ABANDONED UNDERGROUND COAL MINES OF DES MOINES, IOWA AND VICINITY

Technical Paper No. 8

Iowa Department of Natural Resources

Larry J. Wilson, Director

December 1989

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Iowa Department of Natural Resources
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INTRODUCTION

Des Moines, Iowa, the state's capital city, is situated within a portion of the state underlain by abundant coal resources. Early in the city's history, local deposits of coal were a readily available source of fuel for homes, industries, and railroads. Eventually, an underground mining industry arose in the Des Moines area and persisted for over 100 years (1840 to 1947). Recorded production totalled 50,965,427 tons from original reserves estimated at 750 million tons in Polk County (Landis and Van Eck, 1965).

Little direct evidence of the once thriving coal industry is visible in the present-day Des Moines area. However, the underground openings left by mining operations continue to cause problems long after mining ceased. Undermined areas remain subject to subsidence (collapse) of the land surface until the mining opening has become stable. Subsidence in an urban area poses varying degrees of risk to people and property affected by the collapse. Incidents of mine-related subsidence have occurred in the Des Moines area and will probably persist.

Documentation of the coal industry survives in the form of surveyed mine maps, published records, and files accumulated by agencies responsible for monitoring and regulating the industry. Although these records are incomplete, partial delineation of the undermined areas and inferences about the local geology can be made from them.

The purpose of this study is to compile information on past coal-mining activity in the city of Des Moines and the surrounding urbanized area. Greatest emphasis is placed on delineating undermined areas and summarizing documentation from the available records. The limits of the study area encompass the most densely populated portion of the Des Moines area affected by undermining and includes all known underground mines in Polk County. Figure 1 shows the location of the study area and identifies the included communities. Surface mines, not included in the study area, were developed in the southeastern part of the county and produced a small amount of coal during the mid-1950s.

This report consists of five sections: 1) a discussion of coal mines and mining in the Des Moines area; 2) a map which shows locations and extents of identified mines superimposed on a map of Des Moines-area streets; 3) a discussion of local geology; 4) a glossary which explains geologic and mining terminology; 5) appendices which list data for each mine and describe sources and compilation of data.

This report comprises the best currently available information on underground coal mines in

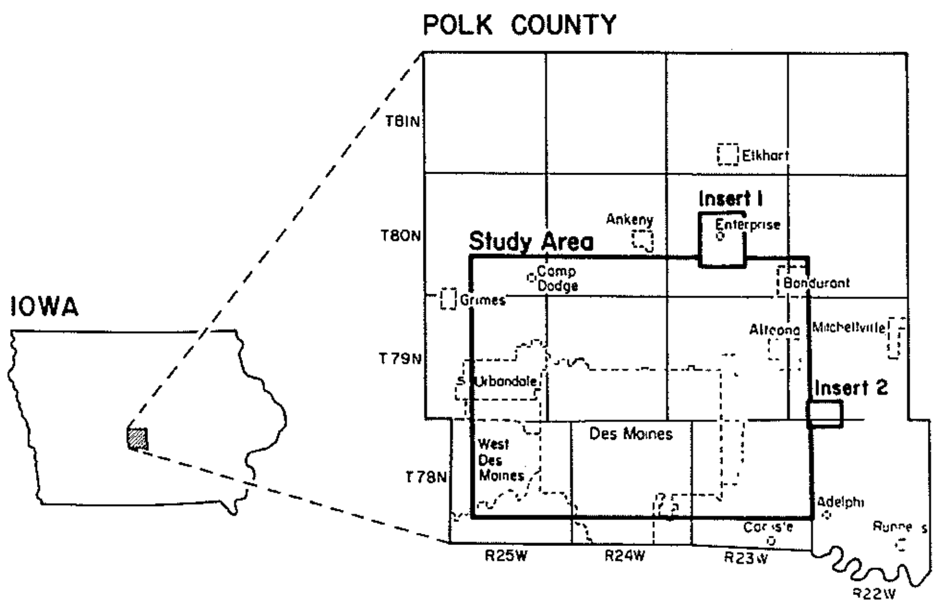

Figure 1. Map showing study area included in this report. Inserts 1 and 2 show the correct locations of portions of the area which were inset to make Plate 1.

the Des Moines area. It includes numerous revisions and additions to the report issued by the Iowa Geological Survey (IGS) in 1979. These refinements were achieved by careful study of a large number of restored mine maps including many which were not previously available. Additionally, use of computer-aided design techniques to prepare the map (Plate I) allowed more accurate transfer of information from mine maps. Caution is advised, however, in using the current report because part of the undermined area cannot yet be delineated due to incomplete or conflicting information.

Documentation of abandoned underground mines, especially in urban areas, is essential for evaluation of potential and existing mine subsidence problems. This report is meant to serve as a reference to known abandoned coal mines, but does not replace mine maps and detailed subsurface geologic data where more specific information is needed. This report serves, secondarily, as a historical reference for what was once an important industry in Des Moines.

SOURCES OF INFORMATION AND RELATED WORK

Preparation of this report was facilitated by results of a number of previous projects. The Des Moines area was included in an inventory of mine-related problems compiled by the Iowa Geological Survey (IGS) from 1979 through 1981 as part of the Abandoned Mine Lands Inventory under contract with the U. S. Department of Interior, Office of Surface Mining. Data for all mines which operated in Iowa were compiled as part of the Mineral Industry Location System under an Iowa Geological Survey contract with the U. S. Bureau of Mines in 1982. Coal mine names, locations, and dates of operation form a large portion of the data. Documentation of abandoned coal mines in Iowa was compiled and organized to create the Iowa Mined Lands Data System as part of a contract with the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, from 1986 to 1988. This compilation of mine-related data and maps provided the information presented in the appendices and Plate I. It is described in further detail in Appendix V.

Recent episodes of mine-related subsidence in southeastern Des Moines were reported by Avcin (1978, 1979) which prompted renewed interest in the abandoned mines underlying the area. In response, Lancaster and Avcin (1979) prepared a map of the Des Moines area published on a limited basis showing outlines of abandoned mines and a compilation of related data. The Des Moines City Engineer's Office modified the map by adding a city street base map and released it in that form.

COAL MINING IN THE DES MOINES AREA

MINING HISTORY

Soldiers stationed at Fort Des Moines about 1840 were the first to mine coal in the area from outcrops along the Des Moines River valley. One of these early mines was located near the Center Street dam on the Des Moines River (Sec. 4, T78N, R24W). However, coal mining did not become an important industry until about 25 years later. The development of coal resources in Des Moines was slowed by an abundant wood supply, unavailability of effective mining techniques, and inadequate transportation (Lees, 1908).

The organization of the Des Moines Coal Company by Wesley Redhead in 1865 marked the beginning of coal mining on a commercial scale. He opened a slope mine north of the city on the west side of the Des Moines River named the Des Moines Coal Co. Mine, indicated as #50 on Plate I. The fledgling coal-mining industry grew steadily and by 1876, 500 men were employed in the mines producing 150,000 bushels (approximately 8,000 tons) of coal annually (Lees, 1908). In 1893, records show there were twenty-three mines operating in Polk County. Twenty supplied coal for the "shipping" market, which implies they were large mining operations. Eighteen were equipped with the latest (for the time) models of steam-powered hoisting engines (Lees, 1908). Most mining activity at this time centered around the community of Sevastapol immediately south of the confluence of the Des Moines and Raccoon rivers. The Pioneer (#92 on Plate I) and Eclipse (#97 on Plate I) mines were major producers at this time.

Des Moines benefitted from the growth of its mining industry. Coal mines provided employment as well as fuel for homes, industries, and railroads. The railroad system expanded in response to the increased availability of fuel and the demand for transportation of the coal to other locations. Railroad spurs were commonly extended to the hoisting shafts of many of the larger mines so that coal could be loaded directly onto rail cars. These large "shipping" mines made Polk County a leading coal producer in Iowa.

Coal production continued to increase with the adoption of more efficient mining methods and the opening of new mines. From 1895 to 1905, over seven million tons were produced in Polk County. From 1906 to 1915, production doubled to over 14 million tons. Unfortunately, the rapid growth of the coal industry was accompanied by increasing numbers of mine-related injuries and fatalities. Early reports (until about 1915) of the State Mine Inspectors' Office include long lists of mining casualties.

Polk County ranked second (Monroe County ranked first) in total coal production during the height of the coal-mining industry. Coal production reached its peak in Polk County (and throughout Iowa) in 1917, when Polk County mines produced 1,880,812 tons of coal and employed nearly 3,000 mine workers. Total coal production for the state was 9,049,806 tons that year (State Mine Inspectors' Report, 1917). United States involvement in World War I was the primary cause for increased coal production. The coal mined in Iowa was shipped to Illinois and Kentucky to replace coal shipped from those states to industrial areas further east for the production of war materials.

Iowa coal production declined sharply with the loss of out-of-state markets after World War I. During World War II, labor shortages and development of new energy sources such as petroleum, hydroelectric, and nuclear power caused the further decline of the coal industry. By 1945, only four underground coal mines remained in operation in Polk County, employing 218 people and producing 128,311 tons of coal. The last underground coal mine in Polk County was the Central Service Mine No. 6 (#45 on Plate I) which closed in 1947.

Hinds (1908), Bain (1896), and Keyes (1894) used data collected from coal mines, coal exploration drilling, water wells, and outcrops to describe three coal seams which reached mineable thickness in the Des Moines area. They were referred to, in descending order, by the informal designations "first vein," "second vein," and "third vein." Some local names such as "Swanwood vein" or "Hastie vein" were used as well. Using this terminology, the historical descriptions suggest that the "first vein" was the smallest producer, probably because it was thin or sporadic in occurrence. The bulk of coal was produced from the "second vein" and "third vein," with the latter most often identified as the mined seam. The informal stratigraphic nomenclature used at the time did not imply that the coal seams were continuous or could be traced across the Des Moines area.

Mining was complicated by discontinuities and irregularities ("faults" in miner's jargon) characteristic of coal seams in the Cherokee Group. "Faults" often limited the extent of mineable coal and contributed to poor roof conditions or intractable flooding problems in the mines. Notes about these problems were commonly added to the mine maps and records as they were prepared.

Multiple-level mining was a common practice where two coal seams in vertical succession reached mineable thicknesses. Upper and lower levels of the mine were usually connected by a shaft or slope, although in some cases they may not have been operated by the same mining company. The Norwood-White mines No. 4 and No. 5 (#8 and #7 respectively, on Plate I) each operated in a different coal seam. A connecting shaft is shown on the maps for these mines.

MINING METHODS

The earliest mines were small drift mines located along streams and river banks and consisted of tunnels dug into an outcropping coal seam. These mines were operated by a few individuals and production was generally low. They were eventually replaced by larger, more efficient operations.

Room-and-pillar mining was the most common method used in the Des Moines area (figure 2). In this method of coal mining, a series of elongate, rectangular rooms were created as the coal was mined. The rooms were separated by pillars of coal left behind to support the roof (overlying rock). Typically, the rooms were arranged at right angles to two parallel corridors which served as haulageways. The parallel haulageways were used to direct movement of miners and coal and as a ventilation system for the mine. This method allowed removal of 40 to 50% of the coal. It was common practice to mine ("rob") the pillars just prior to abandonment to extract the last available coal from the mine. Consequently, less than 50 to

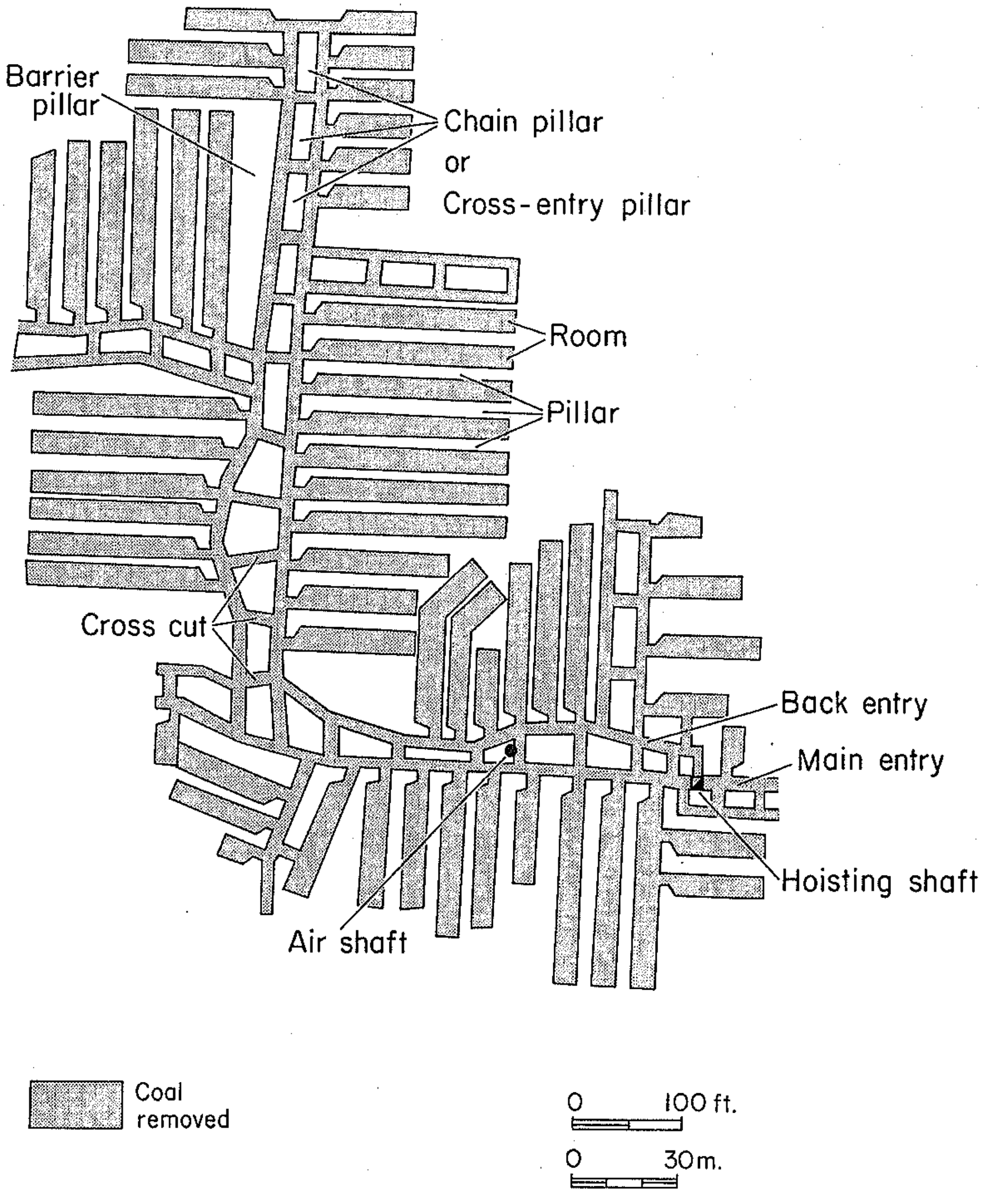

Figure 2. Features of a room-and-pillar mine, the most common method of mining in the Des Moines area. Fifty to sixty percent of the roof area is left supported by coal pillars, although pillar "robbing" decreased the percentage of roof support substantially in some mines.

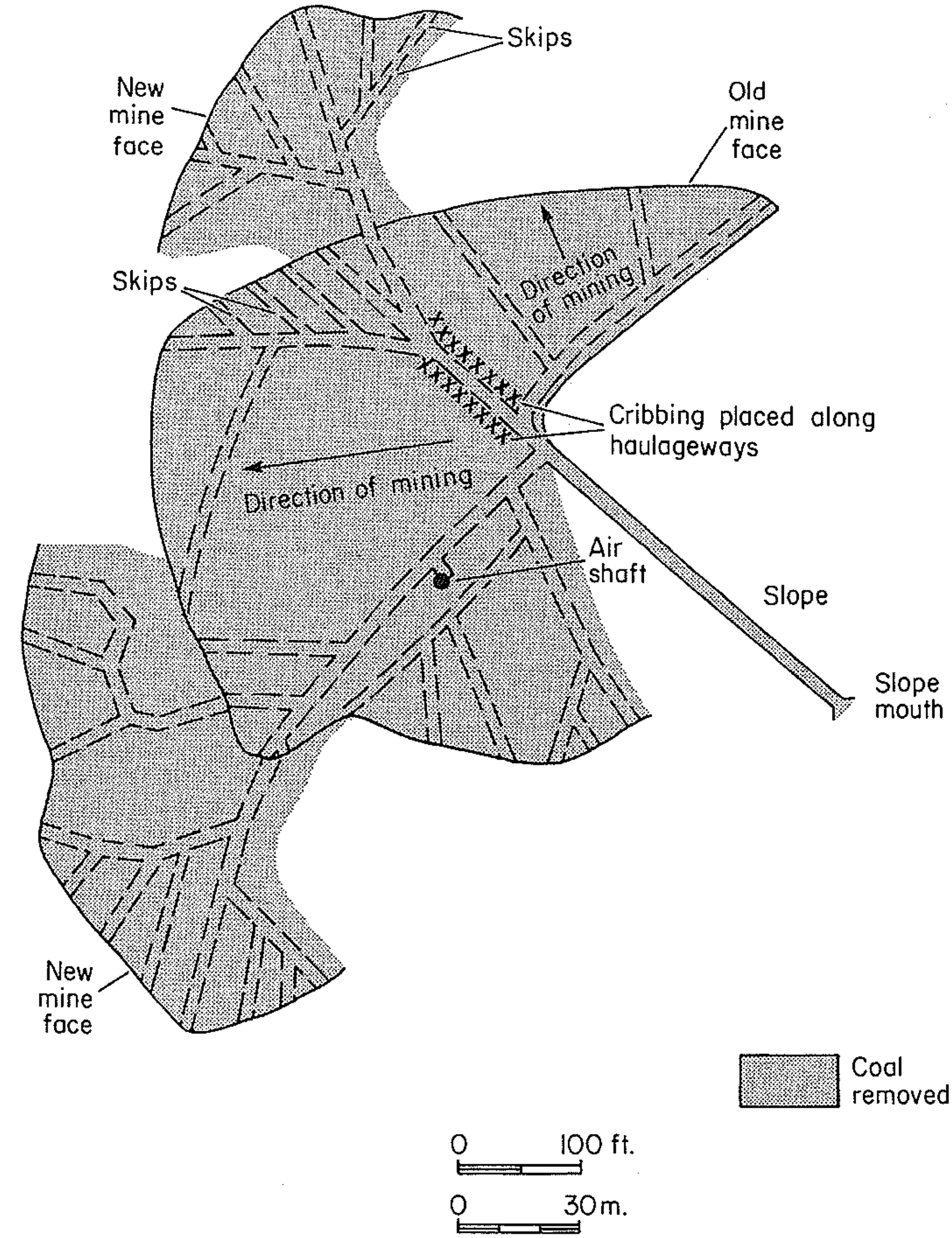

Figure 3. Features of a longwall mine, a method used by a few mines in the Des Moines area where the coal was thin and the roof rock was stable. Nearly 100% of the coal was removed allowing the mine roof to collapse soon after mining. Cribbing (artificial roof support) was installed along the main haulageways to keep them open.

Table 1. Summary of mine site locations and extents.

Type of Information	Number of Mines	Located on Plate I
Mines with known extents	126	
Source of information		
Mine maps	101	yes
State Mine Inspectors' Maps	15	yes
Lease blocks from Annual Reports	10	yes
Mines with unknown extents	96	
Source of information		
Various, location known, extent unknown	34	yes
State Mine Inspector's files, locations, extents unknown	62	no
TOTAL NUMBER OF MINES, ALL TYPES	222	

60% of the roof area was supported when the mine was abandoned, increasing the possibility of roof collapse (Olin, 1965).

Longwall mining was used less often in the Des Moines area, usually as an adjunct to room-and-pillar mining. This method was typically resorted to where the coal seam was too thin to be economically mined by room-and-pillar methods or where the roof rock was exceptionally competent and immediate collapse was unlikely. Longwall mining was much more common in other areas of Iowa such as Centerville in Appanoose County (Howes et al., 1986). In longwall mining, entries were dug outward in a branching pattern into the coal seam and artificial support (usually wood), called "cribbing," was installed along the entries. Then the coal was mined outward from the entries in a fan-shaped pattern (figure 3). Longwall mining allowed removal of 90% or more of the coal.

Most of the mine entrances in the Des Moines area were vertical hoisting shafts, though a few slope entries were dug for shallow coal seams or coal outcrops along the river-valley bluffs. Air shafts were dug in most mines for air circulation and emergency exits.

Coal was mined largely by hand labor when the industry flourished in the Des Moines area. At the working face the coal seam was drilled and the holes were loaded with blasting powder to produce a controlled "shot" (a blast to fracture and loosen the coal). It was then further broken-up using picks and other hand tools. Small coal cars which were pulled by ponies or pushed by men ("pushers") over tracks that ran along the haulageways carried the coal to a central shaft. From there it was hoisted to the surface where it was loaded onto railroad cars or piled for storage. The hoists were powered by steam engines or "horse gins" (Jervis et al., 1951).

ABANDONED COAL MINES IN THE DES MOINES AREA

A total of 222 coal mines operated in the Des Moines area during the period of active coal production. The data available for each mine vary greatly in both quantity and accuracy (Table 1). This study located 160 (shown on Plate I) of the 222 mines and delineated the mined-out extents for 126. Detailed surveyors' mine maps are available for 101 of the locatable mines and are considered the most accurate source of mine locations and extents. Where more than one mine map was available for a mine, the most recent or most extensive was used for mapping. Ideally, this map was drafted after the mine was abandoned, insuring that the outline on Plate I represents the maximum extent of the mine. When these maps were not available, the most recent revisions were used to obtain the mine outline. Measurements from mine maps showed that an area totalling 12,366 acres (19.3 sq. mi.) is undermined by these well-documented mines.

Approximate extents for fifteen mines were obtained from State Mine Inspectors' maps. Comparisons of outlines on these maps with detailed mine maps show that some of the State Mine Inspectors' maps are inaccurate. Therefore, the outlines (Plate I) for these fifteen mines should be viewed as approximate and for this reason they are not included in the total acreage of undermined area. The Western Coal Co. Saylor Mine (#10) is notable because part of its outline was taken from a mine map and part from the State Mine Inspectors' maps. The portion outlined from the mine map was included in the total acreage of undermined land, but the portion obtained from the State Mine Inspectors' maps was not.

The tracts leased by coal companies (lease blocks) outlined in some IGS Annual Reports (e.g., Hinds, 1908; Lees, 1908) were used to show the approximate extents of ten mines. It was not possible to determine how closely the mined areas agreed with the lease blocks; therefore, these outlines should also be viewed as approximations of the actual undermined areas and are not included in the total acreage affected by underground mines.

Thirty-four mines were located for which no extent could be determined. The sources for these included IGS Annual Reports, State Mine Inspectors' Reports, and other unpublished documents. These mines are shown on Plate I as numbered triangles and are included in Appendices I and II. Many of these mines operated before reporting requirements were implemented so it is probable that no maps were filed with the State Mine Inspectors' office. Some of these mines may have been quite large, but their impact on the Des Moines area is difficult to assess because so little is known about them.

Sixty-two additional mines which could not be located were documented for Polk County (Appendix III). The records for these mines lacked location data or contained only vague references such as a post office address. Some of these may represent alternate names for mines which have already been located. Because little is known about them, any assessment of the area they undermined is presently impossible.

As the preceding discussion indicates, the undermined area shown on Plate I is known to be incomplete. The number of mines comprising the well-documented undermined area is 44% of the total number of mines known to have operated in the Des Moines area. The remaining 56% of the total number includes all mines with poorly documented or unknown extents. The total acreage affected by these poorly documented mines is potentially large and their impacts are difficult to assess because so little is known about them.

PART II.

Geology of the Des Moines Area

INTRODUCTION

The geologic setting dictates the location of coal mines, the methods used in mining, and the impact of coal mines on the environment. The following discussion of coal geology is included to further explain the distribution of mining and consequent potential problems related to abandoned mines. An understanding of geologic conditions and processes is not essential to using the abandoned mine map and related information, but is included to provide further information about the area and the mines. A glossary of geologic and mining terms is included at the end of this report to aid the reader.

An economically mineable coal deposit results from a favorable sequence of geologic environments and processes: production and accumulation of peat, burial of the peat to sufficient depth for an adequate period of time to convert it to coal, and uplift of the coal and erosional downcutting of overlying materials bringing it close enough to the surface to be reached by current mining techniques.

Geologic conditions can also affect environmental problems caused by coal mining either during mining or for a period of time following completion of mining. Mine-related subsidence can be delayed or aggravated by physical characteristics of the overburden. Properties of consolidated and nonconsolidated overburden such as permeability, water-table elevation, crushing and shear properties, are complexly interrelated making mine subsidence difficult to characterize. Settling of structures caused by inappropriate construction techniques or instability of surficial material may mimic the subtler effects of mine subsidence in unmined areas or aggravate damage caused by mine subsidence. Under these circumstances, it is often virtually impossible to determine the cause of settling.

GEOLOGIC SETTING OF THE DES MOINES AREA

The bedrock over most of the Des Moines area is assigned to the Cherokee Group of the Pennsylvanian System (figure 4). Small areas of younger Marmaton Group strata are present in the southern and southwestern parts of Polk County (figure 4). In the study area the Pennsylvanian-age strata are separated from underlying Mississippian-age carbonate rocks (e.g. limestone, dolomite) by a major unconformity (Ravn et al., 1984). The Pennsylvanian-age rocks are overlain by Pleistocene glacial tills, loess, and alluvium.

Des Moines and the surrounding area are situated near the northern edge of the Forest City Basin, a shallow Pennsylvanian-age structural basin centered in northwestern Missouri. The result is a gentle regional dip in the strata southwestward toward the center of the basin with gradual thickening of the Pennsylvanian-age rocks to a maximum of approximately 1700 ft. in the southwestern part of Iowa. The maximum thickness of Pennsylvanian-age rocks in the Des Moines area is approximately 450 ft. with the greatest thickness present in the southwestern corner of the county.

DEPOSITIONAL ENVIRONMENT OF THE CHEROKEE GROUP STRATA IN IOWA

The Cherokee Group strata of Iowa were deposited on the shoreline of an ancient sea situated near the equator during Pennsylvanian time (280-310 million years ago). In general terms, deposition occurred on large river-delta complexes. The dominant process in this environment is transport and deposition of sediment by fresh-water streams draining from the continental landmass into relatively shallow seas creating an environment favorable for establishment of coastal swamps. Deposits formed in this fluvial-deltaic environment are typically nonmarine clastic sediments (e.g. mud, sand) derived from the landmass. The deposits are usually lenticular and exhibit rapid lateral variations both in lithology and thickness. The nonmarine deposits are interbedded with sparse, lenticular marginal marine sediments, deposited in brackish water, gradational to marine shales and limestones, deposited in seawater. A tropical climate provided an ideal environment for lush plant growth while the depositional environment determined the type and amount of peat which accumulated as well as the impurities incorporated with the plant matter. Topographic relief was very low and the water table was at or near the land surface during deposition. Eustatic (region-wide) sea level changes exerted a strong influence on deposition in this environment by raising and lowering stream base levels and the

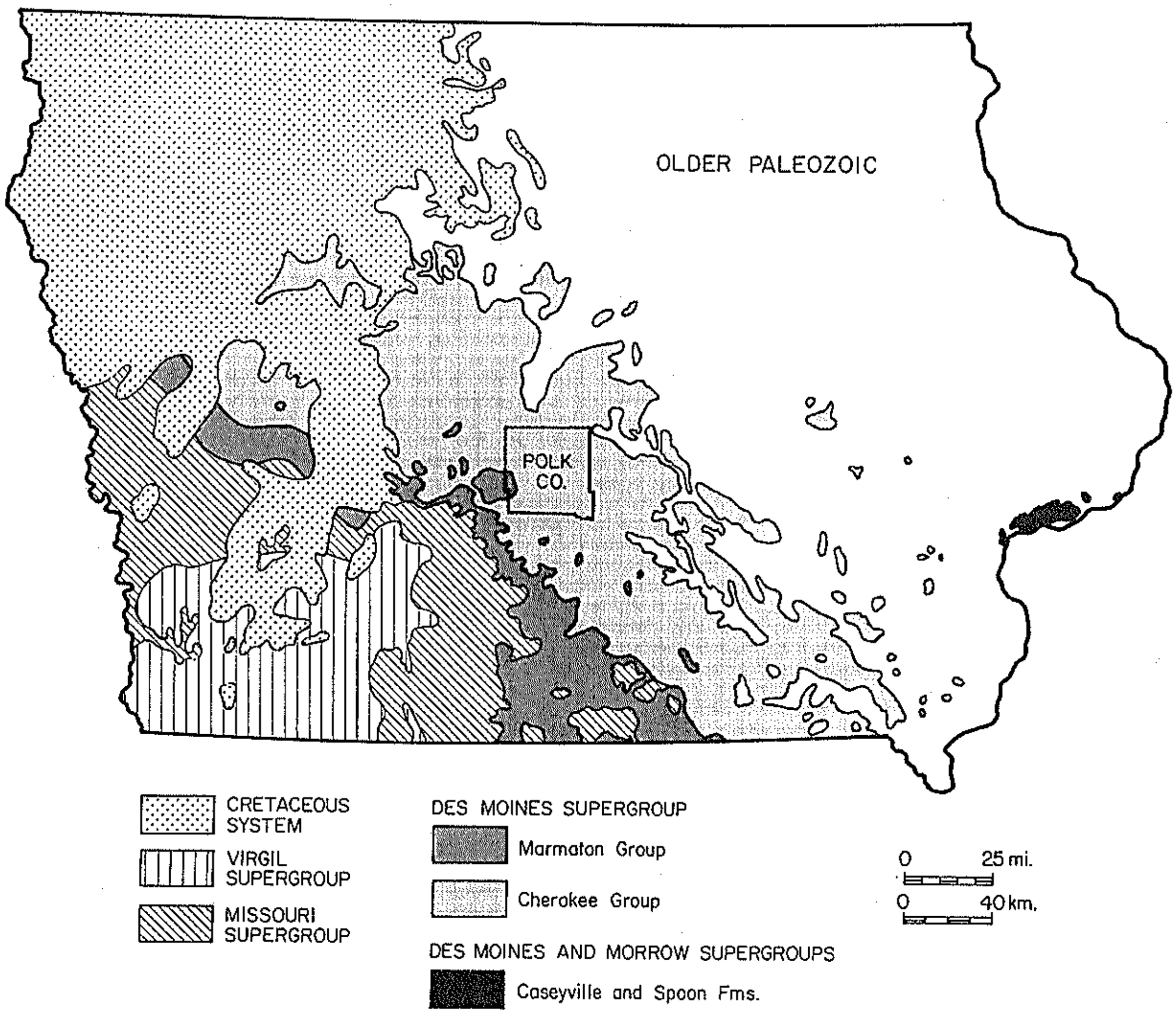

Figure 4. Bedrock geologic map of Iowa showing distribution of Pennsylvanian-age rocks. Pennsylvanian strata are absent in the area marked "Older Paleozoics" which combines all older strata. The Cretaceous overlies and obscures the Pennsylvanian in western and northwestern Iowa. Unconsolidated Pleistocene deposits cover the bedrock throughout the state.

water table. The high water table and poor water circulation provided favorable conditions for the preservation and conversion of the plant material to peat. Later a large influx of sediment buried the peat initiating the changes that ultimately produce coal. Conversion to coal proceeded over a period of time as depth of burial increased. The cumulative effects of burial depth and time determined the coal rank. Circulating groundwater precipitated additional impurities in coal fractures during burial including pyrite, sphalerite, calcite, quartz, and clay.

Horne et al. (1978) suggested a model for depositional environments of coal in fluvial-deltaic settings based on extensive studies of drill hole data and outcrops in the eastern United States. Figure 5, adapted from that work, illustrates the type of setting which may have produced many of the Cherokee Group coals. Note the lenticular coal beds which are limited in extent by channels filled with clastic sediments (mud, silt, and sand). The small embayments between the channels would allow the development of small amounts of

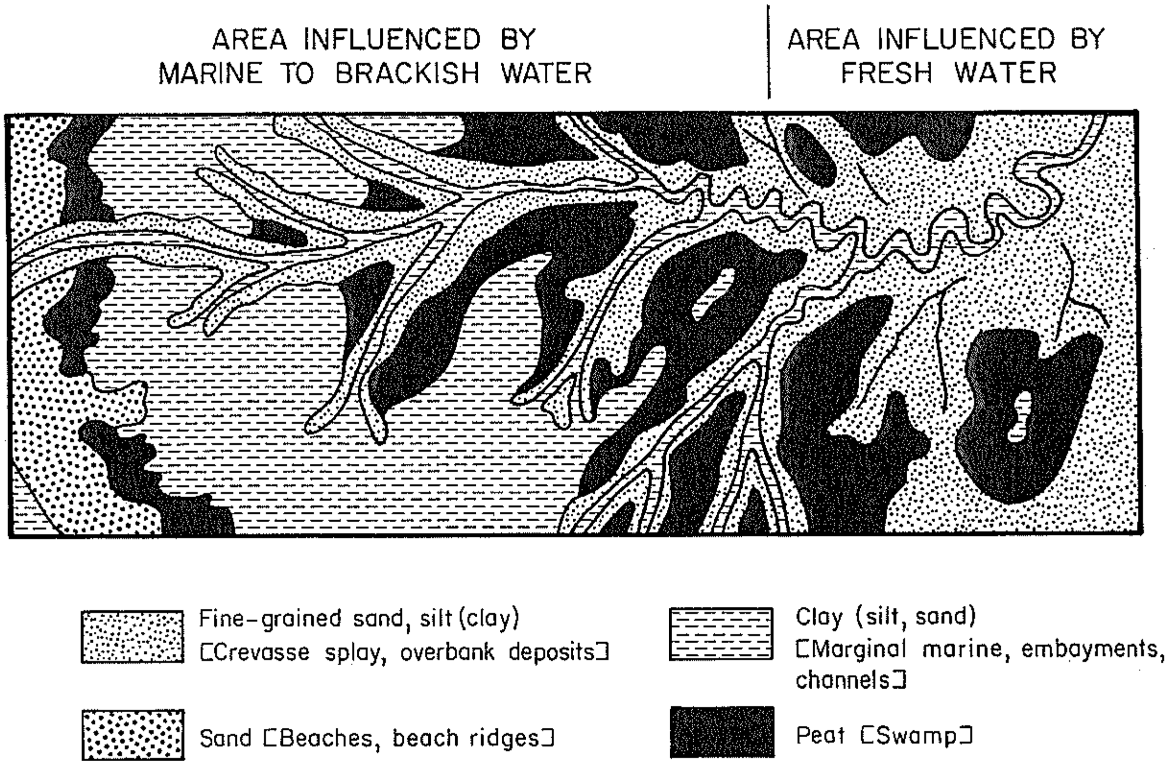

Figure 5. Depositional model of a peat-forming environment on a river delta in a coastal region. Sediments are predominantly nonmarine clastics, although small deposits of impure marine limestone may form in areas away from stream mouths (after Horne et al., 1978). Iowa coal deposits formed in similar environments.

marginal marine grading to marine sediments. Evidence of marine deposition in the Des Moines area is preserved as fossiliferous shales and limestone in outcrop and other subsurface.

STRATIGRAPHY OF THE DES MOINES AREA PENNSYLVANIAN STRATA

Comparisons of the descriptions in Hinds (1908), Bain (1896), and Keyes (1894) with recently obtained geologic and palynologic evidence suggest possible equivalences between the informal designations used in the past and currently accepted stratigraphic nomenclature. All coal seams known to occur in the Des Moines area can be assigned to the Cherokee Group of the Pennsylvanian System (figure 6). In the Des Moines area, and over most of the Midcontinent Region, the Cherokee Group consists predominantly of nonmarine shales, siltstones, and sandstones interbedded with coal seams and thin, discontinuous marine shales and limestones. The marine strata form a progressively larger, although still minor, component of the Cherokee Group strata from base to top. The coals typically become thinner upward and also become more persistent laterally and more uniform both in thickness and quality. Marmaton Group strata, which overlie the Cherokee Group, have been identified in western Polk County. These younger strata include a larger marine component than the Cherokee Group and elsewhere in Iowa include significant coal resources (the Mystic Coal). No significant reserves of this coal have been identified in Polk County. Ravn et al. (1984) and Ravn (1986) provided detailed discussions of Pennsylvanian stratigraphy and geology in Iowa. Swade (1985) discussed the geology and depositional environments of upper

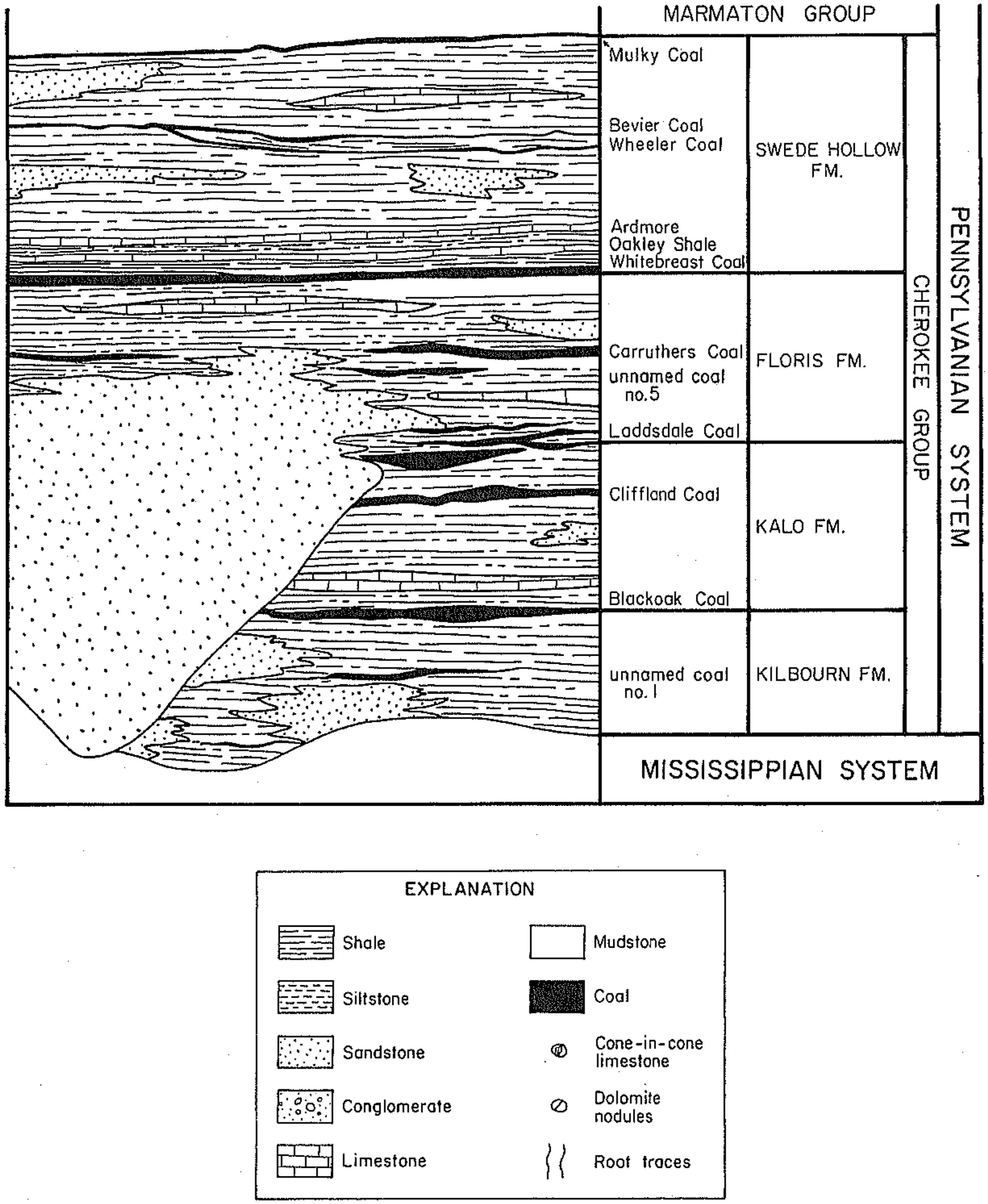

Figure 6. Generalized stratigraphic section of the Cherokee Group in Iowa. Laddsdale, Cliffland, Blackoak coals were mined in the study area. The complexity of the Cherokee Group strata cannot be adequately shown at this scale.

Cherokee and Marmaton for more details on Pennsylvanian geology of the Group strata. The reader is referred to these works state.

A series of cores were drilled in southeast Des Moines to investigate mine subsidence which occurred in 1978 and 1979 (Avcin, 1978, 1979). The geologic descriptions from these cores were combined to produce the composite geologic section for the study area shown in figure 7. Palynological analysis of coals obtained from these cores was used to assign current stratigraphic designations to the coal beds (Ravn, pers. comm., 1987). The "first vein" is probably equivalent to the coal which has now been identified as Laddsdale. Little coal was produced from this seam within the Des Moines area. It was probably much more productive immediately to the southeast in Marion and Warren counties. The mines in the area where the cores were drilled were believed to have operated in the "second vein" and "third vein" (Avcin, 1978, 1979). The "second vein" is probably equivalent to the Cliffland Coal and the "third vein" is probably equivalent to the Blackoak Coal. Based on this analysis, the major coal-producing seams in the Des Moines area were the Cliffland and Blackoak. The coal seam shown below the Blackoak seam in figure 7 is tentatively correlated with the unnamed coal beds of the Kilbourn Formation. Thin coal seams, also assumed to correlate with the unnamed coal beds in the Kilbourn Formation, were noted elsewhere in Des Moines below the "third vein" by Hinds (1908), Bain (1896), and Keyes (1894). These beds apparently did not reach mineable thickness within the area and therefore were not included in the informal stratigraphic designations of the time.

Palynological data are sparse outside of southeast Des Moines making area-wide correlations difficult. Lithologic correlations are problematic at best, but the available data suggest that the equivalencies between the old, informal nomenclature and current stratigraphic nomenclature determined for the southeast Des Moines remain valid over the rest of the study area. Research on regional coal stratigraphy in central Iowa suggests that the Cliffland and Blackoak coals were the most likely to have reached mineable thicknesses, with the Laddsdale reaching mineable thickness locally (Geological Survey Bureau, Iowa Department of Natural Resouces, unpub. files).

GEOLOGY OF THE NORTH DES MOINES DISTRICT

A portion of the North Des Moines District (as it was called ca. 1900) provides an interesting illustration of the relationship between the distribution of coal mines and ancient depositional environments. This area, shown in figure 8, is located along the Des Moines River and Harding Road and extends south from Interstate 80 to about 1/2 mile south of Hickman Road. The outlined mines were all in the "third vein" (probably equivalent to the Blackoak Coal) and are well documented by maps and descriptions. The triangles indicate mines which could be located but not outlined, since no mine maps are known to exist for them.

Notations on mine maps and descriptions of the mines for the area were used to map the original areal extent of workable coal (figure 8). Hinds (1908) described features which limited the extent of the coal as "faults" and identified them as two distinct types of channels. Contemporaneous channels (i.e., those which existed at the same time peat deposition occurred) were the most common and are marked by rapid thinning of the coal from several feet to a few inches where it pinches out against the edge of the channel deposit. The coal is commonly interbedded with clastic rocks (e.g. sandstone, shale) at the thinned edges suggesting overbank or crevasse splay deposits. In this situation the extent of the mine would be limited by the original depositional extent of the peat body. Post-depositional erosional channels (i.e., those which formed after peat deposition ended) which cut out the coal seam are less common. The channel cut-outs are also filled with clastic sediments, but the coal seam terminates abruptly against the channel-filling deposits without any change in thickness. The channel-filling sediment in this case is likely to include fragments of coal and other strata older than the channel. Hinds (1908) believed these to be at least pre-Pleistocene, and possibly as early as Pennsylvanian, in age.

Mine maps and descriptions include numerous references to channels which limit the extent of workable coal (figure 8). The eastern edge of the Flint Brick Company Shaft No. 2 and No. 3, the southern margins of the Madison Coal Company and Eagle No. 2 mines, and the northeastern

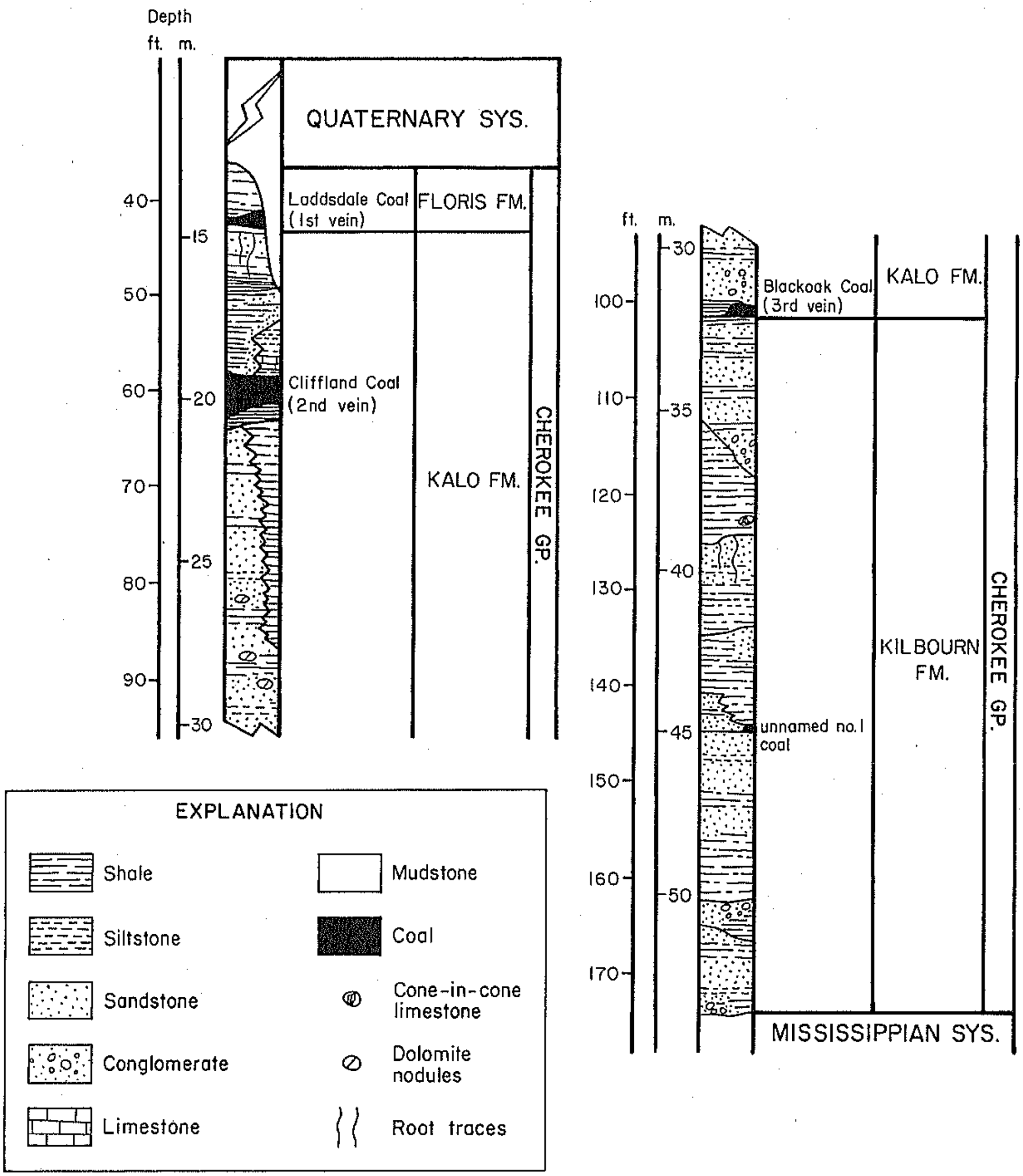

Figure 7. Composite geologic section prepared from cores drilled in southeast Des Moines. Informal stratigraphic designation used by Hinds (1908), Bain (1892), and Keyes (1894) are in brackets following the current coal bed names. The Cliffland Coal was mined in the area where the cores were drilled.

margin of the O.K. Coal Company mine were limited by thinning of the coal seam. The thinning probably occurred adjacent to a contemporaneous stream channel. Erosional channel cut-outs are described between the West Riverside and Flint Brick No. 2 and No. 3 mines and across the Blount and Evans mine and east of the Eagle No. 2 mine. Hinds (1908) suggested that these might be portions of a continuous channel and described it as 400 to 500 feet wide and filled with sandstone, "slate," and "fireclay" based on exposures in the haulageway across it in the Blount and Evans mine. The West Riverside mine also has a haulageway across the channel.

Additional channels were inferred from indirect evidence (figure 8). Maps of the American Coal Company and Eagle No. 2 mines note rapid thinning of the coal along their southern limits. The thinning of the coal appears to represent the edge of a contemporaneous channel. Long haulageways with no attached rooms may represent an attempt to cross a "fault" in the hope of reaching mineable coal on the other side (e.g., the West Riverside Mine). This pattern of mine development is seen on the southwest side of the Bloomfield No. 2 mine where a channel has been described (Hinds, 1908). A "fault" or channel is inferred between the Blount and Evans Mine and the Flint Brick No. 1 mine where a similar pattern is visible.

Figure 8 shows the positions of the channels as pairs of lines if both sides of the feature could be located or as a single line if only one side could be located. The locations of the channels were then used to delineate the possible extents of the bodies of coal in the area, shown as stippled areas. Thus, figure 8 is a geologic map assembled from historic records of coal mining using a current model of depositional processes in a coal-producing environment. The resemblance to the sketch in figure 5 is striking, suggesting that deposition occurred in similar environments by similar processes.

GEOLOGY OF SURFICIAL MATERIALS

Pleistocene-age sediments, overlying the Pennsylvanian-age rocks, comprise the surficial materials in the study area. They consist predominantly of glacial till and loess, and alluvium which range from a few feet to nearly 300 feet in total thickness. The till is typically somewhat sandy and includes lenses of gravel locally at the contact with the underlying Pennsylvanian-age rock.

Characteristic of the Pleistocene deposits are a number of large river-channel systems which resemble those of the Pennsylvanian. These channels also probably account for the greatest thickness of Pleistocene deposits in some areas. Although these channels developed long after coal formation was complete, they restrict the distribution and extents of coal mines in the study area. The channels locally cut out the coal or leave it too weathered near the channel edge to be usable. For example, the Beaver Channel is mapped by GSB (Bettis, pers. comm., 1989) in northeast Des Moines. The Des Moines Coal Co. Marquisville Mine (#11, Plate I), Norwood-White Coal Co. Mine No. 3 (#18), and Western Coal Co. (#29) lie northeast of the northwest-southeast trending channel and were apparently prevented from further development to the southwest by this feature.

Physical characteristics of the Pleistocene-age materials, such as permeability and structural competence, affected the coal mines during their operation and influence the effects of the mined-out areas on the land surface. For example, localized gravel deposits probably contributed to flooding problems which some of the mines experienced. Coal mines with thin roof rock overlain by thick Pleistocene deposits were more prone to roof collapses and required more roof support to be operated safely. Following mining, these same characteristics probably contribute to subsidence problems. Avcin (1979) noted an episode of subsidence which was probably exacerbated by water-saturated gravel lenses at the contact between Pleistocene and Pennsylvanian strata.

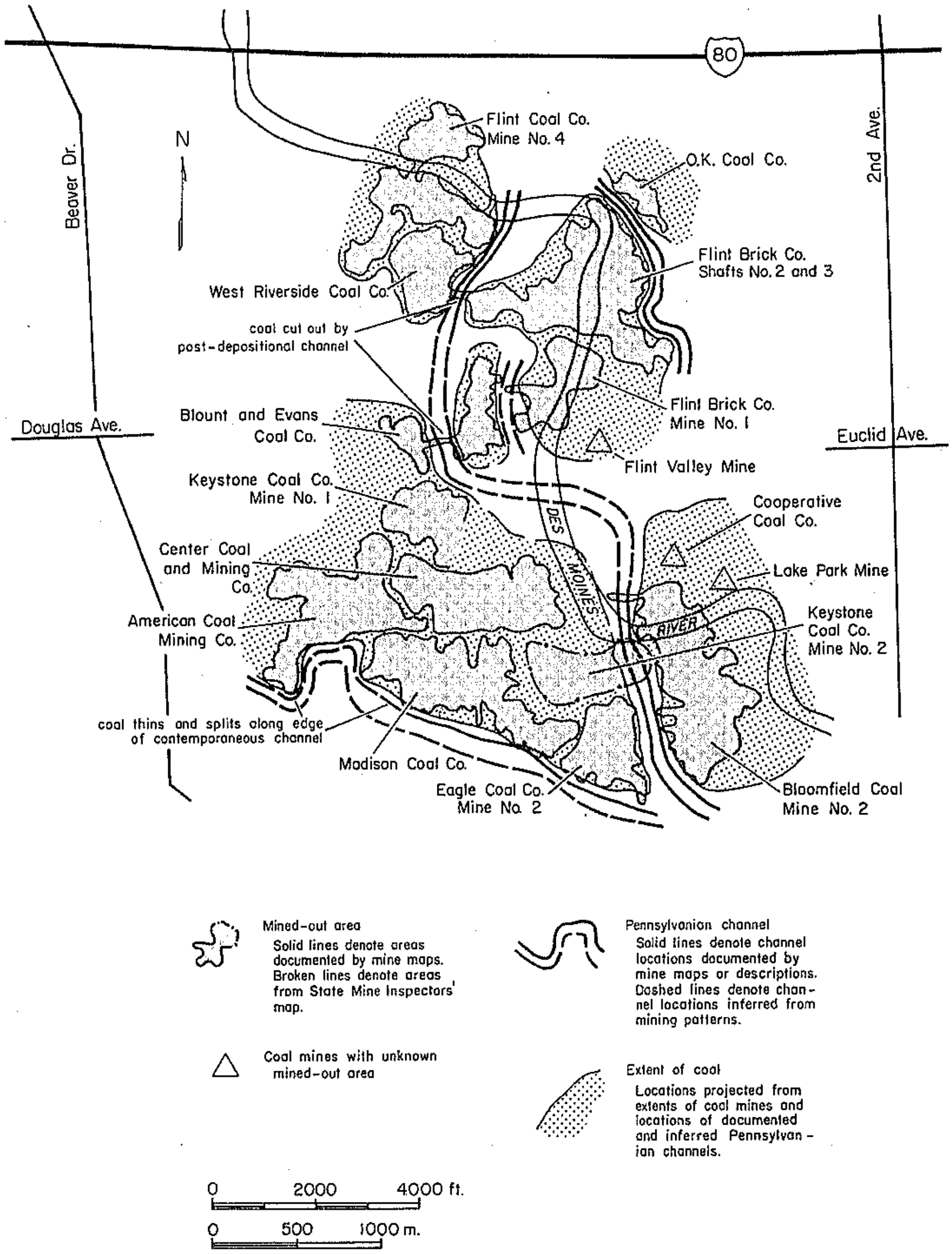

Figure 8. Map of the North Des Moines District showing mines, locations of Pennsylvanian channels, and probable limits of coal deposits. Some major streets are shown for geographic reference. The distribution of coal and documented and inferred channels suggest deposition in an environment like that proposed for the depositional model in figure 5.

ACKNOWLEDGEMENTS

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GLOSSARY OF GEOLOGIC AND MINING TERMINOLOGY

Alluvium, alluvial--general term for detrital deposits made by streams; process of deposition by streams.

Base level--lowest potential level of erosion. This is the lowest elevation which a stream may reach. As a stream approaches this level its rate of flow and hence erosive and sediment-carrying power decrease.

Basin--circular or elliptical sediment-filled depression in the earth's crust characteristic of continental interiors.

Bowlder--(var. of boulder) in coal mining, a mass of rock within a coal seam typically composed of partly decomposed peat which has been permineralized or impregnated with calcite and some pyrite. Fragments of plants are visible in some of these.

Brackish--water whose salinity is intermediate between seawater and streams.

Clastic--refers to particulate sediment without reference to particle size or origin (e.g. quartz sand, clay, etc.)

Consolidated--loose earth materials which have become firm and coherent.

Cretaceous--the span of geologic time from 135 to 65 million years ago and the rocks deposited during that time.

Crevasse splay--a deposit of sediment which forms when a stream breaches its levee due to flooding.

Delta, deltaic--accumulation of sediment at a river mouth, or referring to the delta or processes related to delta formation. Deltas may form wherever a stream empties into another body of water.

Dip--the angle, measured from horizontal, of rock strata which may be described on a regional or local scale.

Eustatic--pertaining to worldwide sea-level changes that affect all oceans, believed to be caused by addition or removal of water from continental icecaps.

Fault--a fracture in rock strata along which there has been displacement ranging from inches to miles.

Fault--(miner's term; see Bowlder) any defect in the coal seam which hinders mining. Faults, in this sense may include actual structural faults (see previous definition), folds, bowlders, channel cut-outs, etc.

Fireclay--(var. of underclay) clay found below coal seams. Fireclays are refractory (ceramic), underclays are not necessarily so.

Fluvial--pertaining to rivers or geologic processes related to rivers.

Fold--bend in rock strata produced by deformation of rock strata.

Formation--a subdivision used in classifying rock units by their composition, characterized by some degree of compositional homogeneity.

Group--a subdivision used in classifying rock units by their composition, i.e., a rock-stratigraphic unit, made up of two or more formations.

Holocene--the period of geologic time from approximately 8,000 years ago to the present. The Holocene is classified as a Stage within the Pleistocene Series in Iowa.

Horse "gin"--a machine powered by draft horses or mules, commonly used to power the hoisting gear in a coal mine.

Lithology--the description of the physical characteristics of a rock.

Loess--wind-deposited silt derived from Pleistocene river valleys.

Marginal marine--refers to deposits or processes which occur at the shoreline or in shallow water near the shore. Conditions such as salinity and temperature are variable and influenced by open ocean and on-shore processes.

Marine--refers to open ocean, with normal salinity, stable temperature, and oxygenation.

Member--stratigraphic subdivision of group, see stratigraphy.

Mississippian--a period of geologic time spanning the interval from 345 to 320 million years ago and the rocks which formed within this time. Mississippian is at the System level in the stratigraphic classification.

Nonconsolidated--any loose earth materials.

Nonmarine--refers to deposits or processes which occur in fresh water bodies such as streams or lakes.

Overbank deposit--fine-grained sediment deposited from suspension on a flood plain by floodwaters that cannot be contained within the stream channel.

Overburden--consolidated or nonconsolidated material which overlies a coal seam.

Palynology, palynostratigraphy--study of fossil spores and pollen and their use in determining correlation and subdivision of lithologic units.

Pennsylvanian--a period of geologic time thought to have covered the span of time from 280 to 320 million years ago. Also refers to the rocks formed during this period. The Pennsylvanian is at System level in the stratigraphic classification.

Pleistocene--the period of geologic time ranging from two to three million years to eight thousand years ago and the deposits formed during this period. The Pleistocene occupies the rank of Series within the Quaternary System. Several periods of continental glaciation during the Pleistocene prompted the informal name "ice age" for this period of time.

Quaternary--the period of geologic time spanning two to three million years ago to the present time and the rocks and nonconsolidated deposited formed during that time. The Quaternary is at the rank of System in the stratigraphic classification in use in Iowa.

Rank--measure of the thermal maturation or degree of metamorphism of coal.

Series--see stratigraphy.

Shipping mine--a coal mine with railroad connections, usually a spur or siding. Shipping mines usually produced more coal than those which produced coal for local markets.

Strata--layers of rock.

Stratigraphy--the study of the arrangement of rock strata, especially geographic position and chronological order of sequence. A hierarchical system of nomenclature is used to describe rock strata. Rock stratigraphic classifications are based on similarities in physical characteristics of the rock layers. Rock stratigraphic terms used in this report are (in ascending order) bed, member, formation, group, supergroup, series, and system. Time stratigraphic classifications are based on time indicators, such as fossils, found in the rocks. Time stratigrahic terms, in ascending order, are era, period, system, series, stage, age, and epoch. The rock stratigraphic terms system and series are approximately equivalent to the time stratigraphic terms period and epoch, respectively.

Subsidence--sinking of land surface, in the context of this report, caused by collapse into an underlying opening such as a mine.

System--see stratigraphy.

Till--unsorted and unstratified mixture of clay, sand, gravel, and boulders deposited directly by a glacier.

Unconformity--a break in the orderly chronological succession of rock strata. An unconformity represents a period of erosion or non-deposition and delimits stratigraphic units.

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ACREAGE:	ENTRANCE TYPE/MINING TYPE:	SHAFT DEPTH:
unkn	unknown/unknown	unkn

COMMENTS FOR MINE Miller Mine:
This mine operated for only eight months. The only known map is for the land leased for this mine; no mine map is available.

E 17th

NO. ON PLATE I:	MINE NAME(S):	YEARS OF OPERATION:	MAP DATE:
53	Eureka Coal Co. Mine No. 2	1896-	none

LOCATION: NW 36 T79N R24W — **TOPOGRAPHIC MAP:** Des Moines SE

ACREAGE:	ENTRANCE TYPE/MINING TYPE:	SHAFT DEPTH:
unkn	vertical/r & p	107 ft.

COMMENTS FOR MINE Eureka Coal Co. Mine No. 2:
This mine was also known as Eureka Coal & Mining. The shaft was located 2.5 mi. north of the State Capitol building. Two coal seams are described from the mine shaft. The first averaged 4.5 ft. thick at 54 ft. below the surface and the second was 3.5 ft. thick at 71 ft. below the surface. The coal which was mined was probably the "3rd vein" or Blackoak. It was known to thicken and dip toward the east from this site. No map is available for this mine; the only known extent was for the leased area.

NO. ON PLATE I:	MINE NAME(S):	YEARS OF OPERATION:	MAP DATE:
54	Diamond Mine	-1884	none

LOCATION: SE NW 36 T79N R24W — **TOPOGRAPHIC MAP:** Des Moines SE

ACREAGE:	ENTRANCE TYPE/MINING TYPE:	SHAFT DEPTH:
unkn	unknown/unknown	unkn

COMMENTS FOR MINE Diamond Mine:
The only known location and extent for this mine is from a lease block map. No mine map is available. A small area was mined out before the Eureka No. 2 opened.

NO. ON PLATE I:	MINE NAME(S):	YEARS OF OPERATION:	MAP DATE:
55	Atlas Mine	-	none
	Atlas Mine	-	none
	Standard Coal Co.	-	none

LOCATION: NE 36 T79N R24W — **TOPOGRAPHIC MAP:** Des Moines SE

ACREAGE:	ENTRANCE TYPE/MINING TYPE:	SHAFT DEPTH:
unkn	shaft/unknown	100 ft.

COMMENTS FOR MINE Atlas Mine:
The Atlas Coal Co. formed in 1887 by reorganization of the Standard Coal Co. In 1887 the company employed 53 suggesting a large operation. No mine map is available; the only information known about the extent of the mine is from a lease block map. The mine worked two coal seams with the upper seam reached from the lower by a slope. Only a small block of coal was available in the upper seam and the lower seam thinned to the east.