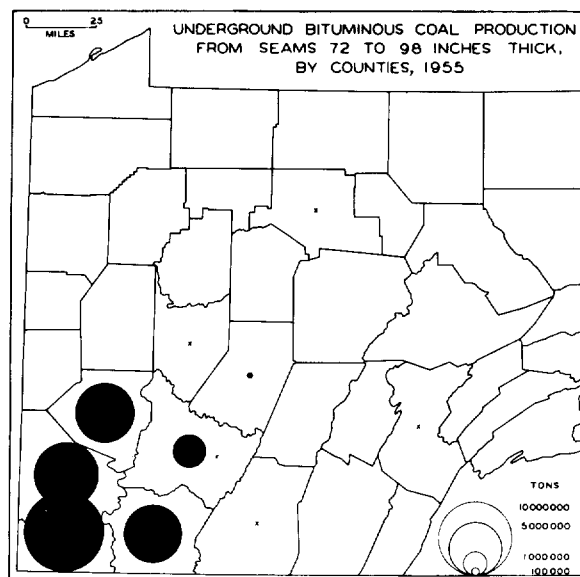
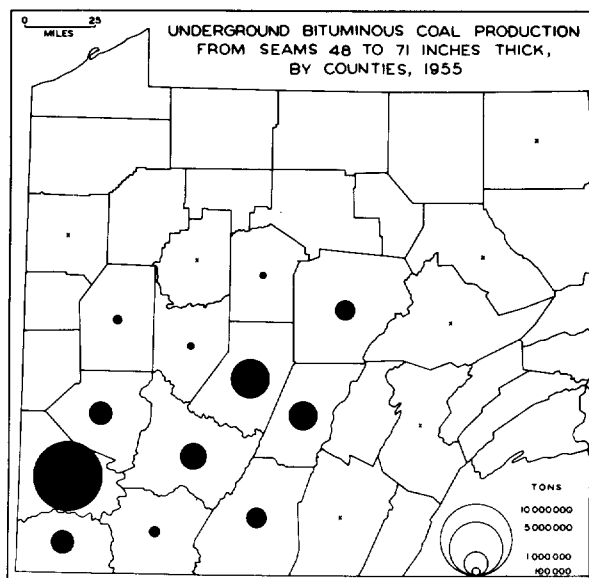
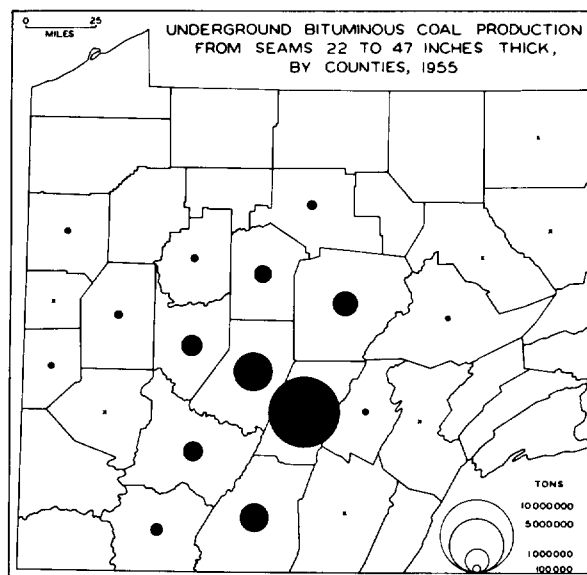
Appendix: Notes 28, 32, 33, and 42.

PRODUCTION

Almost all bituminous coal strip mining operations in Pennsylvania are conducted on a small scale, and none is on a large scale. The greatest annual output from a single pit is under 500,000 tons, and only 29 of the approximately 500 pits in operation produce over 100,000 tons. Most pits produce between 10,000 and 100,000 tons a year; but more than 200 pits yield under 10,000 tons, i.e., have an average workday output of only a few tens of tons.

Most of the Commonwealth's larger strip operations are located in the northern half of the producing area. Greatest concentration of pits is found in an east-west

belt extending from Centre County on the east to Beaver and Lawrence counties on the west. The only significant concentration of larger strip operations outside of this northern belt is the group found in northern Washington County and western Allegheny County. This is in contrast to underground mines, the largest of which are located predominantly in the southern half of the producing area. The small scale of operations at most southern strip pits is due to the virtual disappearance of significant outcrops of economically useable and easily strippable coal in that part of the State.



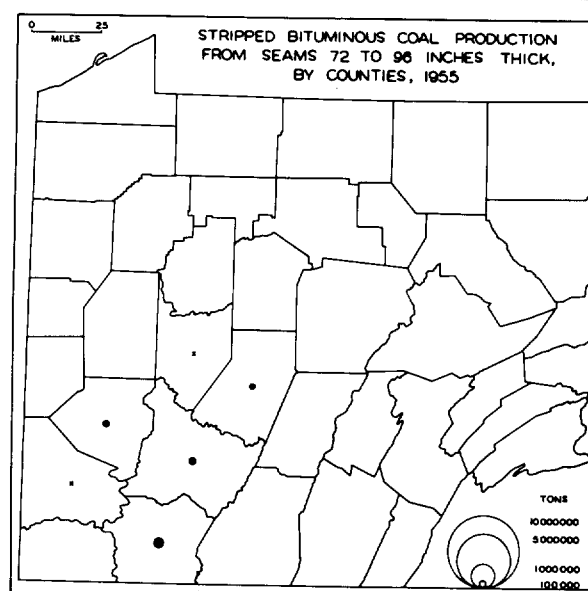
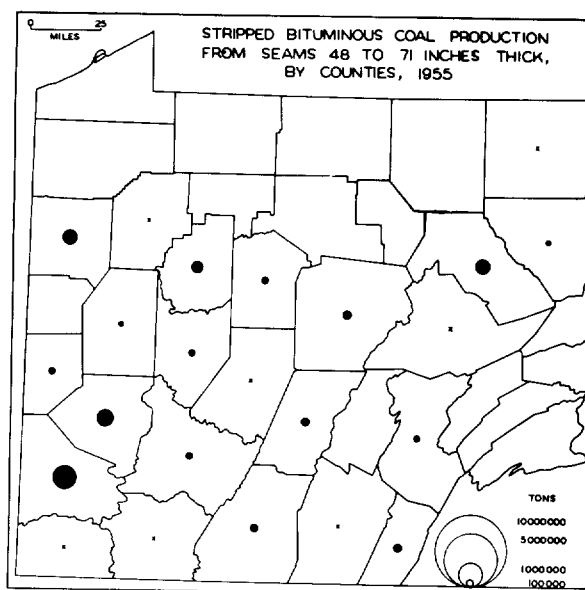
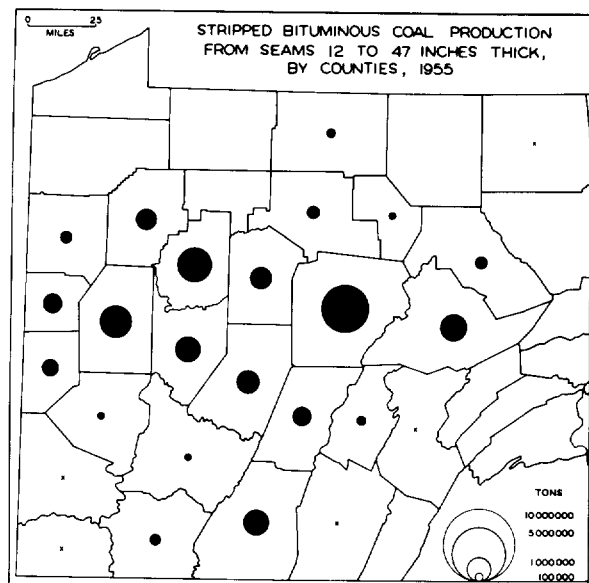
Appendix: Notes 16, 22, 28, 32, and 37.

PRODUCTION FROM UNDERGROUND MINES BY THICKNESS OF SEAMS

Tonnage production, on a county basis, from underground mines utilizing seams of various thicknesses is represented on the above set of maps. Two counties—Cambria and Indiana—rank as major producers of coal from thin seams, although almost every other producing county in western Pennsylvania mines some coal from such seams. Two counties—Indiana and Washington—

are major producers of coal from seams of medium thickness, and in this case also many additional counties yield some coal from such seams.

Five counties—Allegheny, Fayette, Greene, Washington, and Westmoreland—account for almost all deep-mined coal coming from thick seams.



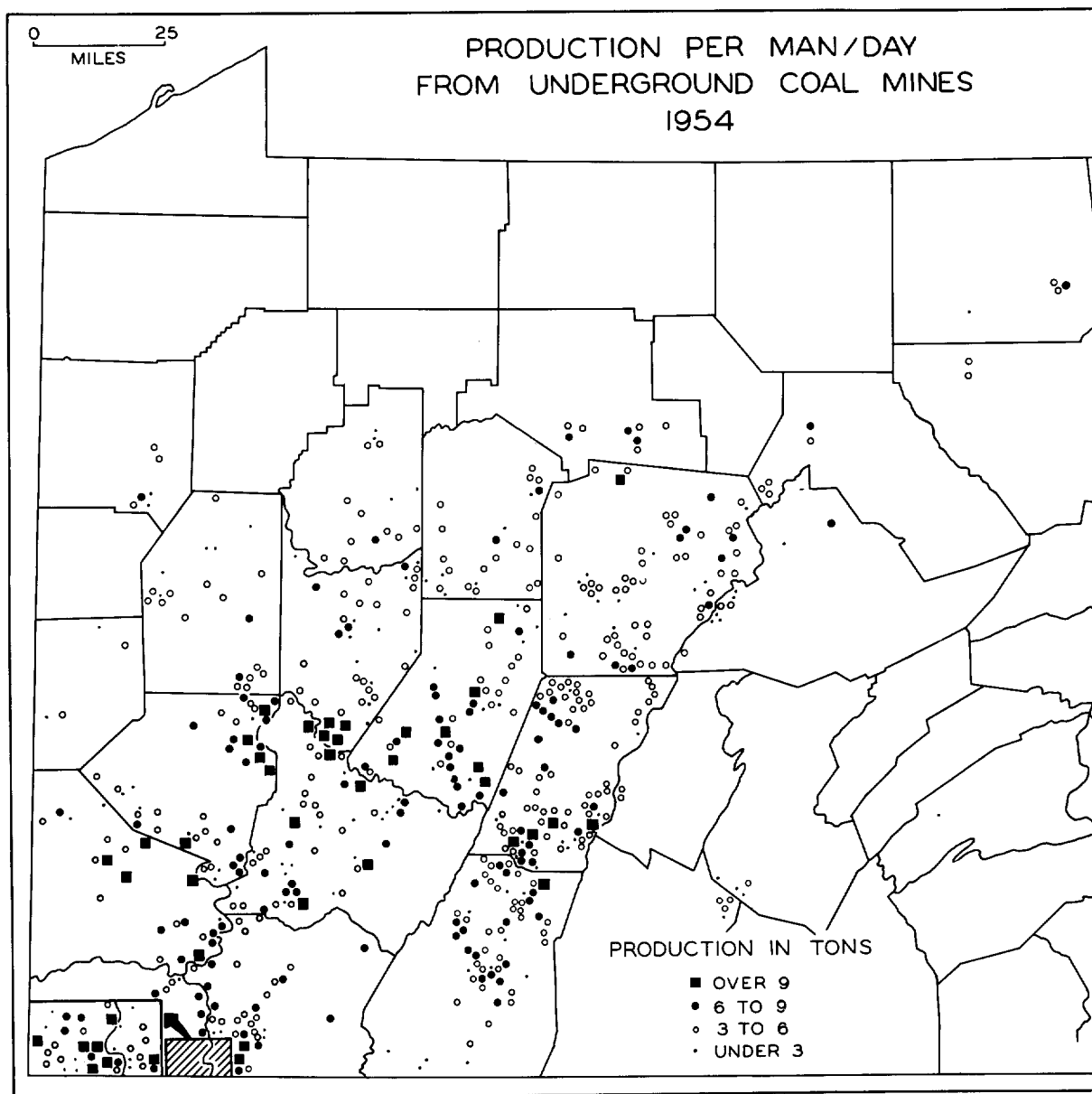
Appendix: Notes 16, 28, 32, and 37.

PRODUCTION FROM STRIP MINES BY THICKNESS OF SEAMS

Tonnage production, on a county basis, from strip mines utilizing seams of various thicknesses is represented on the above set of maps. Every producing county in the State except Fulton and Lycoming produces some coal from thin seams; and three counties—Butler, Clarion, and Clearfield—produce major quantities from such seams. The situation with regard to strip production from medium and thick seams,

however, is markedly different from that for underground mines, for no county produces important amounts of stripped coal from either category of seams.

Medium seams are strip mined in all except four counties; but thick seam stripping is confined to a few counties, mostly those in the southwestern corner of the Commonwealth.



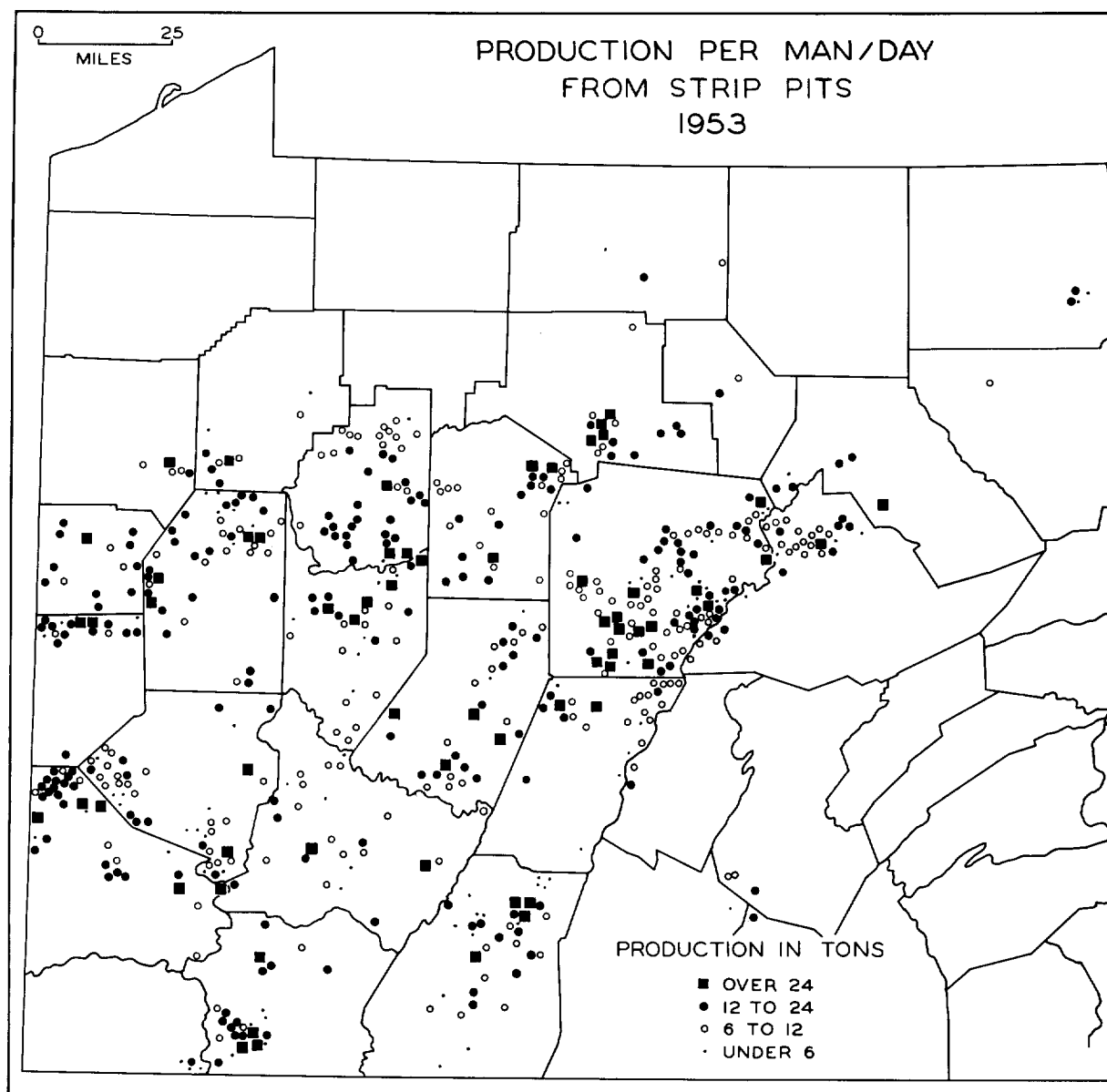
Appendix: Notes 22, 28, 32, and 33.

PRODUCTION PER MAN/DAY

Operating efficiency differs greatly from mine to mine among the underground bituminous coal mines of Pennsylvania. The average output per man/day for all such mines is slightly less than 6 tons, but a few produce more than 20 tons whereas others produce less than 1 ton.

Of the 622 mines mapped above, 128 produce less than 3 tons per man/day, 325 produce from 3 to 6 tons,

125 from 6 to 9 tons, and 44 over 9 tons. Most high-efficiency mines (those in the latter two categories) are located in the southern half of the producing area, where generally thick seams and large-scale mechanized mining operations result in maximum efficiency. Thin-seam mines and small-scale operations, with consequent lower efficiency, characterize the underground mining industry in the north.

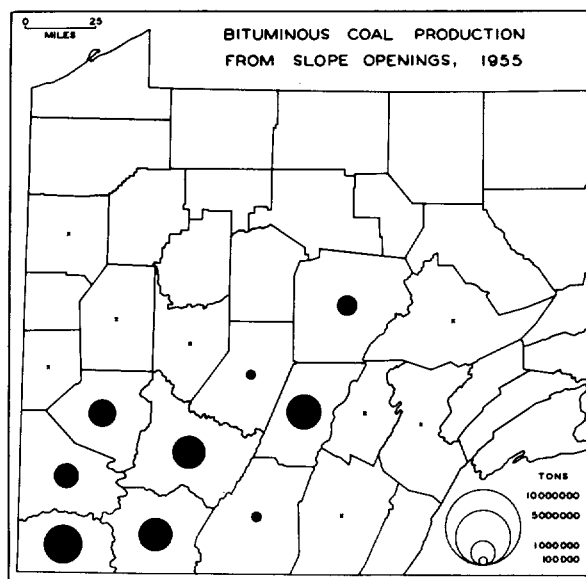
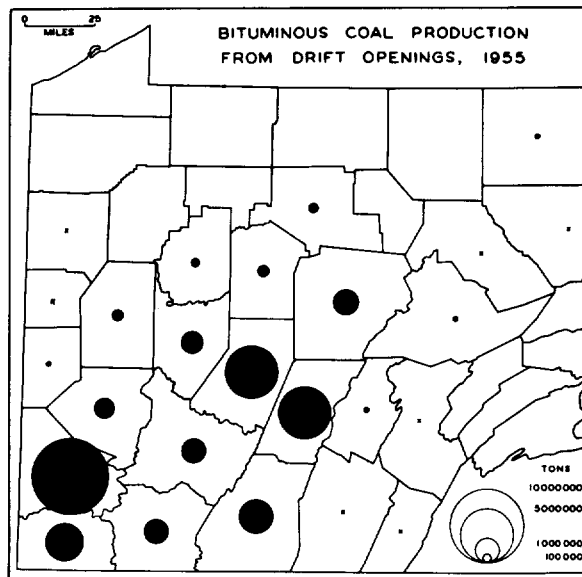
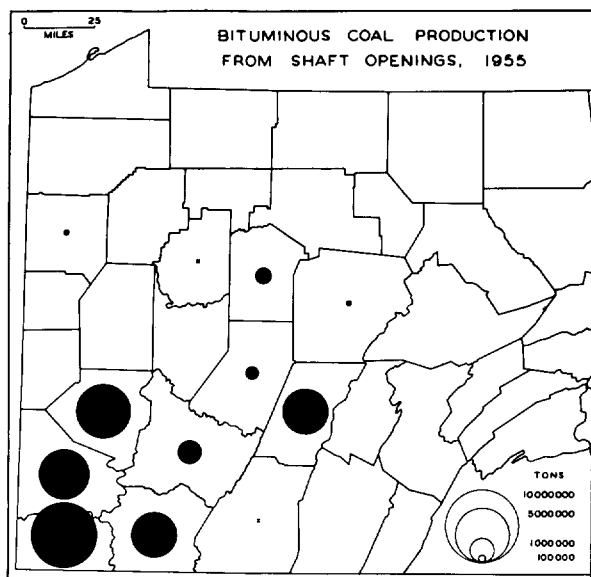


Appendix: Notes 28, 32, 33, and 42.

PRODUCTION PER MAN/DAY

As in the case of underground mines, operating efficiency among Pennsylvania's bituminous coal strip-ping operations differs greatly from pit to pit. The average output per man/day from all strip pits in the Commonwealth is almost 13 tons (as compared with slightly less than 6 tons for deep mines), but a few produce more than 60 tons whereas others produce only a ton or two. Of the 482 pits mapped, 53 produce more than 24 tons per man/day, 179 produce from 12 to 24 tons, 170 from 6 to 12 tons, and 80 less than 6 tons.

Reference to the map above indicates that high-efficiency strip pits (i.e., those in the first two categories) are widely distributed throughout the entire producing area, being found in almost every bituminous coal stripping county in the State. Thus it is evident that stripping can be efficiently practiced under a wide variety of physical conditions and operating procedures. High yields are possible regardless of thickness of seam, nature of the coal, character of overburden, configuration of terrain, or scale of mining operation.



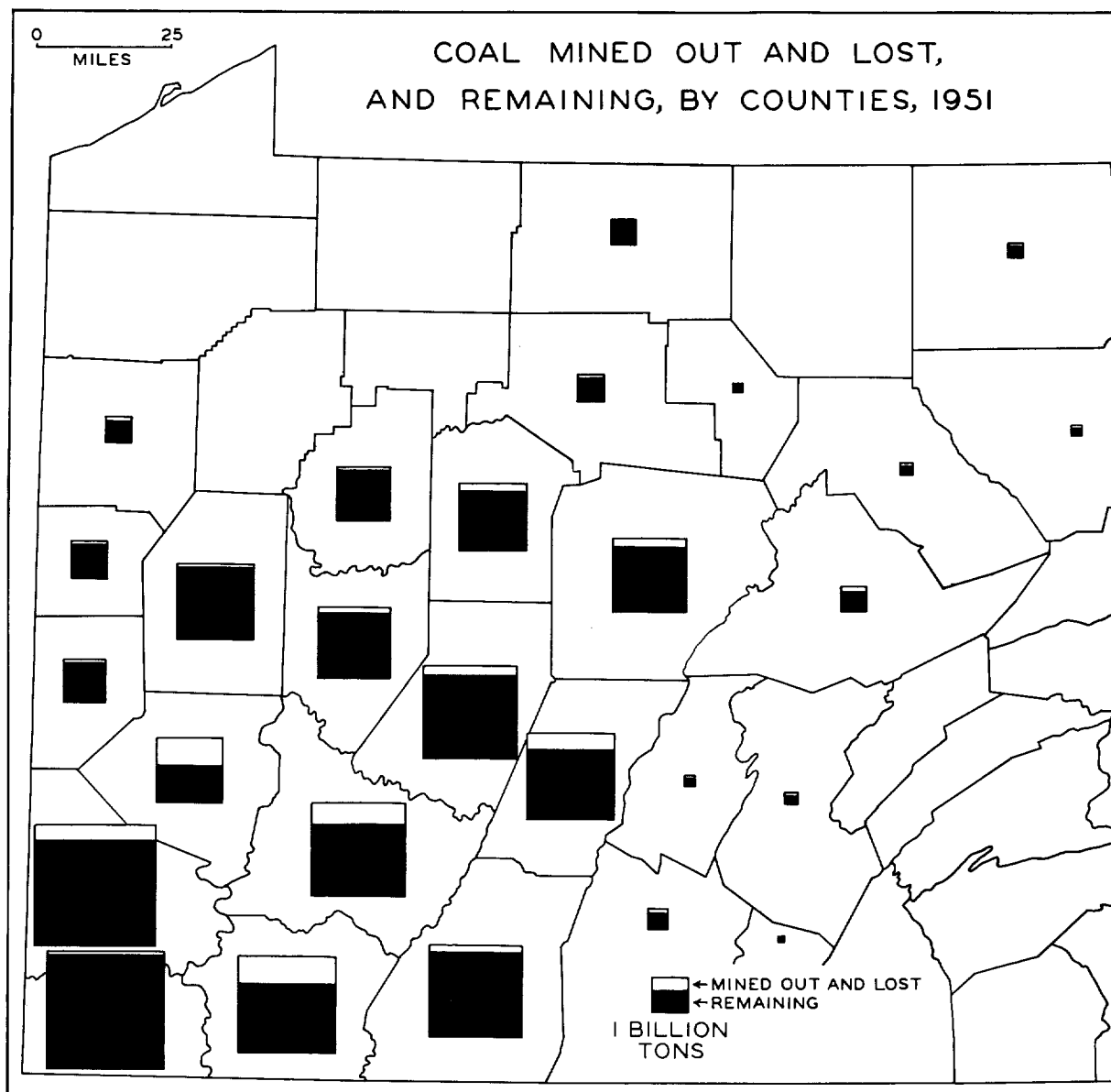
Appendix: Notes 16, 22, 28, 32, 36, and 37.

PRODUCTION FROM UNDERGROUND MINES BY TYPES OF ENTRY

Tonnage production, on a county basis, from underground mines utilizing various types of entries is represented on the above set of maps. Five counties—Allegheny, Cambria, Fayette, Greene, and Washington—stand out as preeminent producers of shaft-mined bituminous coal, with lesser amounts coming from 7 other counties. Three counties—Cambria, Indiana,

and Washington—rank as major producers of drift-mined coal, although every other producing county in western Pennsylvania mines some coal from drift entries.

There are no counties producing large quantities of slope-mined coal, but most produce small to moderate amounts from slope entries.

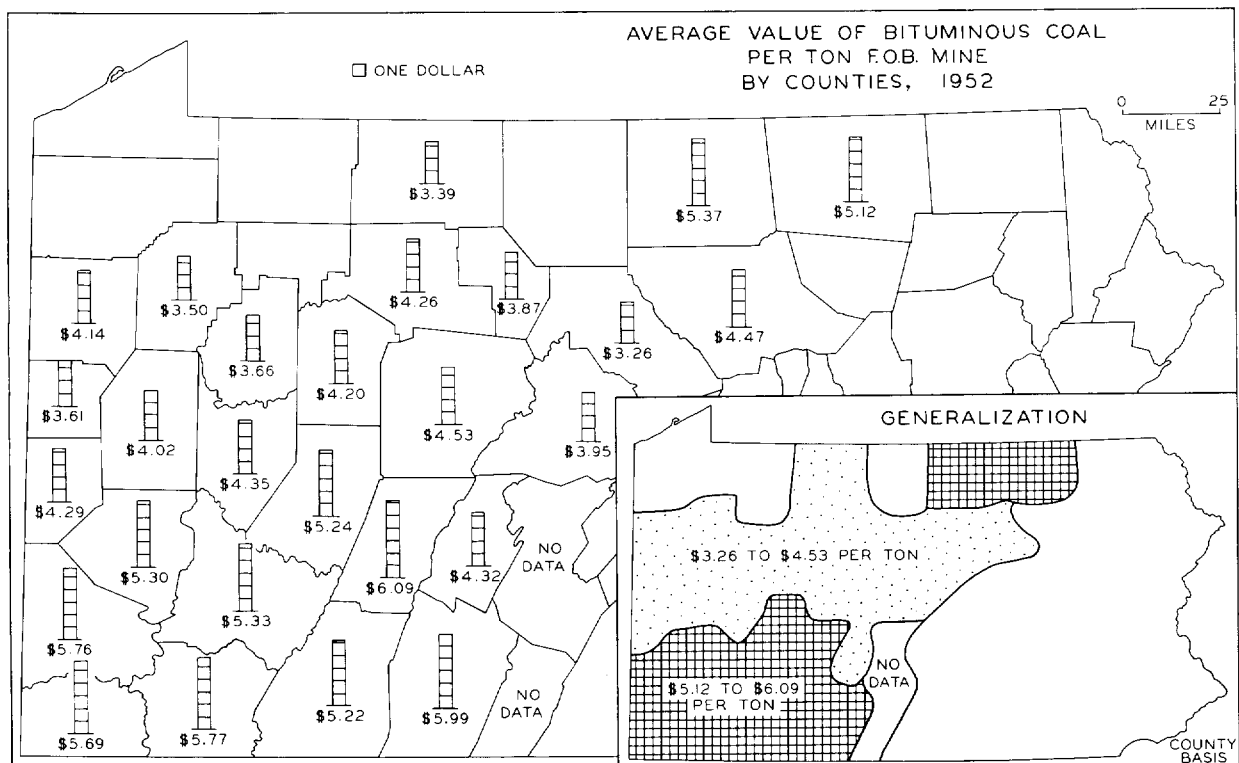


Appendix: Notes 16, 17, 28, and 29.

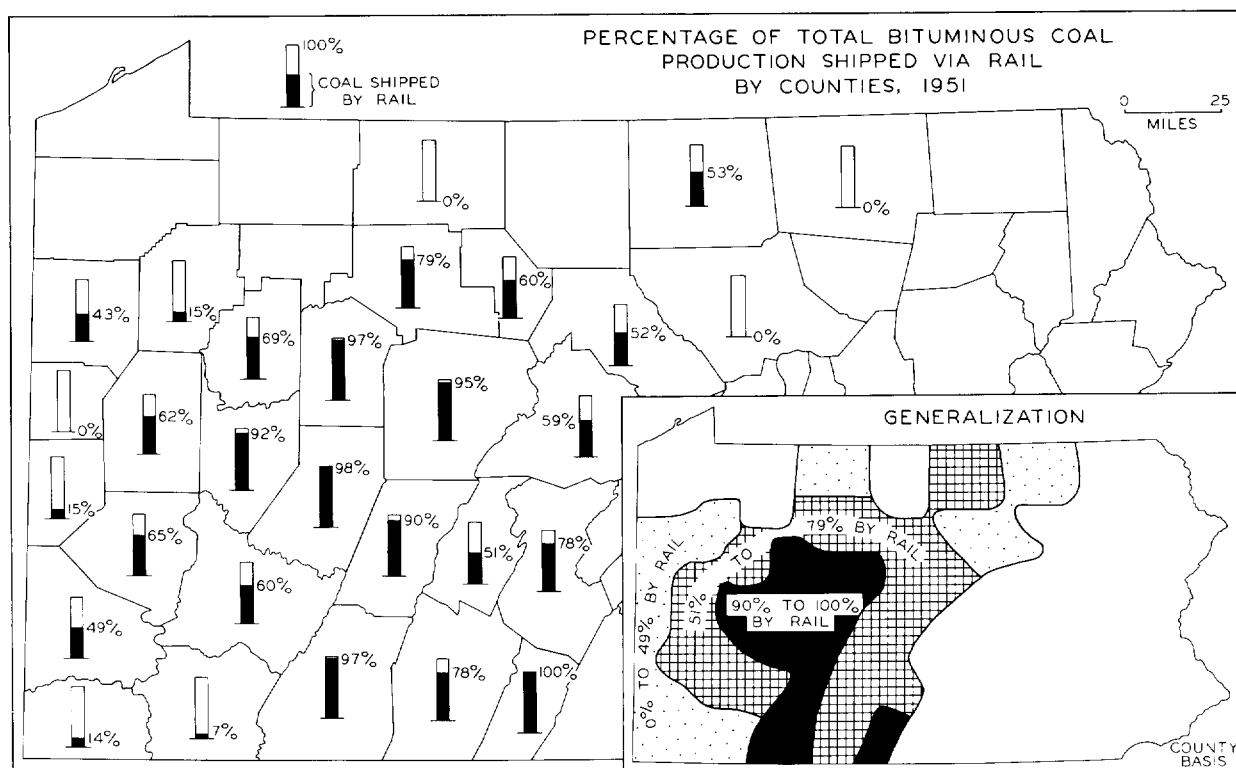
COAL RESERVES

Over one-quarter of the bituminous coal mined out and lost in the United States since the beginning of mining has come from Pennsylvania—over 11 billion tons by 1950. As the above map indicates, most of this coal originated in five counties: Allegheny, Cambria, Fayette, Washington, and Westmoreland. Despite this drain, depletion of the Commonwealth's coal resources is far from complete, for only some 13 per cent of the original reserves are gone. Remaining reserves total more than 75 billion tons, and even in the more heavily mined counties from one-half to three-quarters of the

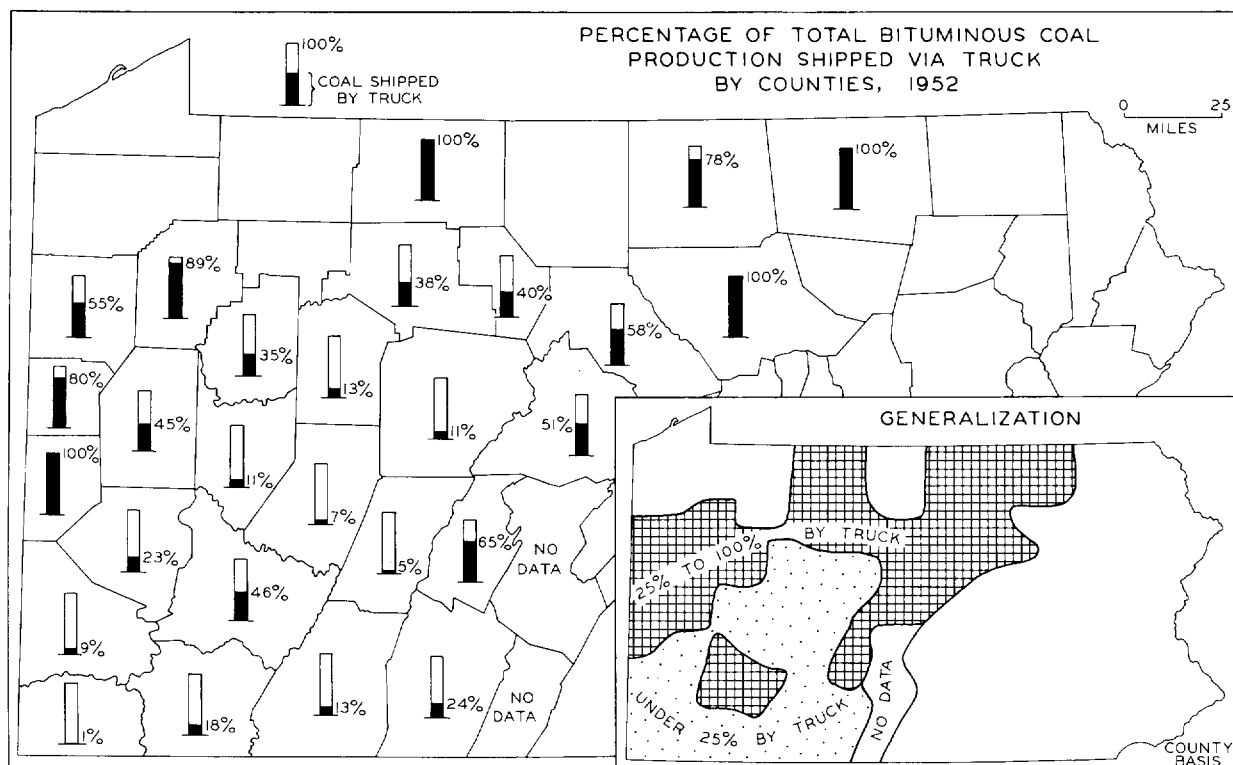
original coal remains. In many other counties over nine-tenths of the original reserves are intact. Much of the earlier mining, however, was carried on in the thicker and hence more easily mined seams, and at places where such seams outcropped and thus were more easily attacked. Also, previous mining tended to utilize the seams with higher quality coals, and those most strategically located with respect to transportation routes and markets. Future mining operations will be handicapped by having to utilize less desirable seams at less desirable locations.



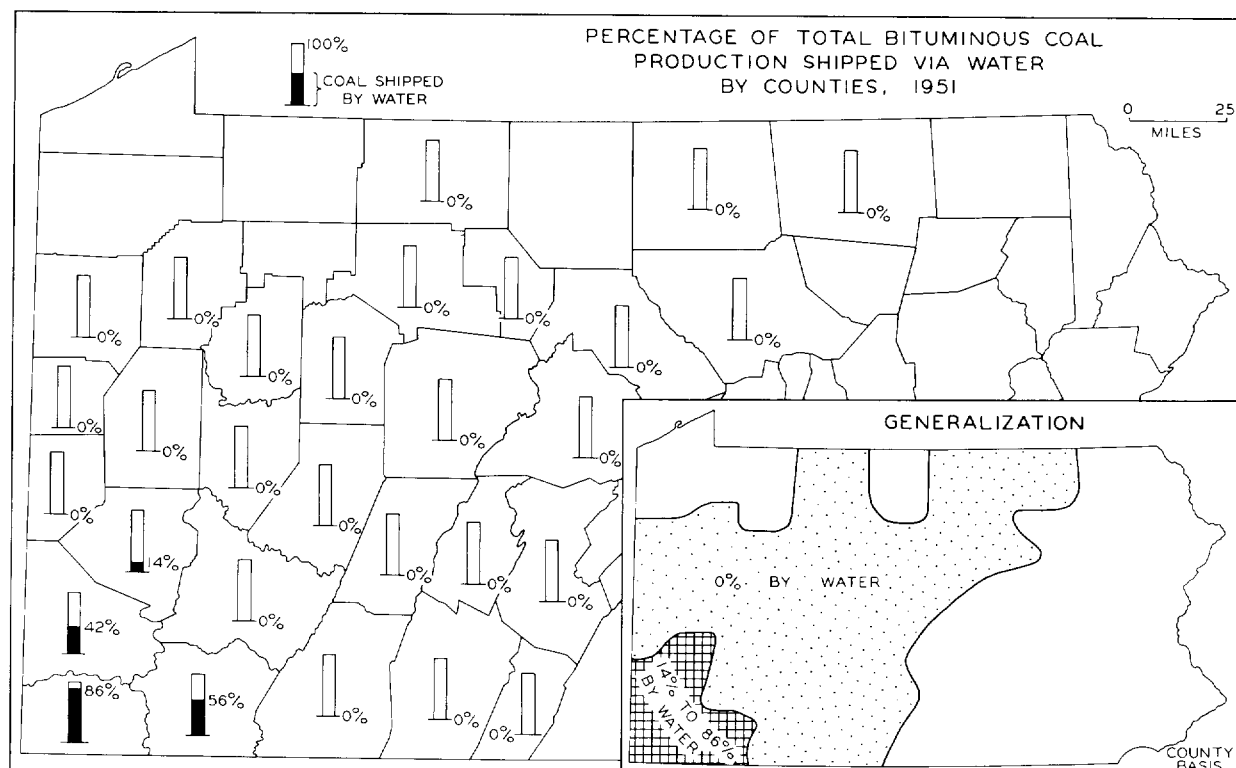
Appendix: Notes 5, 17, and 24.



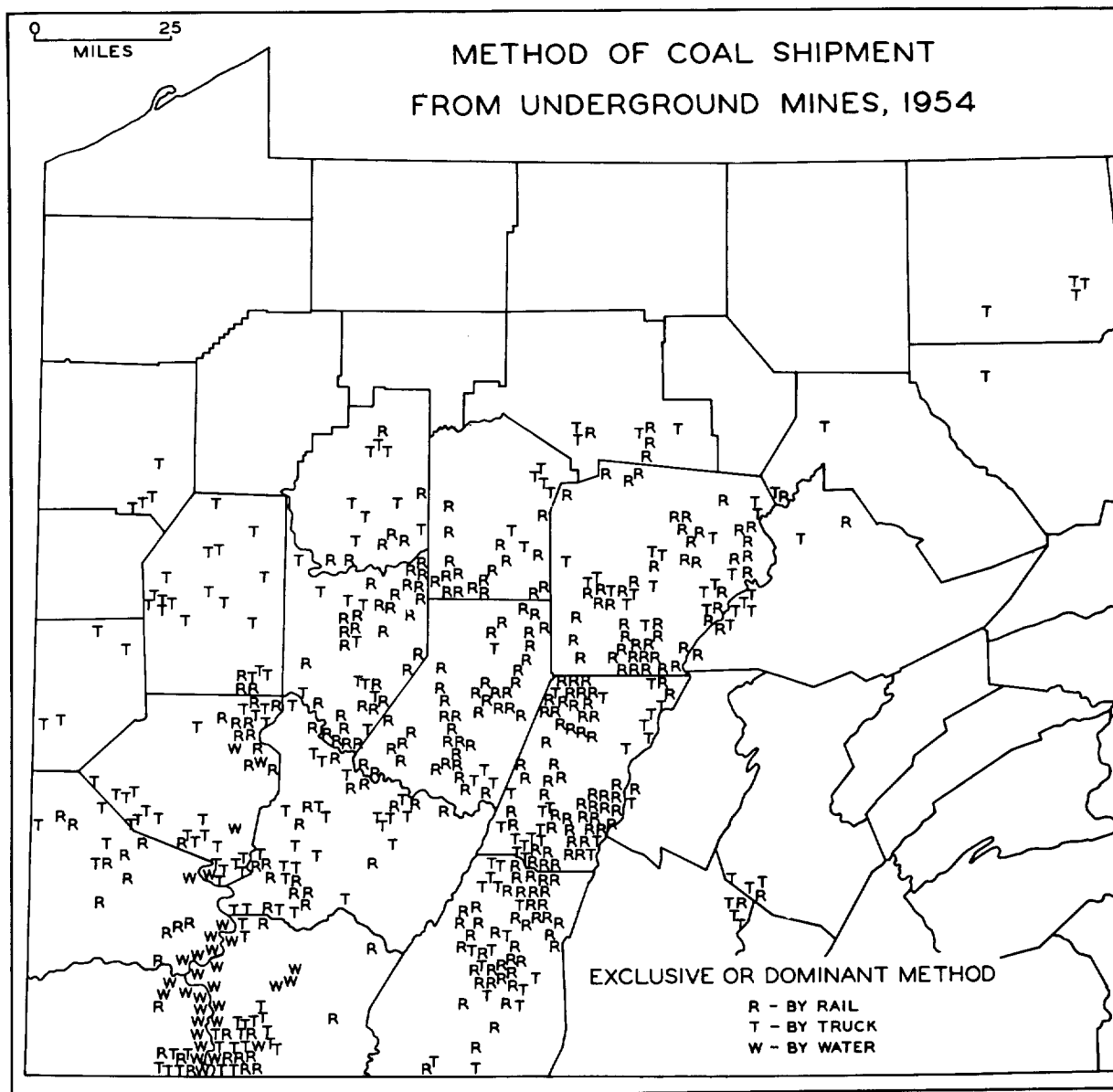
Appendix: Notes 13, 17, 22, and 25.



Appendix: Notes 5, 13, 17, 25, and 26.



Appendix: Notes 13, 17, 22, and 25.



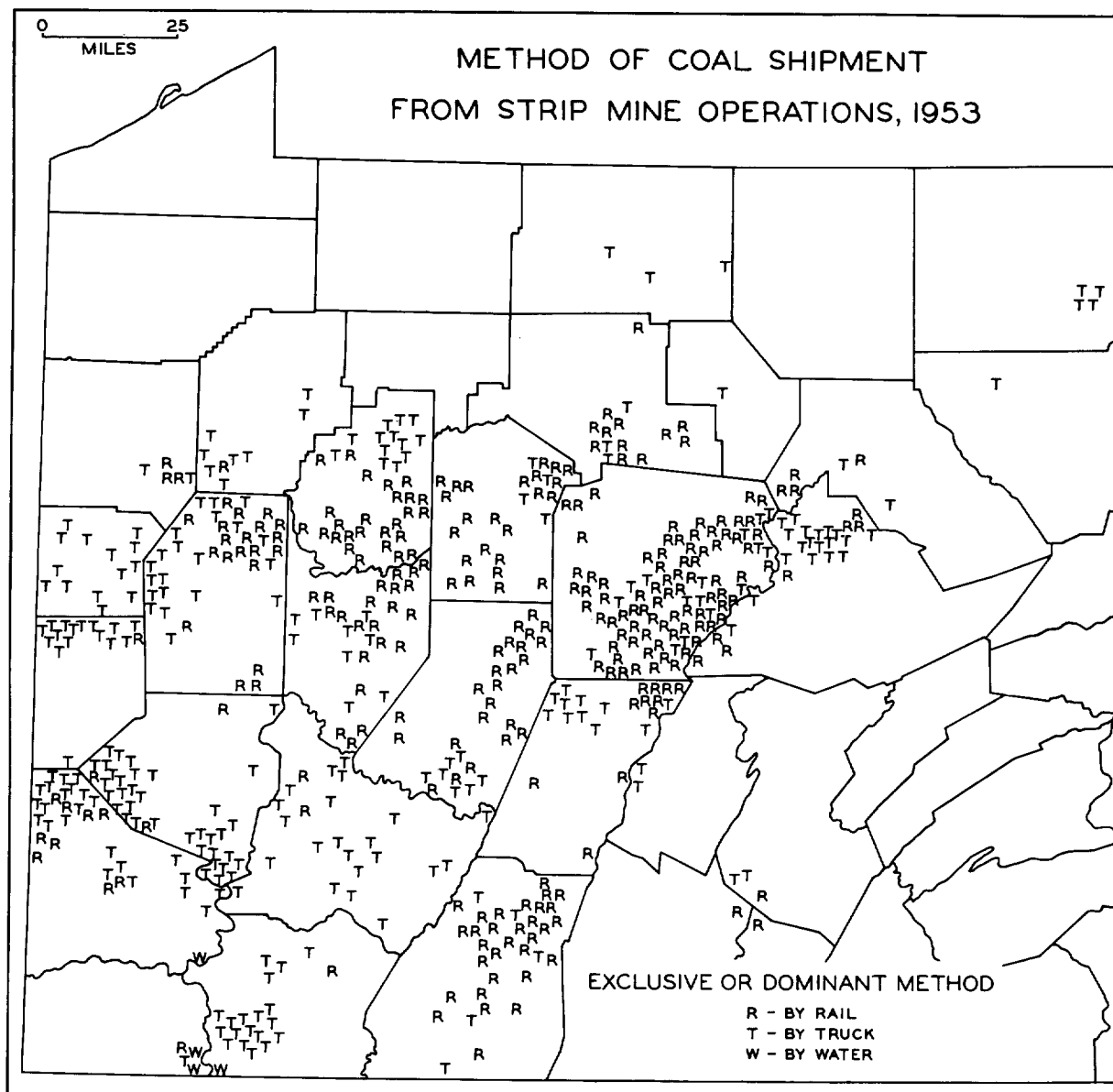
Appendix: Notes 22, 26, 28, 32, and 33.

METHOD OF SHIPMENT

Bituminous coal from Pennsylvania's underground mines is shipped to markets by a variety of methods. During recent decades, truck and water transport have made large inroads into the former almost monopolistic position of the rails.

As the above map illustrates, underground mines chiefly employing water for shipment are limited to some of those situated along navigable portions of the Allegheny and Monongahela rivers and their tributaries,

in eastern Greene, Washington, and Allegheny counties, and western Fayette County. Deep mines shipping predominantly via truck are mostly located in the southern, western, and northern peripheries of the coal producing area. Deep mines utilizing the rails are concentrated primarily in the interior and east-central portions of the producing area, with rails holding a particularly dominant position in Armstrong, Indiana, Cambria, southern Jefferson, southern Clearfield, and northern Somerset counties.



Appendix: Notes 26, 28, 32, 33, and 42.

METHOD OF SHIPMENT

As in the case of underground mines, bituminous coal from Pennsylvania's strip mine operations is shipped to markets by a variety of methods. Of the 553 strip pits mapped above, 284 ship by rail, 265 by truck, and 4 by water. Trucking, therefore, is of considerably greater importance in moving the State's stripped bituminous coal than that obtained underground.

Strip pits using trucks for shipment predominate in

15 counties, which are located mostly about the periphery of the coal producing area. Counties primarily employing the rails are found mainly in the eastern interior, and include especially Armstrong, Clarion, Clearfield, Indiana, and Jefferson counties, as well as Somerset County in the southeast. Strip pits using truck and rail are evenly divided in Cambria County. Only Greene County has a preponderance of pits depending upon water shipment.

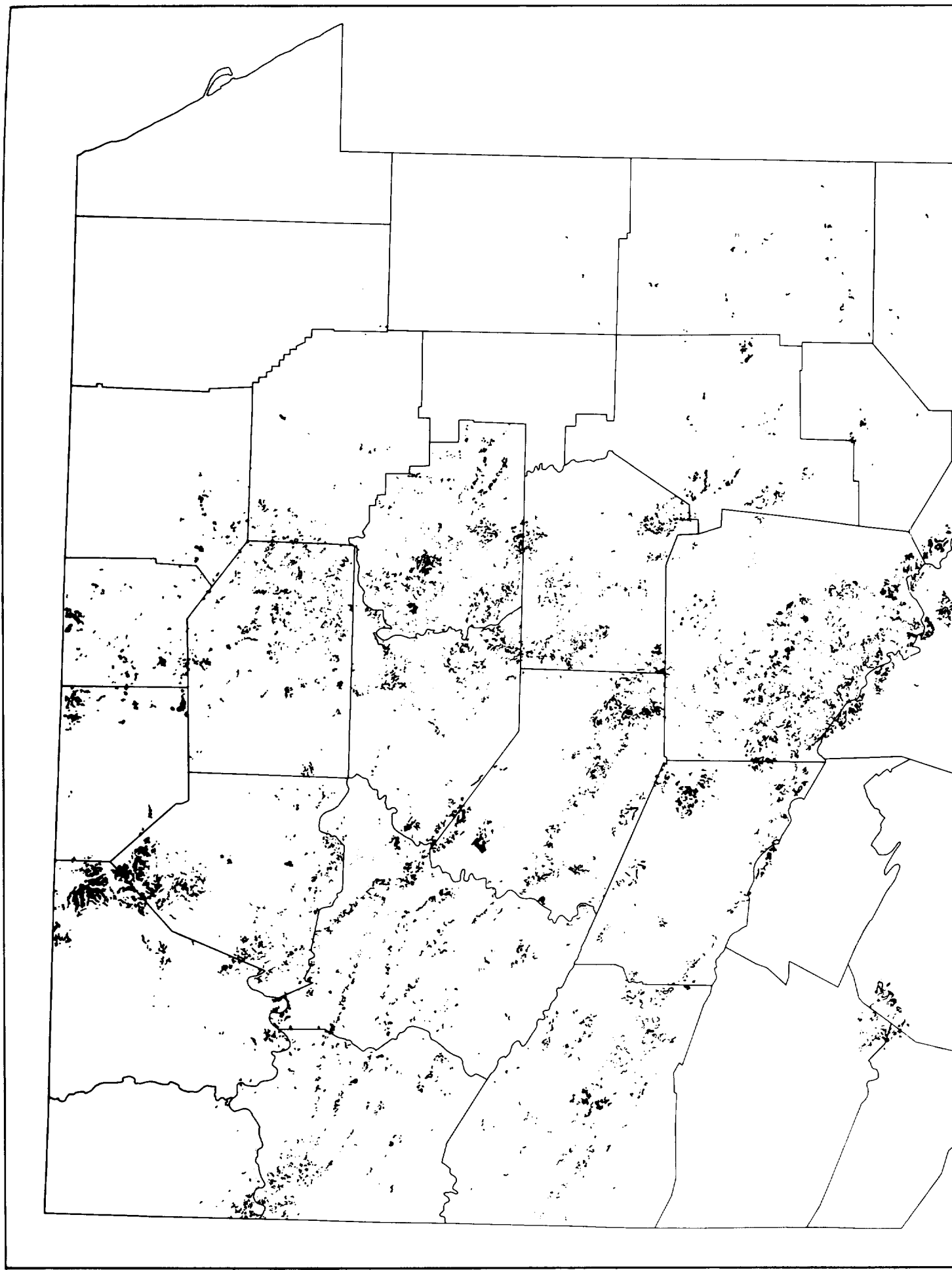
APPENDIX

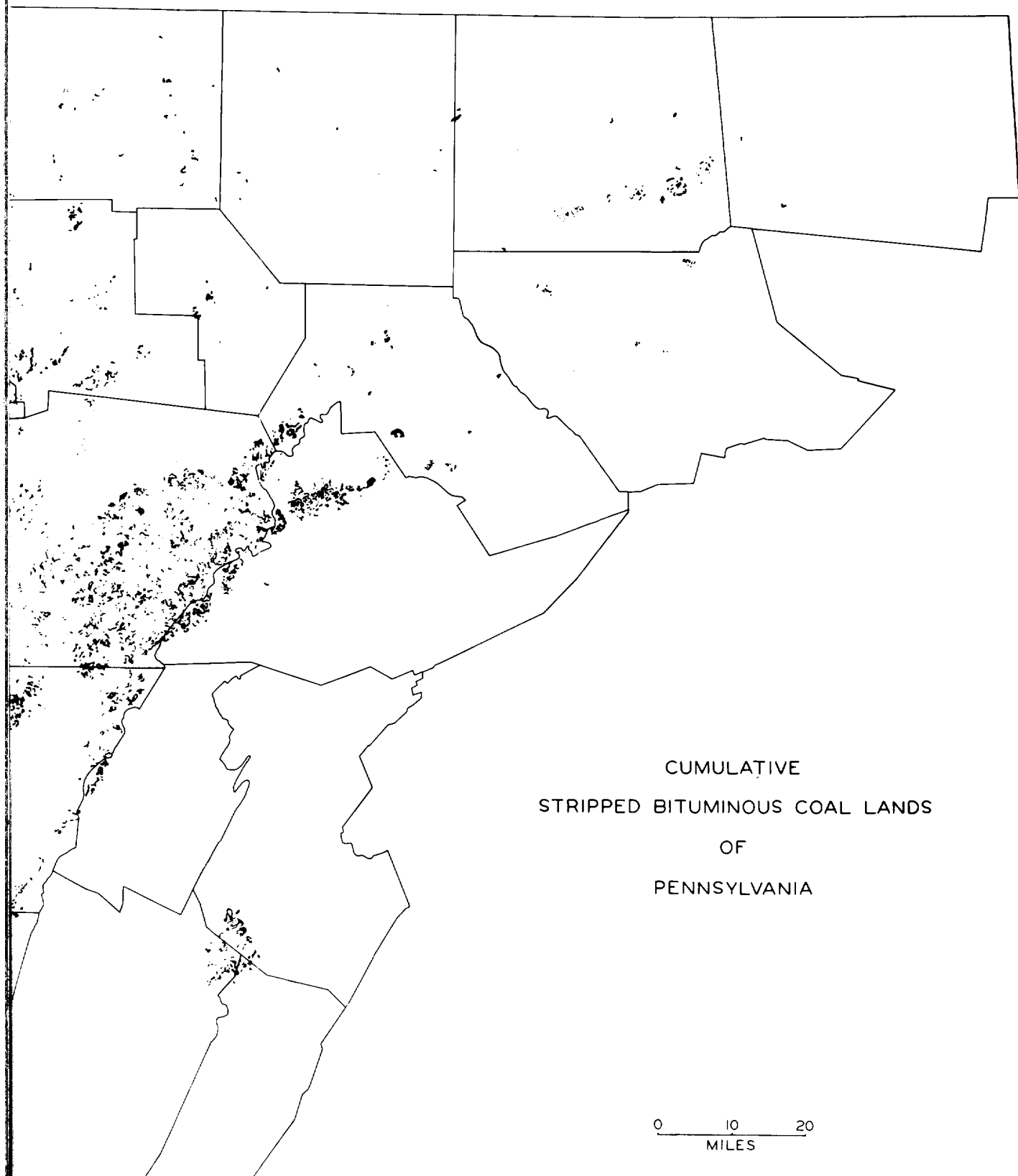
NOTES ON MAPS AND MAP SOURCES

- Note 1. Only bituminous coal producing counties are named.
- Note 2. Includes only the 15 leading states.
- Note 3. Alaska and Hawaii are excluded.
- Note 4. Leading states are those with 1 per cent or more.
- Note 5. Mines producing less than 1,000 tons per year are excluded, except for 1954 when a small percentage of such mines is included.
- Note 6. Total includes some lignite production in New Mexico.
- Note 7. Includes only the 12 leading states.
- Note 8. Leading states are those with reserves exceeding 50,000 million short tons. Includes unrecoverable reserves.
- Note 9. Illinois data are for January 1, 1950.
- Note 10. The term "Mining and Quarrying" does not include petroleum and natural gas production.
- Note 11. The term "Mineral Production" includes coal production.
- Note 12. Data are plotted only for counties having 100 or more employees engaged in mining and quarrying.
- Note 13. Percentages are computed to the nearest whole per cent.
- Note 14. Data refer to coal on a dry, ash-free basis.
- Note 15. Figures are in millions of tons.
- Note 16. No data are available for certain counties having limited production.
- Note 17. Data include both underground and strip mines.
- Note 18. Output from all mines is included.
- Note 19. Output from "small mines" is excluded.
- Note 20. Output from "wagon mines" is excluded.
- Note 21. Includes coal used or sold at the mines.
- Note 22. Underground mines employing fewer than 5 persons underground are excluded. Such mines number in the hundreds, but produce only a few per cent of deep mined coal.
- Note 23. Figures on weeks worked are given to the nearest whole week.
- Note 24. The term "value" indicates price received or charged for coal f.o.b. mine, including selling cost. Coal not sold but used by the producer is included in estimating average value per ton.
- Note 25. Excludes coal used or sold at the mines.
- Note 26. "Coal shipped by truck" does not include coal hauled by truck to railroad sidings or to waterways.
- Note 27. Includes only major non-fatal accidents, i.e., those involving disability of 60 days or more.
- Note 28. Excluding data for Bradford County.
- Note 29. Coal "lost" is coal not recovered in mining or not recovered for other reasons. Of coal remaining, an average loss of 40 to 50 per cent may be assumed. Coal in beds less than 1 foot thick is not included in reserves.
- Note 30. Some mined-out areas on the map are not entirely depleted; these are usually leased to small-scale operators when large-scale mining is no longer feasible.
- Note 31. There is no District 5; the former District 5 was combined with Districts 16 and 23.
- Note 32. No data are available for some mines.
- Note 33. In some instances, data for one of the preceding or succeeding years were substituted when data for the year mapped were not available.
- Note 34. For mines with more than one type of entry, map symbols are crossed.
- Note 35. Shaft depths are the maximum; coal seams shown are the deepest worked.
- Note 36. For a mine having more than one type of opening, production is apportioned according to the numbers of each type of opening.
- Note 37. The symbol X indicates production of less than 37,500 tons.
- Note 38. Dots are placed at, or as near as possible to, the places of employment.
- Note 39. Dots are placed at, or as near as possible to, the mines in which the accidents and fatalities occurred.
- Note 40. Includes all coal except Pennsylvania anthracite.
- Note 41. The symbol X indicates production of less than one million tons.
- Note 42. Symbols represent individual stripping operations. Most mines consist of a single operation, but some mines consist of from 2 to 7 operations.
- Note 43. When two or more seams are utilized at a single operation, the seam yielding the greatest output is plotted.
- Note 44. When two or more seams are utilized at a single operation, the figure represents the average of the thickness of each of the seams utilized.

APPENDIX (continued)

- Note 45. Individual stripping operations employing fewer than 5 persons are each indicated by a dot.
- Note 46. Based on aerial photo mosaics, dated from 1949 to 1957. Includes some clay pits and stone and gravel quarries. Does not include a small percentage of pits that have been reclaimed.
- Note 47. Modified from Ashley, G. H., **A Syllabus of Pennsylvania Geology and Mineral Resources**, Pennsylvania Geological Survey, Fourth Series, Bulletin G 1, 1931, Plate II.
- Note 48. From Sisler, J. D., **Map of the Coal Fields of Pennsylvania**, Pennsylvania Topographic and Geologic Survey, 1929.
- Note 49. From Ashley, G. H., **Bituminous Coal Fields of Pennsylvania, Part I, General Information on Coal**, Pennsylvania Topographic and Geologic Survey, Bulletin M 6, 1928, p. 165.
- Note 50. From Sisler, J. D., **Bituminous Coal Fields of Pennsylvania, Part II, Detailed Description of Coal Fields**, Pennsylvania Topographic and Geologic Survey, Bulletin M 6, 1932, Plates II, III, or IV.
- Note 51. Locations of mine sample sites are approximate.
- Note 52. Data are based on proximate analyses utilizing standardized methods, and in most cases represent composite samples from individual sample sites.
- Note 53. Data refer to coal samples on an as received basis.
- Note 54. Data are based on proximate analyses utilizing standardized methods, and in most cases represent the median of multiple samples from individual sample sites.
- Note 55. From Dutcher, R. R., Fern, J. C., Flint, N. K., and Williams, E. G., **Geological Society of America Guidebook**, 1959, p. 69.





CUMULATIVE
STRIPPED BITUMINOUS COAL LANDS
OF
PENNSYLVANIA

0 10 20
MILES