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Coal Resources of the Dekoven and Davis Members (Carbondale Formation) in Gallatin and Saline Counties, Southeastern Illinois

Russell J. Jacobson

Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

Circular 551
1993

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Illinois State Geological Survey
Morris W. Leighton, Chief

Natural Resources Building
615 E. Peabody Drive
Champaign, Illinois 61820-6964

Cover photo

Exposure of the final-cut highwall in an abandoned surface mine in the Eagle Valley Syncline, NW NE NW, Section 14, T10S,R7E, Saline County. The Davis and Dekoven Coals were mined at this location from 1959 until 1965. The highwall exposes the Dekoven and overlying strata, including the Palzo Sandstone, and the Colchester Coal.

Editor — B. Wathen
Graphic designer — P. Carrillo
Typographer — D. Harding

Printed by authority of the State of Illinois/1993/1200

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ACKNOWLEDGMENTS

I thank C. G. Treworgy, W. J. Nelson, H. H. Damberger, M. L. Sargent, and J. J. Eidel for critically reviewing the manuscript. M. Bargh helped digitize information shown on several of the plates. Bargh also provided invaluable instruction on digitizing features created on the maps and using the ARC/INFO system on the Prime Computer. Nearly all the programs used to produce the tables of coal resources were written by C.G. Treworgy, who also provided instrumental instruction in the ARC/INFO Geographic Information System (GIS). The information in the tables of chemical analyses in appendixes E and F was extracted from an INFO database. R. J. Harvey and C. B. Trask created special INFO programs as part of the Coal Information System (CIS).

ABSTRACT

Total coal resources for the Davis and Dekoven Coal Members in Gallatin and Saline Counties were estimated to be more than 4.1 billion tons, a 24% increase over previous estimates. The estimate includes both deep- and surface-minable resources, of which only about 190 million tons are surface minable. In the two counties, the Davis Coal Member has nearly 2.5 billion tons of coal resources and the Dekoven Coal Member almost 1.6 billion tons. A lower split of the Dekoven has approximately 53 million tons of resources. More than 47 million tons of the deep-minable resources in the Davis have a high potential for development, and about 2.4 billion tons have a moderate potential. About 0.4 million tons of the deep-minable resources in the Dekoven have a high potential for development, and 364 million tons have a moderate potential.

INTRODUCTION

The Davis and Dekoven Coal Members of the Carbondale Formation (Jacobson et al. in preparation, Nelson et al. 1991) are widespread coals of economic interest. They have been identified throughout the Illinois Basin. In east-central Illinois and in Indiana on the eastern edge of the basin, the two seams merge to form the Seelyville Coal Member (Jacobson 1983, 1987). Geophysical and drilling logs show the persistence of these seams in the southeastern part of the basin (Jacobson 1987). Little mapping of the seams has been done in southeastern Illinois, however, except along the crop line of the coals.

A systematic study of the Davis and Dekoven coal resources in this area was initiated in 1988. Three reports will cover the Davis and Dekoven Coals between their outcrop in southeastern Illinois and the southern edge Seelyville Coal, previously studied by C. Treworgy (1981), in east-central Illinois. The first part of the study, covering Saline and Gallatin Counties, is reported in this circular (fig. 1). Hamilton, White, Edwards, Wabash, and Wayne Counties will be studied later.

Depth, thickness, and areal extent of minable coals were obtained primarily by examining numerous electric logs from oil wells and structure tests in the area. Logs from coal shafts and coal test holes were available, as well as logs of gamma density and diamond drill cores; however, most data were gathered near the coal outcrops. These latter types of data were helpful in calibrating estimates of coal thickness from electric logs. More than 1,500 well records were examined, the locations of which are shown on figure 2 and plate 5.

Previous Investigations

Owen (1855) referred to the Davis and Dekoven Coals as the "four-foot coal" and the "three-foot coal." Cady (1919) was the first to estimate coal resources for the two coals in the study area; however, he erroneously correlated the Dekoven and Davis Coals with the Murphysboro Coal in southwestern Illinois. Six years later, Butts (1925) continued to refer to the two coals as equivalent to the Murphysboro Coal Member (Tradewater Formation) and showed crop lines of the Davis and Dekoven Coals on his geologic map of the Eagle Valley–Shawneetown area. Wanless (1939) was the first to recognize that the Davis and Dekoven Coals were equivalent to the Wiley and Greenbush Coal Members of western Illinois rather than the older Murphysboro Coal.

Cady (1952), in a significant statewide study of coal resources, estimated that roughly 2.0 billion tons of resources were present in the Davis Coal and more than 1.3 billion tons in the Dekoven Coal in the two counties. Cady did not distinguish between deep- and surface-minable coal resources. Smith (1957) mapped surface-minable coal resources in the Davis and Dekoven in Saline and Gallatin Counties. He was also the first to note the presence of a parting in the Dekoven Coal in Williamson County.

Treworgy et al. (1978) analyzed surface-minable coal resources in the study area to determine the amount of coal that could be considered surface minable under the economic conditions of the mid-1970s. Of the 72.5 million tons of surface-minable coal resources in the Dekoven, they estimated that 12.8 million tons met the conditions of economic minability. They estimated that 14.5 million tons of a total 49.7 million tons of resources in the Davis had a high potential for development.

In a statewide study, Treworgy and Bargh (1982) estimated that there were 1.8 billion tons of resources in the Davis and a little more than 1.2 billion tons in the Dekoven for Saline and Gallatin Counties. These figures are very similar to Cady's 1952 estimate, which is understandable because Treworgy and Bargh based their estimate on the coal resource maps generated under Cady's direction.

More recently, Nelson and Lumm (1986a–c) mapped the northern one-half of the Eagle Valley Syncline region in a series of three geologic quadrangle maps at a scale of 1:24,000. Using newly available data, they remapped the crop line of the Davis Coal. This crop line, combined with that mapped by Smith (1957), was digitized for use in the current study.

Structural Setting and Evolution

The study area is situated in the southeastern corner of Illinois, along the south crop line of the Davis and Dekoven Coals (fig. 1). The northwestern four-fifths of the study area is part of the Fairfield Basin, which is the deepest part of the Illinois Basin in the state. The northern four-fifths of the total area underlain by the Davis and Dekoven Coals is separated from the southern one-fifth by the Rough Creek-Shawneetown Fault System. The southern area is known as the Eagle Valley Syncline. The Rough Creek–Shawneetown Fault System consists

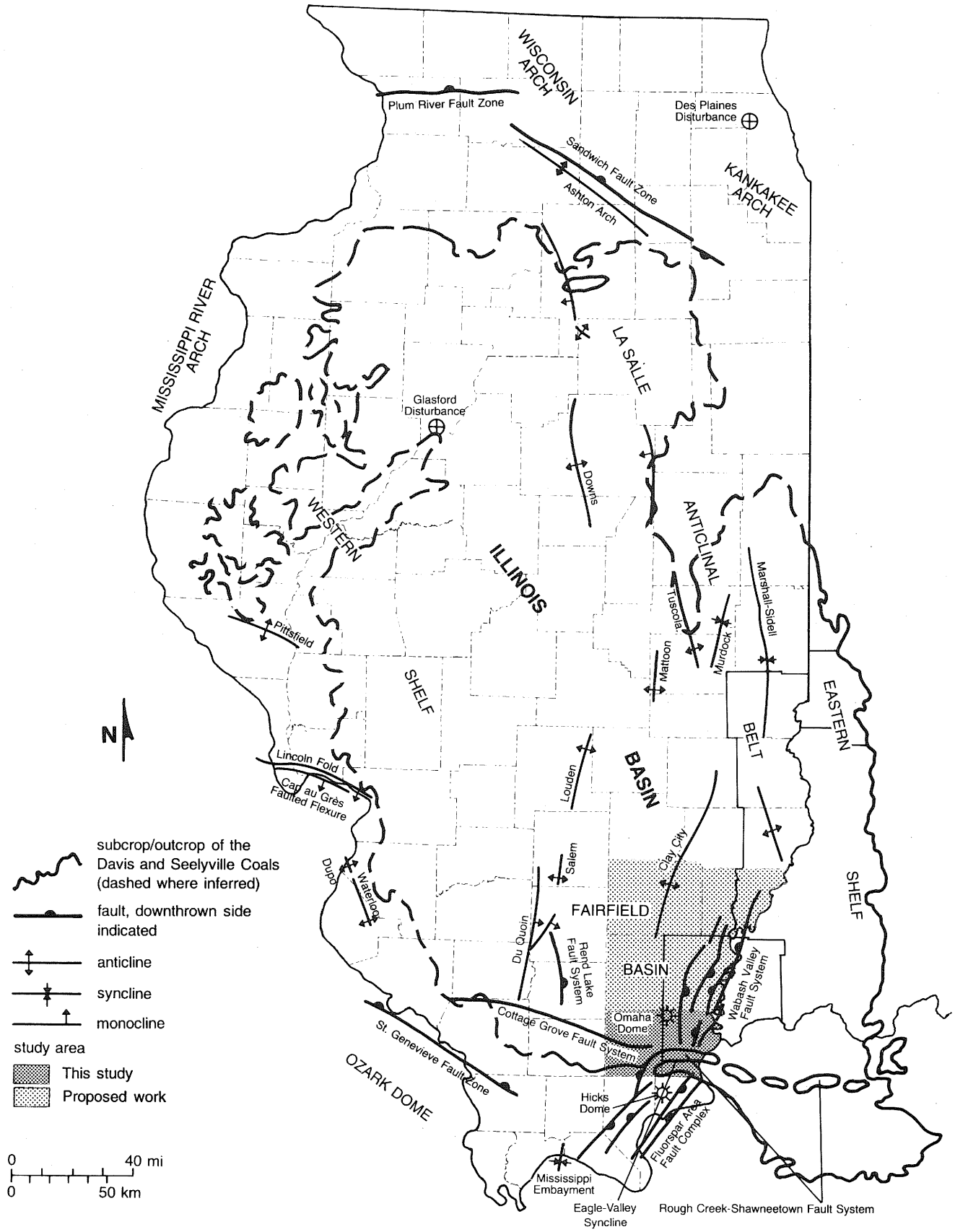

Figure 1 Principal geologic structures in the Illinois Basin Coal Field and location of the study area (after J. Treworgy 1981); crop line of the Davis and Seelyville Coal Members.

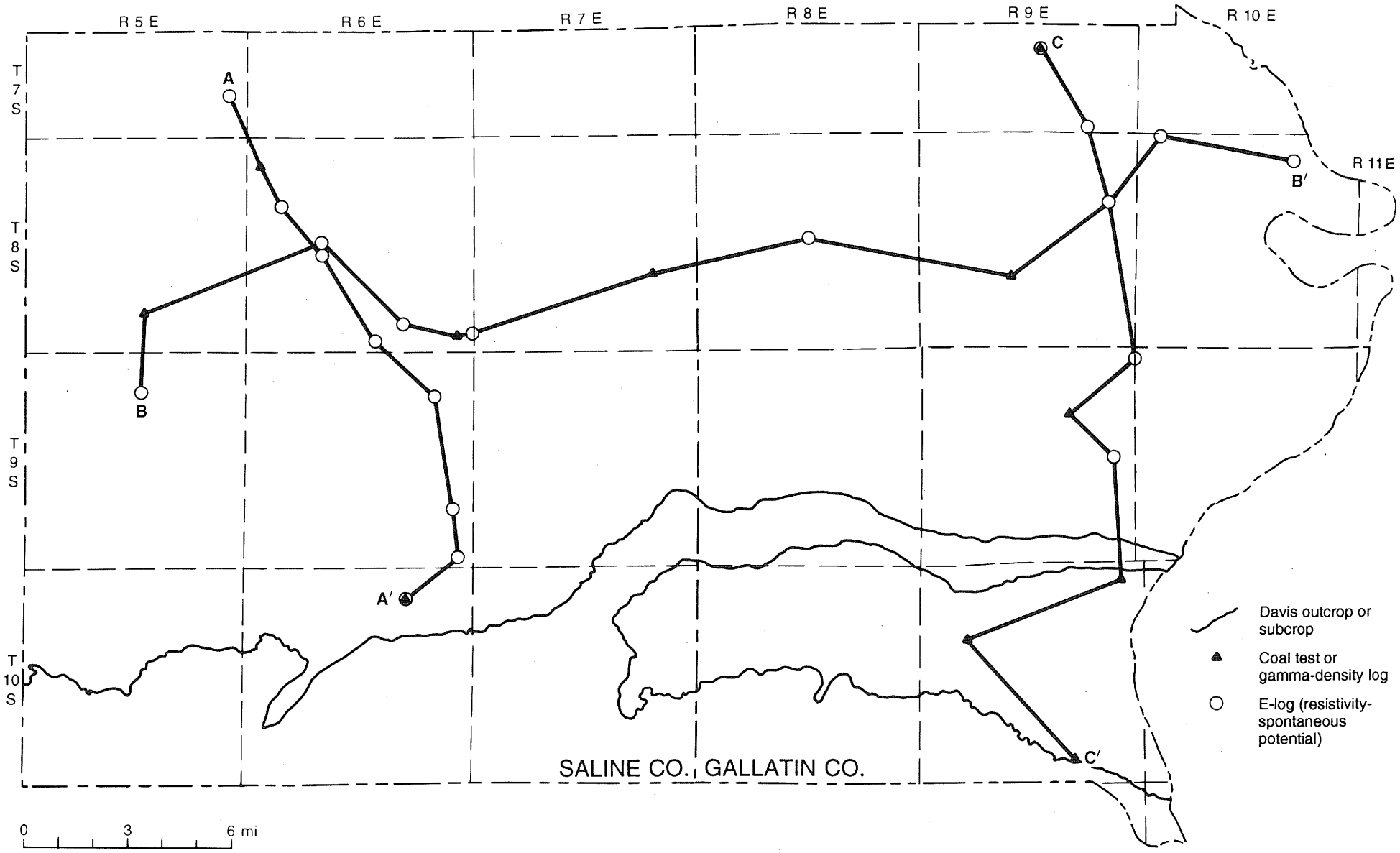

Figure 2 Location of cross sections shown on plate 5.

of a narrow, uplifted, and intensely deformed zone from which the Davis and Dekoven Coals were eroded. Displacements within the fault zone are measured in thousands of feet; however, the coals are at approximately the same elevation in the Eagle Valley Syncline because they are 1/4 to 1/2 mile north of the fault zone. Nelson and Lumm (1984; Nelson, personal communication 1990) postulated that the fault zone originated during Cambrian era (or earlier) rifting and that it was intermittently active throughout the Paleozoic era, including the Pennsylvanian Period.

The Eagle Valley Syncline is an elongate trough roughly 3 to 6 miles wide and more than 12 miles long in southeastern Illinois (pl. 1). The fold is asymmetrical. It has a steeper northern flank that dips from 10° to 30° southward and a more gentle southern flank that dips from 6° to 9° northward (Nelson and Lumm 1984). Within the Eagle Valley Syncline, a number of northeast-trending normal fault zones (the Grindstaff, Herod, and an unnamed fault zone in T10S, R6–8E) have been mapped near the south edge of the crop line of the Davis and Dekoven (Nelson and Lumm 1984, 1986a–c; pl. 1). The faults outline narrow grabens within which the coal-bearing strata are downdropped.

The Wabash Valley Fault System trends north–south through Gallatin County (Bristol and Treworgy 1979). The structure map of the Davis Coal (pl. 1) shows that offsets along the various faults of the system (e.g., the Albion–Ridgway, Cottonwood, Inman East, Herald-Phillipstown, Inman West, and Junction Faults) vary between 100 and 400 feet. The fault system consists of a zone of horsts and grabens that are bounded by high-angle normal faults. The Wabash Valley Fault System is a product of late or post-Pennsylvanian extension (Nelson, personal communication 1990).

In the study area, the Cottage Grove Fault System is located in west-central Saline County and extends to roughly the east-central edge of Saline County (Nelson and Krausse 1981; pl. 1). The fault system consists of a major west-trending master fault and northwest-trending subsidiary faults. Vertical offsets along the master fault are typically less than 100 feet; however, vertical displacements along some segments are as much 200 feet and pose major obstacles to mining. Ultramafic dikes intruded along some faults of the northwest-trending subsidiary system and altered adjacent coal to natural coke (Clegg 1955, Clegg and Bradbury 1956). The Cottage Grove Fault System is interpreted to have developed as a right-lateral wrench fault during late Pennsylvanian and Early Permian time. This interpretation is based on the fact that faults of the system cut rocks of late Pennsylvanian age, and that radiometric dating of associated ultramafic dikes gives an Early Permian age (Nelson and Lumm 1984).

The Omaha Dome, in northwestern Gallatin County, is a nearly circular uplift 3 to 4 miles in diameter (fig. 1, pl. 1). The uplifted dome may be the product of igneous intrusions in Upper Devonian and younger rocks (Nelson, personal communication 1990).

METHODS

The methods for preparing resource estimates and reliability classifications follow those of earlier Illinois State Geological Survey (ISGS) reports (Smith 1957, Smith and Stall 1975, Treworgy and Bargh 1982).

The current study relied on computer technology for all phases, except for the initial data acquisition and interpretation. This technique represents a significant advancement over previous computer applications in ISGS coal resource studies in which contour maps (e.g., coal thickness, depth, and structure) were produced by hand and then digitized to calculate coal resources with the help of ISGS customized software (see appendix A for a more complete discussion of computer methods).

A Prime 9955 minicomputer and the ARC/INFO Geographic Information System (GIS) mapping and database software package were used in all phases of this project. (Please note that the use of trade names is for descriptive purposes only and should not be considered an endorsement by the ISGS.) The stratigraphic data (e.g., unit depth and thickness) were entered into the INFO database program. The resulting data file was used with customized ARC routines (written by ISGS personnel) to produce coal thickness, structure, interval, and depth maps that are illustrated in the figures and plates. The 150-foot overburden line, crop line, and mined-out areas for the Davis Coal were digitized and combined with the coal thickness maps in the ARC software. Areas densely drilled for oil and urban and public areas (e.g., parks and national forest land) were mapped, and the information was digitized; the maps were then combined with the thickness maps. The data compiled by these processes were plotted to produce the coal resource maps. These computer data were also used to calculate the coal resources using ARC routines developed by the ISGS.

Sources of Information

Most of the data used in this report originate from records of holes drilled to locate oil and gas deposits. The majority of records from these holes are geophysical logs consisting of standard electric logs with spontaneous potential and resistivity curves. A few density and gamma logs are also available. Records from coal test holes (both drillers' logs and core descriptions) and measured sections from mine shafts were found for scattered locations in the study area. These latter data were useful as a check on interpretations of electric logs.

Hopkins (1968) discussed the usefulness, accuracy, and limitations of electric logs in a resource study of the Springfield Coal of southeastern Illinois. Thickness

Table 1 Summary of reliability classifications for coal resource study.

Class	Maximum distance from datum points[a]	Accepted datum points	Remarks
IA proved	0.5 mile	Mined-out areas, diamond drill holes, outcrops, coal tests	Approximately equivalent to "measured" category of the USGS
IB probable	2 miles	All points of class IA plus gamma-density logs	Approximately equivalent to "indicated" category of the USGS
IIA strongly indicated	4 miles	All points of class IA and IB plus electric logs, and good drillers' logs from oil and water wells	Approximately equivalent to "inferred" category of the USGS

[a] Based on Cady (1952).

estimates made from electric logs are generally considered accurate to within 1 foot.

Classification of Resources

In this study, coal resources were divided, based on the reliability of data sources, into the three standard classes used by the ISGS to classify coal resources (table 1). These reliability classes correspond to classes used by Cady (1952), except that geophysical logs were used to include more coal in the "strongly indicated" category.

Development Potential of Deep-Minable Resources

The potential for development of coal resources can be rated by comparing characteristics of mapped coal resources with those of deposits currently being mined. Treworgy and Bargh (1982) adopted a classification system for the development potential of coal deposits (fig. 3). They classified deposits with characteristics (e.g., depth and thickness) similar to those of coals currently undergoing mining as having a high potential for development. They classified deposits similar to those being explored and leased but not yet mined as having moderate development potential. Resources with significantly inferior characteristics were classified as having low potential for development. Because this classification relies on characteristics of currently mined or unminable resources, it allows for flexibility in changing the coal's category of development potential as new coal is discovered, as choicer coals are exhausted, and as mining technology, market conditions, and laws change.

Thickness and depth are two major factors in rating the development potential of deep-minable coals. Information on these two factors was obtained by Treworgy and Bargh (1982) for seams being mined and leased. The data, together with additional information that came from interviews with coal companies and consultants, were used to define four categories of development potential. Figure 3 illustrates this classification system.

High development potential Coal deposits that have the highest potential for development are those with thicknesses and depths equivalent to deposits currently being mined. At present, this category includes deposits that are more than 4.5 feet thick and less than 400 feet deep, or more than 5.5 feet thick and less than 1,000 feet deep.

Moderate development potential This category includes coal seams that are currently undergoing active leasing but are somewhat thinner or deeper than deposits currently being mined. Included in this category are deposits that do not meet the criteria for high potential but that meet the following requirements: at least 3.5 feet thick and less than 1,000 feet deep, at least 4.5 feet thick and less than 1,200 feet deep, or at least 5.5 feet thick with no depth limit.

Low development potential Coal resources that do not meet the criteria for high or moderate potential are classified as having low development potential. Deposits in this category are significantly thinner and deeper than deposits undergoing active mining or leasing today. This coal is normally included by the ISGS in its resource estimates because it is technically minable.

Other Restrictions

This report also includes estimates of coal resources that have a restricted potential for mining because they lie beneath cultural features such as cities, parks, highways, and railroads, or because they are in areas heavily drilled for oil and gas. The resources near these features are tabulated in appendixes B, C and D and are excluded from the resources classified by reliability and development potential.

Resource Calculations

In this report, the figure of 1,800 tons of coal per acre-foot of coal was used for tonnage estimations. This conforms

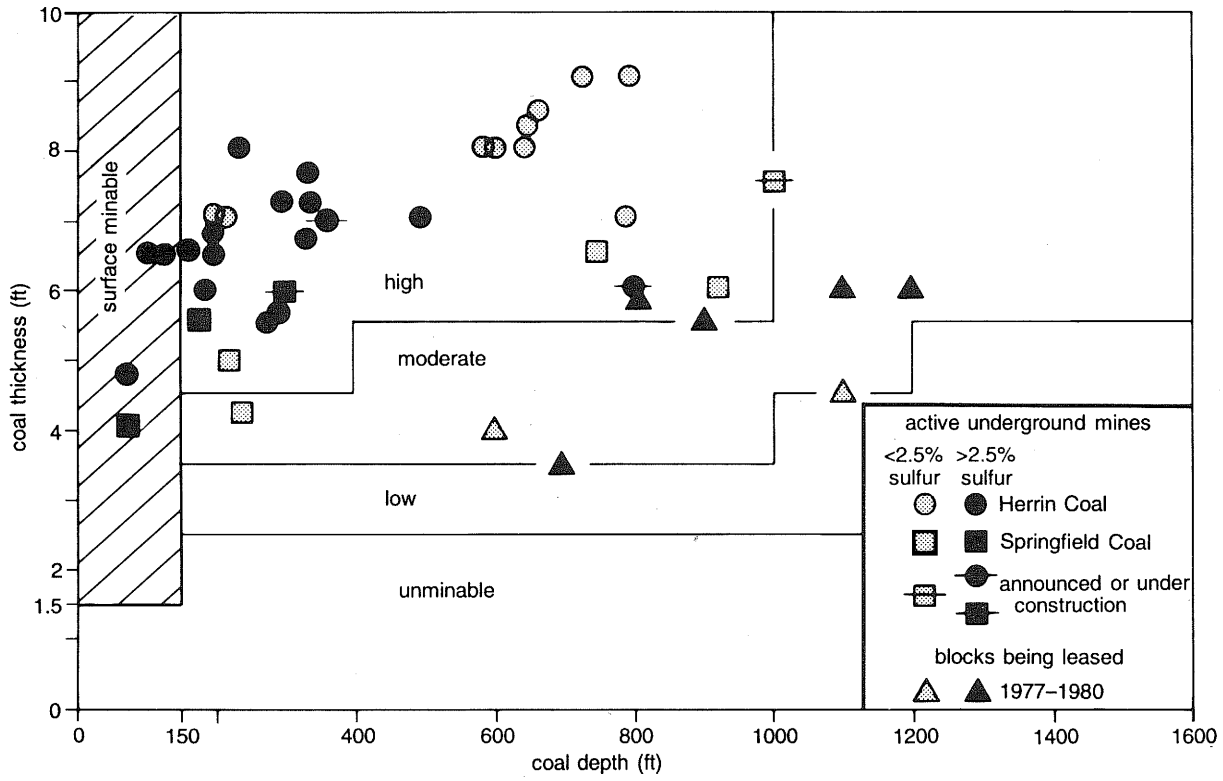

Figure 3 Classification of development potential of deep-minable coal resources in Illinois, as determined from the thickness and depth of coal currently being mined or leased.

to the figure used to estimate resources of highly volatile, bituminous coal, according to the U.S. Geological Survey (USGS) and the ISGS in previous publications. It is equivalent to a specific gravity of 1.32 g/cm^3. Only clean-coal thickness is included. Because most coal thickness data are derived from electric logs that do not permit exclusion of shale partings, somewhat exaggerated resource figures may result, as compared with those derived from high quality logs that permit the recognition of shale partings in coal beds.

Mapping of Coal Outcrops and Overburden Thickness

Maps of coal outcrops (Smith 1957, Nelson and Lumm 1986a–c) were used. Modifications were made to the maps for locations where new data indicated the need to do so. Because the crop lines of the Davis and Dekoven Coals are very close together (roughly 200 feet apart), only the crop line of the Davis was actually digitized and used for computations, a technique that exaggerated resource estimates by 5 to 6 million tons for the Dekoven Coal in the two counties.

The 150-foot overburden thickness contour was made by interpolation of the intervals between topographic and coal structure maps at a scale of 1:62,500. Only the 150-foot contour was generated so that total surface-minable coal resources at depths of less than 150 feet could be estimated. In standard ISGS studies, 50- and 100-foot overburden categories are generated. A future study is planned to detail the surface-minable resources of the Dekoven and Davis Coals. That study will include the additional overburden categories.

Thickness of the Coal

On plates 2 to 4, isopach lines (at 1-foot intervals, starting at 0.5 foot) show the thickness distribution of the coal. Coal resources were calculated for each township by using the average thickness value (full feet) between adjacent isopach lines.

Average thickness values and isopach intervals used for this study were similar to those used in previous ISGS studies (Smith 1957, Smith and Stall 1975, Cady 1952, Treworgy and Bargh 1982). The standard lower limits of 18 inches for surface-minable coal and 28 inches for deep-minable coal were used.

Mined-Out Coal

Areas of mined-out coal are shown on plates 2, 3, and 4. Information was taken from computer maps currently on file and updated periodically by members of the ISGS Coal Section staff. The mined-out areas include the extent of mining through January 1, 1989.

COAL GEOLOGY AND STRATIGRAPHY

The interval of Pennsylvanian strata examined in this study extends from the Stonefort Limestone Member of the Tradewater Formation below the Davis Coal to the Houchin Creek Coal Member of the Carbondale Formation above the Dekoven Coal (fig. 4). Detailed discussion of the stratigraphy has been limited to the coals and immediate roof strata. The cross sections of plate 4 illustrate stratigraphic relations of these coals and other key units. Additional discussion of this stratigraphic section can be found in Hopkins and Simon (1975) and Nelson et al. (1991). Key beds above and below the Davis and Dekoven Coals were mapped to investigate stratigraphic relationships.

Davis Coal Member

The Davis Coal Member of the Carbondale Formation is the thickest and most widespread coal below the Colchester Coal Member in the study area. It averages about 4 feet thick in Saline and Gallatin Counties (fig. 5, pl. 2). Large areas are 5 to 6 feet thick or less than 3 feet thick. The Davis thins to less than 2 feet thick in more than 10 areas.

In general, the coal in the study area increases in depth northward toward the center of the Fairfield Basin. Within the grabens, depths range from 800 to nearly 1,200 feet. The Davis ranges in depth from zero at its crop line to more than 1,100 feet in the northern part of the study area, and in downdropped blocks in the Wabash Valley Fault System. These general trends can be interpreted from the structure map of the Davis (pl. 1) using 400 feet above mean sea level (msl) as the average elevation of the land surface.

Interval Between the Davis and Dekoven Coal Members

Electric logs from the study area indicate that the Davis Coal is typically overlain by shale. Data from cores, outcrops in mines, and gamma logs show this shale to be a black, highly fissile, carbonaceous marine shale in many areas. Gray, silty shales or siltstones are locally developed (see cross sections of pl. 5).

The interval between the Davis Coal and the overlying Dekoven Coal in the southeastern part this interval ranges from 10 to 35 feet; in the northern part, this interval ranges from 20 to more than 60 feet (fig. 6). In the northern area, where the Davis to Dekoven interval is thicker, the interval includes a clastic parting in the Dekoven and all strata between the Davis and the main upper minable bench of the Dekoven. The interval between the Davis and the lower split of the Dekoven averages 10 feet, which is significantly less than the average of 20 to 25 feet in the area where the Dekoven is not split. Examination of the lithology of the interval between the Davis and the Dekoven in the area where the split is absent shows the presence of sandstone above roof shales of the Davis Coal. This sandstone is generally absent in the areas where the Dekoven is split; the interval between the lower split of the Dekoven and the Davis decreases where this sandstone is absent.

Lower Split of Dekoven Coal

A parting in the Dekoven Coal produces a lower split from the main bench of the Dekoven Coal, which is referred to as the lower Dekoven Coal. Although previous authors (Smith 1957, Jacobson 1987) recognized a split in the Dekoven, it had not been mapped in detail prior to this study. The lower Dekoven is 1 to 2 feet thick through most of the area of its occurrence (fig. 7). In local areas of up to several square miles, the lower Dekoven is as much as 3 feet thick.

The parting consists of a clastic wedge that interrupted peat accumulation in the northwestern third of the study area (fig. 8). The parting increases in thickness northwestward from a featheredge to a maximum of 55 feet. Lithologically, the parting consists mostly of sandstone (especially in the thicker areas), in addition to siltstone and shale near its edge. The main upper bench of the Dekoven Coal is generally less than 3 feet thick above this parting (fig. 9).

Dekoven Coal Member

The Dekoven Coal Member of the Carbondale Formation, like the Davis Coal, is widespread across the area. It averages 3 feet thick through most of the two counties (fig. 9 and pl. 2), and it locally reaches 4 to 5 feet thick in a large part of the eastern half of the report area. In the northwestern third of the report area, the Dekoven Coal thins, leaving large areas where the coal is less than 2 feet thick.

The depth of the Dekoven varies from zero along the crop line to more than 1,100 feet at the north-northwest edge of the study area. This deepening reflects the dip of the coal into the Fairfield Basin. The deeper areas of Dekoven are also found in the grabens along the Wabash Valley Fault System. In these areas, the depth of the Dekoven varies from 800 to more than 1,100 feet. Given an average surface elevation of 400 feet for the area, these depth trends can be interpreted from the structure map of the Davis (pl. 1).

Roof strata of Dekoven Coal The Dekoven is typically overlain by either medium to dark gray, silty shale and siltstone or by a massive, thick sandstone. This contrasts with the black carbonaceous shale that typically overlies the Davis Coal in most of the study area.

Previous Mining

All of the mining in the Dekoven and Davis Coals to date has occurred along their crop lines, mostly in surface mines. The two coals were mined together because they occur no more than 15 to 30 feet apart. Underground mining has been restricted to few small operations in Section 35, T10S, R9E, Gallatin County, and Sections 16 and 17, T10S, T6E, Saline County.

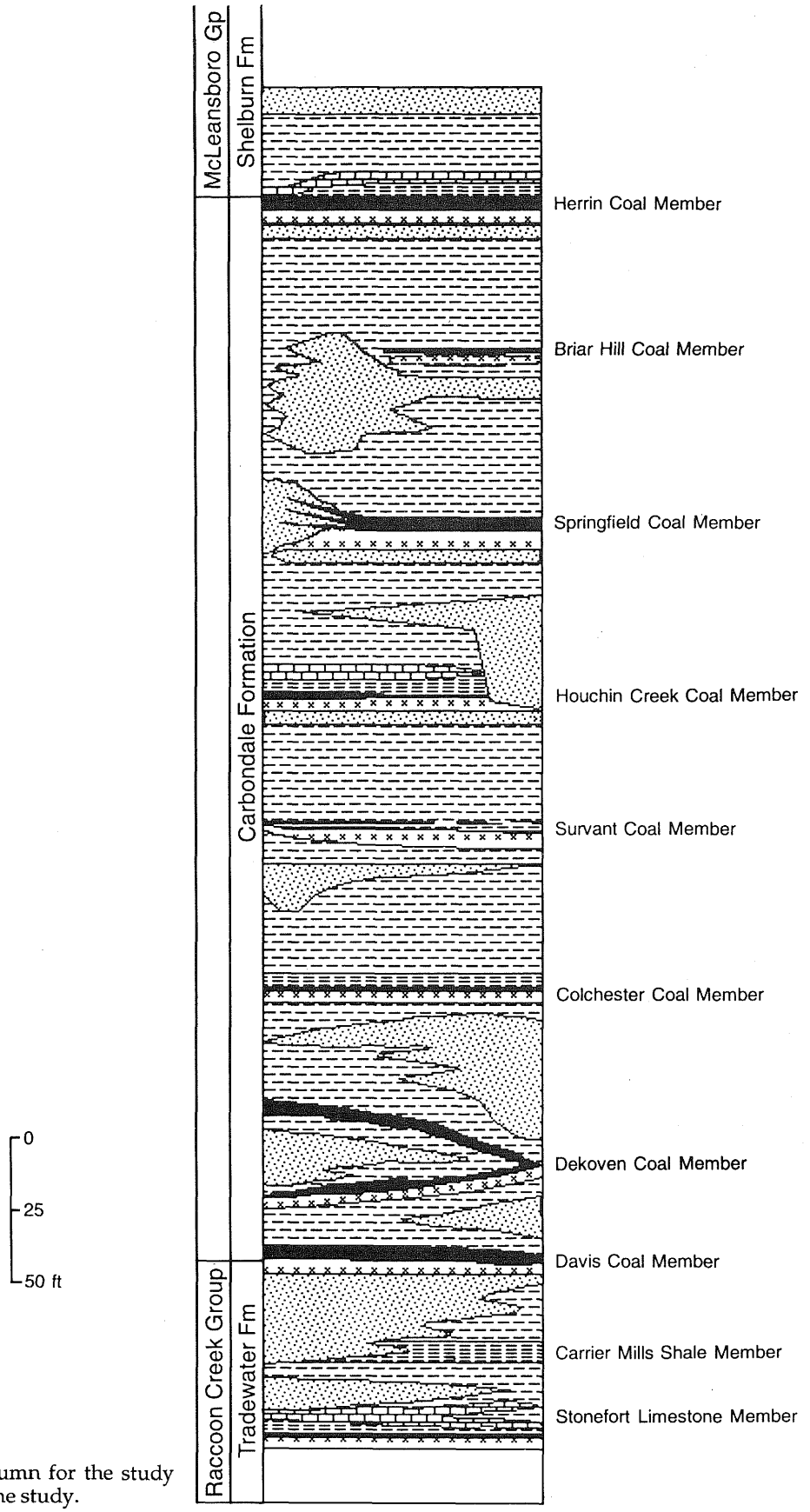

Figure 4 Stratigraphic column for the study area with key beds used in the study.

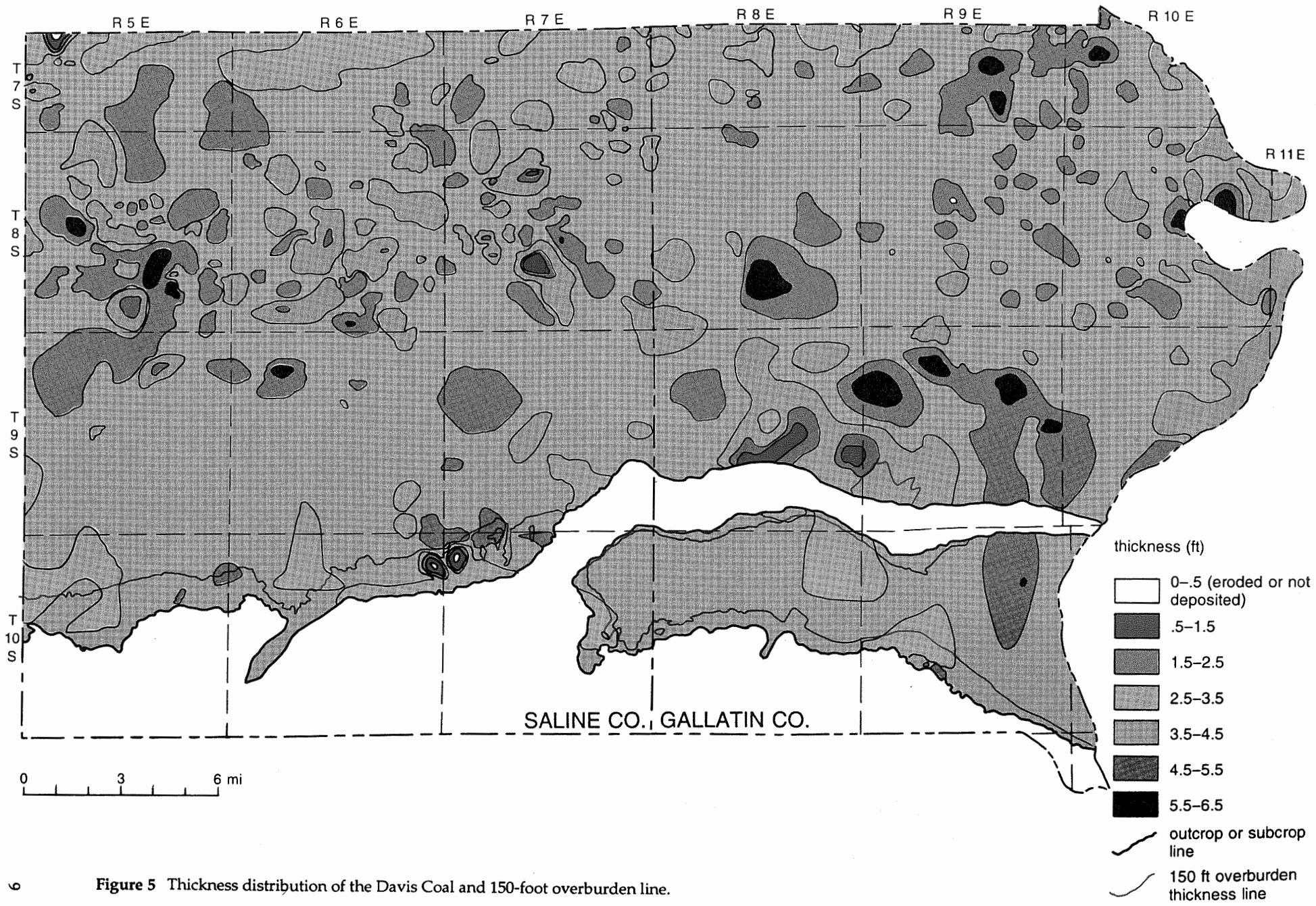

Figure 5 Thickness distribution of the Davis Coal and 150-foot overburden line.

Figure 6 Thickness of the interval between the Davis and Dekoven Coals. Where Dekoven is split, this is interval to main upper bench of the Dekoven Coal.

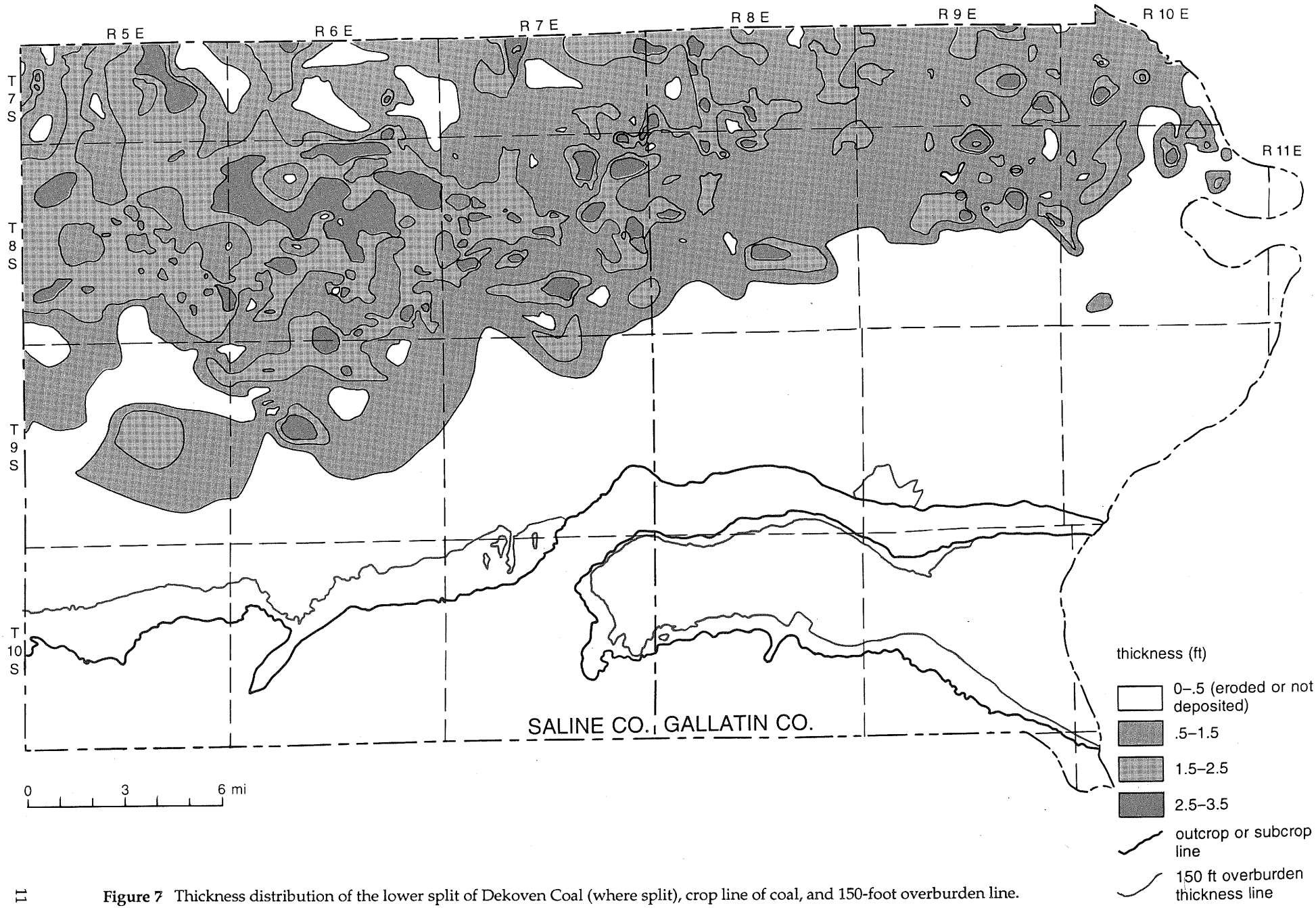

Figure 7 Thickness distribution of the lower split of Dekoven Coal (where split), crop line of coal, and 150-foot overburden line.

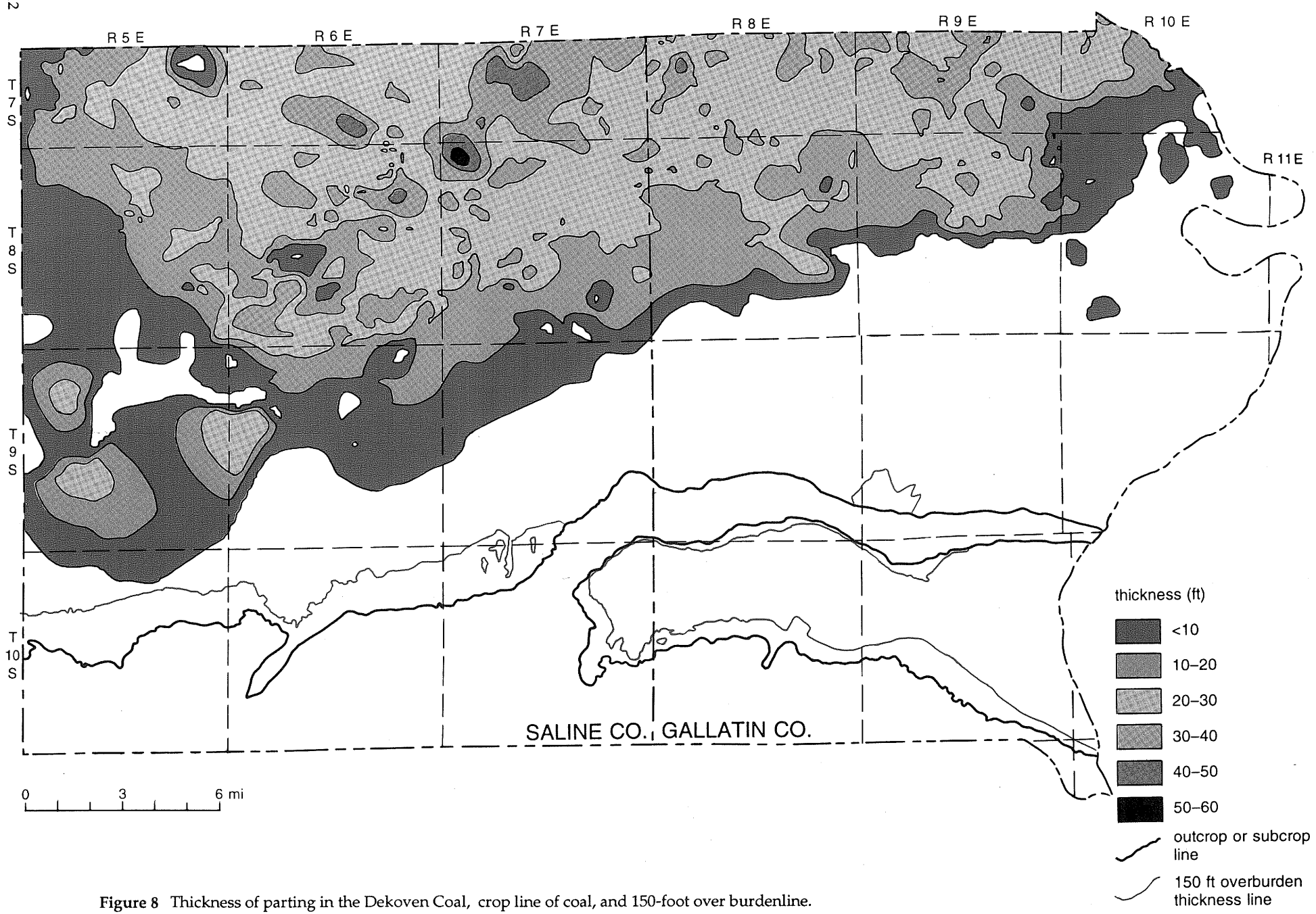

Figure 8 Thickness of parting in the Dekoven Coal, crop line of coal, and 150-foot over burdenline.

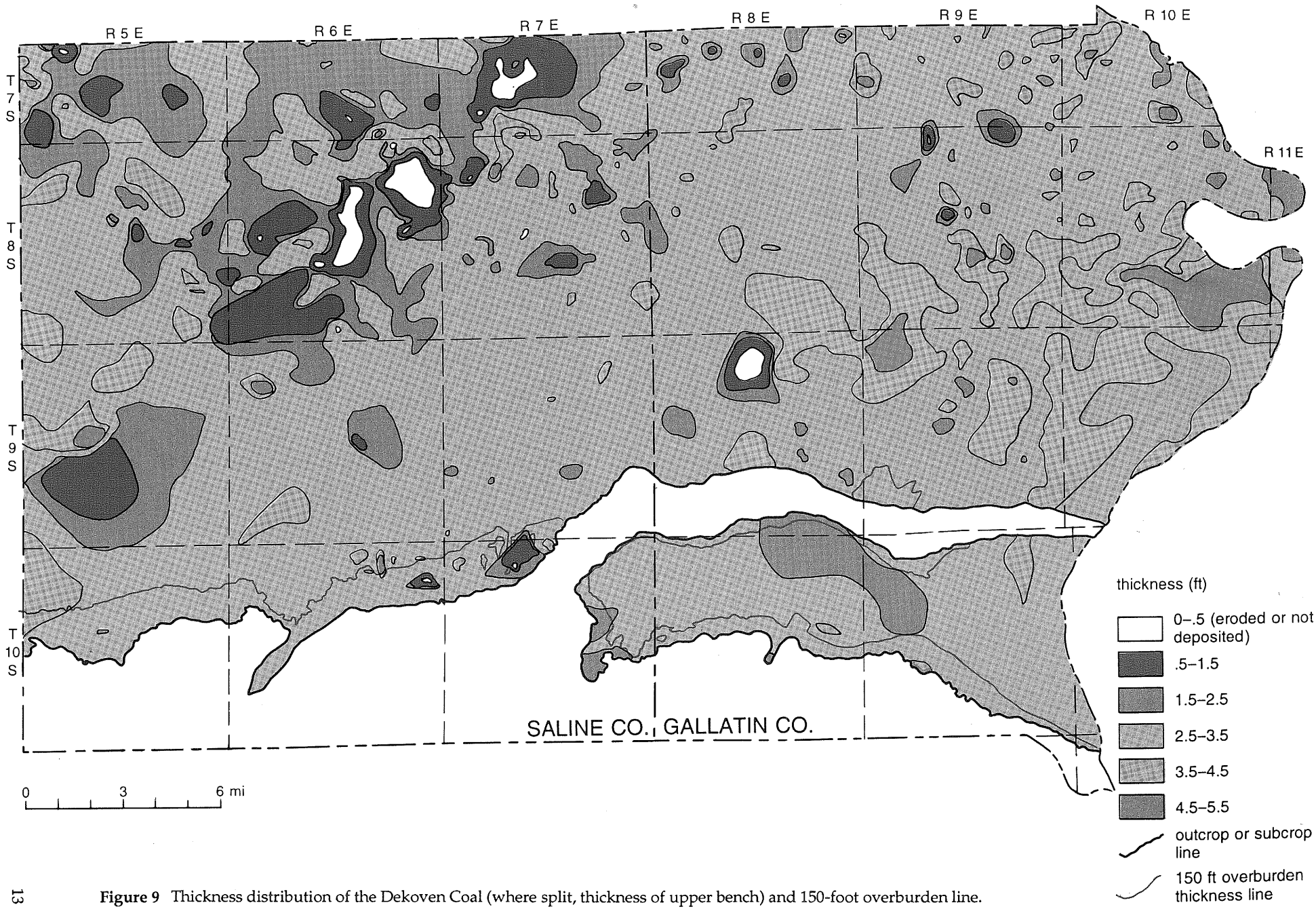

Figure 9 Thickness distribution of the Dekoven Coal (where split, thickness of upper bench) and 150-foot overburden line.

MINING GEOLOGY

Nature of Roof Strata

The major source of data in this study was electric logs, which do not provide detailed information on the roof lithologies. A thorough search of all ISGS mine notes and records about these mines also revealed little information about problems with the overburden in any of surface mines or roof strata in underground mines. The following generalizations about roof lithologies and expected mining conditions are based on the general lithologies that can be inferred from the electric logs, the descriptions in mine notes, and the few available core logs.

The Davis Coal is overlain by a fissile, black, carbonaceous shale similar to that above many other coals of the Carbondale Formation (e.g., the Springfield Coal Member). This shale averages 5 feet thick in the study area. It is overlain by variable successions of gray shale, siltstone, and sandstone. Above other coals, black shale is often overlain by a marine limestone. Black fissile shale makes fairly competent roof, but the strata overlying the black shale are not as strong. Where planar-bedded sandstone with shale partings is present, roof stability can be further reduced. Sandstones within 10 to 15 feet above the coals are likely sources of groundwater influx to underground workings.

The Dekoven Coal is overlain by shales, silty shales, and sandstones of variable lateral extent. Areas with lateral variation in roof lithology commonly have unstable roof conditions (Krausse et al. 1979). Thick, well cemented sandstone can produce a strong roof, but the common presence of transitional shaley sandstones, siltstones, and shales reduces the competence of the roof.

Two of the three underground mines reported groundwater problems that may relate to porous sandstones, fracturing, faulting, or a combination of these factors.

The general absence of carbonate rocks in the Davis and Dekoven interval could lead to problems in reclamation of surface mines. The lack of acid-buffering carbonate in the overburden contributes to problems with acid mine drainage, and it hinders the establishment of vegetation during mine reclamation.

Faulting

Many faults are present in the study area (pl. 1). Mines, now abandoned, encountered faults, particularly near the major fault systems. Fractures, commonly associated with faulting, can also lead to unstable roof conditions in underground mines. Faults and associated fractures may provide conduits for groundwater and gas. The presence of steep dips (15–20°, locally up to 45°) close to the master fault of the Cottage Grove caused mining problems. Nelson (1981) noted that blocks of coal had to be left unmined because of steep dips.

Igneous Dikes

Mica-peridotite dikes found in association with the northwest-trending subsidiary faults of the Cottage Grove Fault System have interfered with coal mining. Coal on both sides of these dikes is often altered to natural coke by heat from the igneous intrusion (Clegg 1955, Clegg and Bradbury 1956), and the altered coal is of little use as fuel. The width of the altered zone varies from a few inches to many feet (Nelson 1981, 1984).

COAL RESOURCES

Table 2 summarizes the coal resources by coal seam, county, and reliability class. A more detailed analysis by township, reliability class, and restricted resources is presented in appendixes B and C. Deep-minable resources are summarized in table 3 by development potential and reliability class. A detailed analysis by township of the development potential for deep-minable resources is provided in appendix D.

Total Resources

Class I and II coal resources were estimated to be more than 2.1 billion tons for the Dekoven and Davis Coals in Gallatin County (table 2). In Saline County, class I and II coal resources were estimated to be greater than 2 billion tons. The total for the two counties is 4.1 billion tons (table 2), as compared with the estimate of 3.3 billion tons made by previous workers (e.g., Cady 1952).

For this study, estimates of resources given in appendixes B and C represent the total coal resources and include both deep (>150 ft deep) and surface-minable (<150 ft deep) coal.

Deep-minable resources Deep-minable coal resources have generally been defined as those coal seams that are at least 28 inches thick and have an overburden of 150 feet or greater. These resources in reliability classes I and II total 4 billion tons (table 3), 2.4 billion tons of which have a high to moderate development potential. Slightly more than 1.5 billion tons have a low development potential; 266 million tons are classified as restricted because they lie beneath public lands, cities, or within areas heavily drilled for oil and gas.

Surface-minable resources This report follows definitions for thickness and overburden depth established by Smith (1957) and Treworgy et al. (1978). Surface-minable coals include seams that are 18 or more inches thick and at depths of less than 150 feet. Surface-minable resources have been calculated by township and county and by reliability class (appendixes B and C). These figures update and expand the estimates of Smith (1957), who calculated surface-minable resources for only part of Saline County and not for Gallatin County.

Table 2 Total coal resources (in millions of tons).[a]

County and coal seam	Reliability class IA	IB	IIA	Seam total	Restricted[b]
Gallatin County					
Dekoven	49	526	347	921	53
Lower Dekoven	0	6	2	8	1
Davis	66	708	430	1,204	74
County total	115	1,240	778	2,133	128
Saline County					
Dekoven	129	335	224	688	56
Lower Dekoven	0	16	29	45	1
Davis	172	571	550	1,294	87
County total	302	922	803	2,027	143
Seam total					
Dekoven	178	861	570	1,609	108
Lower Dekoven	0	22	31	53	2
Davis	239	1,279	980	2,498	160
Grand total	417	2,162	1,581	4,160	271

[a] Note because of rounding, the values of row and column totals may vary by 1 million tons from actual total of components listed.
[b] Restricted tonnages for lower Dekoven only include oil fields, not other restrictions.

Surface-minable coal was mapped in a narrow swath along the crop line in the southern tier of townships in the report area. One or both coals lie at depths of less than 150 feet along the subcrop in T10S and a part of T9S. Plates 2 to 4 show the 150-foot overburden line, which was calculated for the Davis Coal using the structure map (pl.1) and 15-minute quadrangle maps. The same line was used for the Dekoven Coal because the 150-foot overburden lines for the Davis and Dekoven Coals practically coincide at the 1:62,500 scale of mapping.

The class I and II surface-minable resources were estimated to be more than 73 million tons in Gallatin County and 116 million tons in Saline County. This is an increase of nearly 26 million tons above the values estimated by Smith (1957). Overall, the new estimates more than double the previous estimates of surface-minable coal resources in the Dekoven and Davis Coals in this area.

Dekoven Coal

Total resources Estimates of class I and II coal resources are 921 million tons for Gallatin County and 688 million for Saline County, a total of slightly more than 1.6 billion tons (table 2). Another 108 million tons of Dekoven was classified as restricted.

Deep-minable resources Slightly more than 1.5 billion tons of the resources estimated for the Dekoven Coal are deep minable (table 3). Of these resources, 0.4 million tons have a high development potential, 364 million tons have a moderate development potential, and nearly 1.2 billion tons have a low development potential. About 106 million tons of the total is classified as restricted.

Surface-minable resources Class I and II surface-minable resources for Dekoven Coals in class I and II were estimated to be slightly more than 33 million tons for Gallatin County and 51 million tons for Saline County, a total of 84 million tons.

Lower Split of Dekoven Coal

Total resources For the lower Dekoven Coal, total class I and II resources were estimated at nearly 8 million tons for Gallatin County and almost 45 million tons for Saline County, a total of 53 million tons.

Deep-minable resources All of the resources estimated for the lower Dekoven are at depths greater than 150 feet. In the areas where the Dekoven lies at surface-minable depths, it is not split into two benches. None of these deep-minable resources can be classified as having a high or moderate development potential (table 3). About 2 million tons of these resources fall into the restricted category.

Davis Coal

Total resources Class I and II resources of more than 1.2 billion tons of Davis Coal are estimated for Gallatin County and 1.3 billion tons for Saline County, a total of 2.5 billion tons (table 2). Another 160 million tons of the Davis are classified as restricted.

Table 3 Deep-minable coal resources (in millions of tons).[a]

County and coal seam	Development potential				Reliability			
	High	Moderate	Low	Restricted[b]	IA	IB	IIA	Total
Gallatin County								
Dekoven	0	285	603	52	41	501	346	888
Lower Dekoven	0	0	8	1	0	6	2	8
Davis	32	952	180	74	57	678	429	1,164
County total	32	1,237	791	127	98	1,185	777	2,060
Saline County								
Dekoven	0	79	557	54	105	310	221	637
Lower Dekoven	0	0	45	1	0	16	29	45
Davis	15	1,056	159	84	141	541	547	1,229
County total	15	1,135	761	139	246	867	797	1,911
Seam total								
Dekoven	0	364	1,159	106	145	811	567	1,524
Lower Dekoven	0	0	53	2	0	22	31	53
Davis	47	2,007	339	158	198	1,220	976	2,394
Grand total	47	2,372	1,551	266	343	2,053	1,574	3,971

[a] Note because of rounding, the values of row and column totals may vary by 1 million tons from actual total of components listed.
[b] Restricted tonnages for Lower Dekoven only include oil fields.

Deep-minable resources Slightly less than 2.4 billion tons of the resources in the Davis Coal are classified as deep-minable in Gallatin and Saline Counties (table 3). Only 47 million tons are considered to have a high potential for development, although more than 2 billion tons have a moderate potential for development. Nearly 340 million tons have a low development potential. Restricted coals amount to 158 million tons.

Surface-minable resources Estimates of this Davis coal (reliability classes I and II) are nearly 40 million tons for Gallatin and 65 million tons for Saline County.

COAL QUALITY

Appendix E summarizes the chemical analyses available in the ISGS files for the Davis and Dekoven Coals. Unless otherwise noted, ranges and averages for the analysis of individual samples cited below are on an as-received basis.

Samples with unusually high moisture content are marked in the tables of appendix E with an asterisk in the moisture column. Mine notes did not indicate why these samples had such a high moisture (for example, a rainfall before sampling). Neither moist samples nor composite samples were used in the computation of the statistics below.

Total sulfur values for both coals are typical for coals in the Illinois Basin, which are generally high sulfur (by the usual definition of 2.5% or more total sulfur). The average heating values for each coal on a moist, mineral matter free (mmmf) basis is approximately 14,300 Btu/lb.

Thus, these coals fall in the rank of highly volatile, bituminous A coal as defined by the ASTM standards. This is the expected rank for southern Illinois coals, which typically rank higher than coals to the northwest (Damberger et al. 1989).

Davis Coal

The ash content of the Davis Coal ranges from 7.6% to 17.8% with an average of 8.4%. Sulfur content averages 3.2% and ranges from 2.0% to 4.7%. Moisture ranges from 1.9% to 7.0% for the Davis Coal and averages 4.4%.

Heating values range from 11,435 to 13,400 Btu/lb with an average of 12,917 Btu/lb. The heating value for the Davis averages 14,386 Btu/lb on a mmmf basis. Fixed carbon averages 51%, and volatile matter averages 35.7% for the Davis Coal.

Dekoven Coal

The ash content of the Dekoven averages 11% and ranges from 8.1% to 16.9%. Total sulfur varies from 2.3% to 5.5% and averages 3.7%. Moisture averages about 4.3% and ranges from 2.3% to 6.6%.

The heating value in these samples averages 12,524 Btu/lb and ranges from 11,445 to 13,157 Btu/lb. The Dekoven averages 14,360 Btu/lb on a mmmf basis. Volatile matter averages 36.4%, and fixed carbon averages 48.3%. The ash content of most of the Dekoven and Davis falls within the range of 6% to 14% typically seen in Illinois Basin coals (Damberger et al. 1989).

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APPENDIX A
COMPUTER HARDWARE, SOFTWARE, AND METHODOLOGY

Much of the map work and the resource tabulations for this study were done on a Prime 9955 minicomputer. More than 1,500 drill-hole records were interpreted and entered into the INFO database package that resided on the Prime. Data entered into this database included location, surface elevation, depth, type of data utilized, thickness of the key stratigraphic units between the Houchin Creek Coal and the Carrier Mills Shale, and the lithology and thickness of the Dekoven Coal parting.

Contour maps of thickness, depth, and structure of the Davis and Dekoven Coals were then generated with the help of the ARC software, which allows the generation of various types of lines (arcs) on map plots and the calculation of the areas inside of the polygons formed by the intersection of lines on those maps. Once the data were converted into a form that ARC could use, contour maps were generated for each of the coals. Buffers were generated around datum points for reliability classes IA, IB, and II. The ARC software has specific routines that allow buffers to be generated around datum points at a specified distance. The 150-foot overburden line was constructed by hand from the interpolation between the coal structure maps and the topographic maps covering the area. This line was digitized and added to the same file as the thickness contours.

The next step in the process was to generate the oil-field buffers on the map for areas that are intensively drilled for oil and gas. Two buffers of 150 and 475 feet were drawn around all oil-well datum points in the ISGS Geologic Record Unit's computer files for the study area. These buffers were combined so that densely drilled areas could be shown on the maps. Mining laws require a 150-foot barrier of unmined coal to be left around wells. This restriction generally makes it difficult to develop standard mine entries in areas where wells are laid out on a 20-acre spacing (450–475 feet between wells). Densely drilled areas were defined in this study as all areas with wells spaced less than 950 feet apart. The areas had to be at least two wells wide and have a minimum of four wells. Two wells wide was defined as two other wells at right angles within 950 feet. This definition allowed delineation of all areas with wells drilled on 20-acre spacing or less. The lines from the 475-foot (half of the 950 feet in the definition) buffers were used to determine which wells lie within this 20-acre pattern. These areas were combined with the 150-foot buffers to delineate areas of dense drilling that were removed from the coal resource data (designated oil-wells in the tables).

The thickness contour lines were combined with the reliability buffers, oil-well buffers, 150-foot overburden line, and mined-out areas on a single map for each given area. These maps were plotted to produce plates 1 through 3.

Two more items were then added to the computer file that contained the thickness, oil, reliability, mined-out-area, and 150-foot overburden polygons. First, topographic maps at a scale of 1:62,500 (the scale of 15-minute quadrangle maps) were used to digitize public lands (e.g., parks and the Shawnee National Forest) and urban areas into the computer file. The resulting arcs or lines were converted to polygons. Similarly, the coal-depth contour map files mentioned earlier were converted from arcs to polygon files. The two digitized files, topographic and depth contour data, were combined with the other computer files containing the thickness, oil, reliability, mined-out area, and 150-foot overburden polygons. The resulting file containing these maps was then converted into a file of polygons, from which the ARC/INFO program could compute the area within each of the polygons. Two ARC/INFO programs were written to then calculate the area in each of the polygons, convert the data, and tabulate the coal resources for each of the three coals by reliability and by development potential. The first program also calculated the resources at less than the 150-foot depth using the polygons created by the 150-foot overburden line. The tabulations from this program are found in appendices B and C.

APPENDIX B
DEKOVEN COAL RESOURCES, GALLATIN AND SALINE COUNTIES

Table B1 Dekoven resources in Gallatin County.

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T7S, R8E	Deep	36	0	37,108	10,489	3,433
		48	0	2,920	604	79
		Total	0	40,028	11,093	3,512
		Township total	0	40,028	11,093	3,512
T7S, R9E	Deep	36	0	35,118	8,757	3,811
		48	0	8,255	4,124	1,259
		60	0	0	499	0
		Total	0	43,373	13,380	5,070
		Township total	0	43,373	13,380	5,070
T7S, 10E	Deep	36	0	8,925	15,541	1,797
		48	0	4,781	5,019	2,276
		60	0	804	84	180
		Total	0	14,510	20,644	4,253
		Township total	0	14,510	20,644	4,253
T8S, R8E	Deep	36	0	37,061	63,667	2,825
		48	0	3,391	20,424	449
		Total	0	40,452	84,091	3,274
		Township total	0	40,452	84,091	3,274
T8S, R9E	Deep	36	3,157	57,008	14,101	6,120
		48	5,301	29,729	3,648	3,128
		60	0	1,405	730	0
		Total	8,458	88,142	18,479	9,248
		Township total	8,458	88,142	18,479	9,248
T8S, R10E	Deep	36	2,441	42,041	6,972	9,029
		48	256	28,164	10,423	2,344
		60	0	2,658	19,820	13
		Total	2,697	72,863	37,215	11,386
		Township total	2,697	72,863	37,215	11,386
T8S, R11E	Deep	36	0	0	3,670	0
		48	0	0	1,614	0
		60	0	0	314	0
		Total	0	0	5,598	0
		Township total	0	0	5,598	0

Table B1 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T9S, R8E	Surface	24	428	639	0	44
		36	0	766	16	440
		48	401	1	0	0
		Total	829	1,406	16	484
	Deep	36	3,015	24,752	32,352	3,915
		48	1,750	4,077	10,978	0
		Total	4,765	28,829	43,330	3,915
		Township total	5,594	30,235	43,346	4,399
T9S, R9E	Surface	48	897	5,323	0	0
		Total	897	5,323	0	0
	Deep	36	1,140	41,054	14,301	3,814
		48	6,923	25,228	12,887	747
		60	0	159	6,327	0
		Total	8,063	66,441	33,515	4,561
		Township total	8,960	71,764	33,515	4,561
T9S, R10E	Deep	36	719	6,279	25,704	2,351
		48	190	16,287	44,438	0
		60	0	0	348	0
		Total	909	22,566	70,490	2,351
		Township total	909	22,566	70,490	2,351
T9S, R11E	Deep	36	0	0	525	0
		48	0	0	443	0
		Total	0	0	968	0
		Township total	0	0	968	0
T10S, R8E	Surface	24	0	150	0	0
		36	1,481	8,947	228	3
		48	61	76	0	0
		Total	1,542	9,173	228	3
	Deep	36	4,957	34,608	356	1,781
		48	1,021	18	0	0
		Total	5,978	34,626	356	1,781
		Township total	7,520	43,799	584	1,784
T10S, R9E	Surface	24	2	8	0	0
		36	4,755	8,667	0	0
		48	82	0	0	0
		Total	4,839	8,675	0	0
	Deep	36	6,277	46,069	4,444	2,721
		48	3,389	2,223	0	0
		Total	9,666	48,292	4,444	2,721
		Township total	14,505	56,967	4,444	2,721

Table B1 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T10S, R10E	Deep	36	0	744	1,888	0
		Total	0	744	1,888	0
		Township total	0	744	1,888	0
T11S, T9E	Surface	36	0	185	115	0
		Total	0	185	115	0
	Deep	36	0	0	4	0
		Total	0	0	4	0
		Township total	0	185	119	0
T11S, R10E	Surface	36	0	0	466	0
		Total	0	0	466	0
	Deep	36	0	0	556	0
		Total	0	0	556	0
		Township total	0	0	1,022	0
		County total	48,643	525,628	346,876	52,559

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.

Table B2 Dekoven resources in Saline County.

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T7S, R5E	Deep	36	0	2,974	18,796	679
		48	0	0	1,894	568
		60	0	0	256	135
		Total	0	2,974	20,946	1,382
		Township total	0	2,974	20,946	1,382
T7S, R6E	Deep	36	0	4,299	13,064	517
		48	0	0	606	56
		60	0	0	149	0
		Total	0	4,299	13,819	573
		Township total	0	4,299	13,819	573
T7S, R7E	Deep	36	1	10,347	10,600	160
		48	0	9	2,158	0
		Total	1	10,356	12,758	160
		Township total	1	10,356	12,758	160
T8S, R5E	Deep	36	1,312	38,645	32,517	3,880
		48	0	6,992	14,222	459
		60	0	0	32	23
		Total	1,312	45,637	46,771	4,362
		Township total	1,312	45,637	46,771	4,362
T8S, R6E	Deep	36	814	16,278	19,589	2,015
		48	35	395	2,143	268
		60	0	0	4	0
		Total	849	16,673	21,736	2,283
		Township total	849	16,673	21,736	2,283
T8S, R7E	Deep	36	2,203	52,315	24,942	13,813
		48	279	4,381	2,235	736
		60	0	0	335	122
		Total	2,482	56,696	27,512	14,671
		Township total	2,482	56,696	27,512	14,671
T9S, R5E	Deep	36	1,330	38,102	19,283	4,070
		48	0	11,367	8,111	509
		60	0	757	1,195	0
		Total	1,330	50,226	28,589	4,579
		Township total	1,330	50,226	28,589	4,579
T9S, R6E	Deep	36	18,998	46,486	19,638	19,296
		48	2,617	4,505	35	2,551
		60	0	829	0	0
		Total	21,615	51,820	19,673	21,847
		Township total	21,615	51,820	19,673	21,847

Table B2 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T9S, R7E	Surface	24	166	0	0	0
		36	2,528	12	75	57
		48	125	0	0	0
		Total	2,819	12	75	57
	Deep	36	38,244	40,417	28,191	366
		48	972	261	1,116	0
		Total	39,216	40,678	29,307	366
		Township total	42,035	40,690	29,382	423
T10S, R5E	Surface	24	0	4	0	0
		36	7,045	7,903	0	472
		48	46	2,372	0	0
		Total	7,091	10,279	0	472
	Deep	36	12,324	7,081	0	2,520
		48	2,765	8,080	0	0
		Total	15,089	15,161	0	2,520
		Township total	22,180	25,440	0	2,992
T10S, R6E	Surface	24	709	70	0	0
		36	7,656	8,285	2,205	0
		48	201	0	0	0
		60	2	0	0	0
		Total	8,568	8,355	2,205	0
	Deep	36	13,731	8,294	0	317
		48	1,832	0	0	0
		60	356	0	0	0
		Total	15,919	8,294	0	317
		Township total	24,487	16,649	2,205	317
T10S, R7E	Surface	24	913	1,231	0	224
		36	4,018	4,710	12	940
		48	991	0	0	17
		Total	5,922	5,941	12	1,181
	Deep	36	7,071	7,569	98	825
		48	52	0	0	0
		Total	7,123	7,569	98	825
		Township total	13,045	13,510	110	2,006
		County total	129,336	334,970	223,501	55,595

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.

Table B3 Lower Dekoven resources in Gallatin County.

Township and range	Minable resource type[a]	Thickness (in.)		Tonnage (in thousands) IA	IB	IIA	Restricted[b]
T7S, R8E	Deep	36		0	1,673	21	52
			Total	0	1,673	21	52
			Township total	0	1,673	21	52
T7S, R9E	Deep	36		0	1,364	0	0
			Total	0	1,364	0	0
			Township total	0	1,364	0	0
T7S, R10E	Deep	36		0	0	449	0
			Total	0	0	449	0
			Total	0	0	449	0
T8S, R8E	Deep	36		0	434	1,272	275
			Total	0	434	1,272	275
			Township total	0	434	1,272	275
T8S, R9E	Deep	36		0	1,802	0	259
		48		0	417	0	0
			Total	0	2,219	0	259
			Township total	0	2,219	0	259
T8S, R10E	Deep	36		0	275	0	115
			Total	0	275	0	115
			Township total	0	275	0	115
			County total	0	5,965	1,742	701

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.
[b] Restricted totals include oil pools.

Table B4 Lower Dekoven resources in Saline County.

Township and range	Minable resource type[a]	Thickness (in.)		Tonnage (in thousands) IA	IB	IIA	Restricted[b]
T7S, R5E	Deep	36		0	0	4,198	39
			Total	0	0	4,198	39
			Township total	0	0	4,198	39
T7S, R6E	Deep	36		0	0	395	131
			Total	0	0	395	131
			Township total	0	0	395	131
T7S, R7E	Deep	36		0	113	1,481	0
		48		0	0	527	0
			Total	0	113	2,008	0
			Township total	0	113	2,008	0
T8S, R5E	Deep	36		0	2,260	3,306	76
			Total	0	2,260	3,306	76
			Township total	0	2,260	3,306	76
T8S, R6E	Deep	36		16	8,059	18,210	290
			Total	16	8,059	18,210	290
			Township total	16	8,059	18,210	290
T8S, R7E	Deep	36		285	5,174	845	451
		48		0	103	0	0
			Total	285	5,277	845	451
			Total	285	5,277	845	451
T9S, R6E	Deep	36		0	43	484	0
			Total	0	43	484	0
			Township total	0	43	484	0
			County total	301	15,752	29,446	987

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.
[b] Restricted totals include oil pools.

APPENDIX C
DAVIS COAL RESOURCES, GALLATIN AND SALINE COUNTIES

Table C1 Davis resources in Gallatin County.

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T7S, R8E	Deep	36	0	6,555	3,408	1,150
		48	0	52,478	10,084	5,718
		60	0	1,328	605	38
		Total	0	60,361	14,097	6,906
		Township total	0	60,361	14,097	6,906
T7S, R9E	Deep	36	0	1,039	2,866	196
		48	0	36,416	11,218	5,475
		60	0	23,743	1,251	1,165
		72	0	2,762	0	0
		Total	0	63,960	15,335	6,836
		Township total	0	63,960	15,335	6,836
T7S, R10E	Deep	36	0	0	1,861	14
		48	0	12,394	23,825	3,880
		60	0	5,393	2,844	1,258
		72	0	942	254	0
		Total	0	18,729	28,784	5,152
		Township total	0	18,729	28,784	5,152
T8S, R8E	Deep	36	0	3,949	3,505	74
		48	0	51,201	74,970	2,897
		60	0	700	27,101	1,570
		72	0	0	7,128	0
		Total	0	55,850	112,704	4,541
		Township total	0	55,850	112,704	4,541
T8S, R9E	Deep	36	326	2,687	104	4
		48	7,476	102,995	21,611	10,357
		60	2,086	13,691	1,624	1,734
		72	0	72	0	0
		Total	9,888	119,445	23,339	12,095
		Township total	9,888	119,445	23,339	12,095
T8S, R10E	Deep	36	297	6,934	7,999	774
		48	3,233	67,234	22,547	13,619
		60	0	10,748	5,182	1,199
		72	0	2,840	0	0
		Total	3,530	87,756	35,728	15,592
		Township total	3,530	87,756	35,728	15,592

Table C1 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T8S, R11E	Deep	36	0	0	7,202	0
		48	0	0	2,702	0
		60	0	0	332	0
		Total	0	0	10,236	0
		Township total	0	0	10,236	0
T9S, R8E	Surface	36	659	467	0	0
		48	379	1,680	21	676
		Total	1,038	2,147	21	676
	Deep	36	474	9,169	16,874	0
		48	4,773	17,719	35,653	4,640
		60	0	2,969	8,087	1,544
		72	0	0	768	0
		Total	5,247	29,857	61,382	6,184
		Township total	6,285	32,004	61,403	6,860
T9S, R9E	Surface	36	672	3,991	0	0
		Total	672	3,991	0	0
	Deep	36	0	8,035	3,654	1,112
		48	2,185	44,085	16,709	1,918
		60	7,821	28,470	12,640	3,298
		72	0	4,677	7,969	0
		Total	10,006	85,267	40,972	6,328
		Township total	10,678	89,258	40,972	6,328
T9S, R10E	Deep	36	0	0	14,313	0
		48	957	17,199	55,565	3,135
		60	237	9,325	5,441	0
		72	0	10	0	0
		Total	1,194	26,534	75,319	3,135
		Township total	1,194	26,534	75,319	3,135
T9S, R11E	Deep	36	0	0	857	0
		Total	0	0	857	0
		Township total	0	0	857	0
T10S, R8E	Surface	36	0	128	0	0
		48	2,036	12,152	304	4
		Total	2,036	12,280	304	4
	Deep	36	2,699	8,111	0	0
		48	7,637	48,074	475	2,538
		Total	10,336	56,185	475	2,538
		Township total	12,372	68,465	779	2,542

Table C1 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T10S, R9E	Surface	36	2,604	1,268	0	0
		48	2,760	9,850	0	0
		60	0	46	0	0
		Total	5,364	11,164	0	0
	Deep	36	449	6,639	0	72
		48	11,762	50,707	5,041	4,221
		60	4,901	15,842	1,137	0
		72	28	65	0	0
		Total	17,140	73,253	6,178	4,293
		Township total	22,504	84,417	6,178	4,293
T10S, R10E	Deep	48	0	991	2,517	0
		Total	0	991	2,517	0
		Township total	0	991	2,517	0
T11S, R9E	Surface	48	0	247	154	0
		Total	0	247	154	0
	Deep	48	0	0	6	0
		Total	0	0	6	0
		Township total	0	247	160	0
T11S, R10E	Surface	48	0	0	622	0
		Total	0	0	622	0
	Deep	48	0	0	741	0
		Total	0	0	741	0
		Township total	0	0	1,363	0
		County total	66,451	708,017	429,771	74,280

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.

Table C2 Davis resources in Saline County.

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T7S, R5E	Deep	36	0	0	9,007	183
		48	0	3,501	47,439	2,419
		60	0	5,023	14,676	33
		Total	0	8,524	71,122	2,635
		Township total	0	8,524	71,122	2,635
T7S, R6E	Deep	36	0	322	22,490	678
		48	0	8,185	38,044	230
		60	0	5,240	1,696	0
		Total	0	13,747	62,230	908
		Township total	0	13,747	62,230	908
T7S, R7E	Deep	36	0	914	8,204	0
		48	1	15,232	50,398	214
		60	0	1,913	4,736	0
		Total	1	18,059	63,338	214
		Township total	1	18,059	63,338	214
T8S, R5E	Deep	36	379	3,754	7,774	173
		48	1,113	48,741	48,143	4,359
		60	533	33,009	16,975	1,885
		72	4	3,800	1,577	27
		Total	2,029	89,304	74,469	6,444
		Township total	2,029	89,304	74,469	6,444
T8S, R6E	Deep	36	5	8,760	18,754	2,052
		48	3,647	48,080	55,789	4,787
		60	0	7,393	10,260	775
		72	0	0	74	0
		Total	3,652	64,233	84,877	7,614
		Township total	3,652	64,233	84,877	7,614
T8S, R7E	Deep	36	500	8,486	5,179	2,645
		48	3,353	69,613	33,934	16,571
		60	312	9,705	6,472	3,334
		72	0	37	0	0
		Total	4,165	87,841	45,585	22,550
		Township total	4,165	87,841	45,585	22,550
T9S, R5E	Deep	36	0	2,333	2,120	0
		48	2,340	66,072	62,936	7,241
		60	0	20,526	7,528	190
		Total	2,340	88,931	72,584	7,431
		Township total	2,340	88,931	72,584	7,431

Table C2 *continued*

Township and range	Minable resource type[a]	Thickness (in.)	Tonnage (in thousands) IA	IB	IIA	Restricted
T9S, R6E	Deep	36	2,188	2,367	0	192
		48	24,435	68,647	31,716	30,442
		60	1,768	4,416	2,762	531
		72	0	1,117	0	0
		Total	28,391	76,547	34,478	31,165
		Township total	28,391	76,547	34,478	31,165
T9S, R7E	Surface	36	63	0	0	0
		48	2,799	16	100	75
		60	1,238	0	0	0
		Total	4,100	16	100	75
	Deep	36	6,435	1,456	1,139	43
		48	40,954	38,939	37,189	432
		60	5,053	16,656	0	0
		Total	52,442	57,051	38,328	475
		Township total	56,542	57,067	38,428	550
T10S, R5E	Surface	36	1,238	1,481	0	0
		48	7,496	10,931	0	630
		60	364	18	0	0
		Total	9,098	12,430	0	630
	Deep	36	5,497	3,751	0	0
		48	10,992	12,645	0	3,360
		60	1,092	0	0	0
		Total	17,581	16,396	0	3,360
		Township total	26,679	28,826	0	3,990
T10S, R6E	Surface	24	212	4	0	0
		36	1,998	2,694	0	0
		48	9,160	7,632	2,942	0
		60	253	0	0	0
		Total	11,623	10,330	2,942	0
	Deep	36	3,935	1,651	0	0
		48	14,765	8,861	0	421
		60	1,301	0	0	0
		Total	20,001	10,512	0	421
		Township total	31,624	20,842	2,942	421
T10S, R7E	Surface	24	233	176	0	0
		36	1,606	4,683	0	508
		48	4,095	2,202	16	996
		60	1,073	0	0	23
		Total	7,007	7,061	16	1,527
	Deep	36	408	0	0	0
		48	9,028	10,335	132	1,102
		60	561	0	0	0
		Township total	9,997	10,335	132	1,102
		County total	17,004	17,396	148	2,629

[a] Surface-minable resources occur at depths of less than 150 feet. Deep-minable resources occur at depths of greater than 150 feet.

APPENDIX D
DEVELOPMENT POTENTIAL OF DEEP-MINABLE COAL RESOURCES

Table D1 Development potential of Dekoven Coal in Gallatin County.

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T7S, R8E	36	0	0	47,597	489	0	2,944
	48	0	3,524	0	0	0	79
	Total	0	3,524	47,597	489	0	3,023
T7S, R9E	36	0	0	43,875	164	0	3,647
	48	0	7,055	5,324	0	0	1,259
	60	0	499	0	0	0	0
	Total	0	7,554	49,199	164	0	4,906
T7S, R10E	36	0	0	24,466	719	0	1,078
	48	0	9,800	0	1,273	0	1,003
	60	0	888	0	0	0	180
	Total	0	10,688	24,466	1,992	0	2,261
T8S, R8E	36	0	0	100,728	435	0	2,390
	48	0	23,815	0	0	0	449
	Total	0	23,815	100,728	435	0	2,839
T8S, R9E	36	0	0	74,266	1,172	0	4,948
	48	0	38,574	104	1,094	0	2,034
	60	0	2,135	0	0	0	0
	Total	0	40,709	74,370	2,266	0	6,982
T8S, R10E	36	0	0	51,454	0	0	9,029
	48	0	38,737	106	0	0	2,344
	60	0	22,478	0	0	0	13
	Total	0	61,215	51,560	0	0	11,386
T8S, R11E	36	0	0	3,670	0	0	0
	48	0	1,614	0	0	0	0
	60	0	314	0	0	0	0
	Total	0	1,928	3,670	0	0	0
T9S, R8E	36	0	0	60,119	2,921	994	0
	48	0	16,805	0	0	0	0
	Total	0	16,805	60,119	2,921	994	0
T9S, R9E	36	0	0	56,495	3,274	0	540
	48	0	45,038	0	683	0	64
	60	0	6,486	0	0	0	0
	Total	0	51,524	56,495	3,957	0	604

Table D1 *continued*

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T9S, R10E	36	0	0	32,702	2,351	0	0
	48	0	59,732	1,183	0	0	0
	60	0	348	0	0	0	0
	Total	0	60,080	33,885	2,351	0	0
T9S, R11E	36	0	0	525	0	0	0
	48	0	443	0	0	0	0
	Total	0	443	525	0	0	0
T10S, R8E	36	0	0	39,921	0	1,781	0
	48	0	1,039	0	0	0	0
	Total	0	1,039	39,921	0	1,781	0
T10S, R9E	36	0	0	56,790	0	2,721	0
	48	0	5,612	0	0	0	0
	Total	0	5,612	56,790	0	2,721	0
T10S, R10E	36	0	0	2,632	0	0	0
	Total	0	0	2,632	0	0	0
T11S, R9E	36	0	0	4	0	0	0
	Total	0	0	4	0	0	0
T11S, R10E	36	0	0	556	0	0	0
	Total	0	0	556	0	0	0
	County total	0	284,936	602,517	14,575	5,496	32,001

Table D2 Development potential of Dekoven Coal in Saline County.

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T7S, R5E	36	0	0	21,770	99	0	580
	48	0	744	1,150	17	0	551
	60	0	256	0	0	0	135
	Total	0	1,000	22,920	116	0	1,266
T7S, R6E	36	0	0	17,363	0	0	517
	48	0	606	0	0	0	56
	60	0	149	0	0	0	0
	Total	0	755	17,363	0	0	573
T7S, R7E	36	0	0	20,948	160	0	0
	48	0	2,167	0	0	0	0
	Total	0	2,167	20,948	160	0	0
T8S, R5E	36	0	0	72,474	2,805	0	1,075
	48	0	21,214	0	180	0	279
	60	0	32	0	0	0	23
	Total	0	21,246	72,474	2,985	0	1,377
T8S, R6E	36	0	0	36,681	1,147	0	868
	48	0	2,573	0	137	0	131
	60	0	4	0	0	0	0
	Total	0	2,577	36,681	1,284	0	999
T8S, R7E	36	0	0	79,460	8,673	0	5,140
	48	0	6,895	0	112	0	624
	60	0	335	0	0	0	122
	Total	0	7,230	79,460	8,785	0	5,886
T9S, R5E	36	0	0	58,715	4,070	0	0
	48	0	19,478	0	509	0	0
	60	0	1,952	0	0	0	0
	Total	0	21,430	58,715	4,579	0	0
T9S, R6E	36	0	0	85,122	19,296	0	0
	48	0	7,157	0	2,551	0	0
	60	0	829	0	0	0	0
	Total	0	7,986	85,122	21,847	0	0
T9S, R7E	36	0	0	106,852	100	266	0
	48	0	2,349	0	0	0	0
	Total	0	2,349	106,852	100	266	0
T10S, R5E	36	0	0	19,405	2,520	0	0
	48	0	10,845	0	0	0	0
	Total	0	10,845	19,405	2,520	0	0
T10S, R6E	36	0	0	22,025	317	0	0
	48	0	1,832	0	0	0	0
	60	356	0	0	0	0	0
	Total	356	1,832	22,025	317	0	0

Table D2 *continued*

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T10S, R7E	36	0	0	14,738	0	825	0
	48	0	52	0	0	0	0
	Total	0	52	14,738	0	825	0
	County total	356	79,469	556,703	42,693	1,091	10,101

Table D3 Development potential of Davis Coal in Gallatin County.

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T7S, R8E	36	0	0	9,963	46	0	1,104
	48	0	62,562	0	1,683	0	4,035
	60	0	1,933	0	38	0	0
	Total	0	64,495	9,963	1,767	0	5,139
T7S, R9E	36	0	0	3,905	0	0	196
	48	0	14,174	33,460	219	0	5,256
	60	0	24,994	0	0	0	1,165
	72	85	2,677	0	0	0	0
	Total	85	41,845	37,365	219	0	6,617
T7S, R10E	36	0	0	1,861	0	0	14
	48	0	36,129	90	1,739	0	2,141
	60	0	8,237	0	617	0	641
	72	1,196	0	0	0	0	0
	Total	1,196	44,366	1,951	2,356	0	2,796
T8S, R8E	36	0	0	7,454	0	0	74
	48	0	125,310	861	583	0	2,314
	60	0	27,801	0	0	0	1,570
	72	7,128	0	0	0	0	0
	Total	7,128	153,111	8,315	583	0	3,958
T8S, R9E	36	0	0	3,117	0	0	4
	48	0	113,046	19,036	2,660	0	7,697
	60	0	17,401	0	0	0	1,734
	72	72	0	0	0	0	0
	Total	72	130,447	22,153	2,660	0	9,435
T8S, R10E	36	0	0	15,230	0	0	774
	48	0	91,690	1,324	0	0	13,619
	60	0	15,930	0	0	0	1,199
	72	2,840	0	0	0	0	0
	Total	2,840	107,620	16,554	0	0	15,592
T8S, R11E	36	0	0	7,202	0	0	0
	48	0	2,702	0	0	0	0
	60	0	332	0	0	0	0
	Total	0	3,034	7,202	0	0	0
T9S, R8E	36	0	0	26,517	0	0	0
	48	0	58,145	0	2,877	1,763	0
	60	2,042	9,014	0	1,544	0	0
	72	768	0	0	0	0	0
	Total	2,810	67,159	26,517	4,421	1,763	0
T9S, R9E	36	0	0	11,689	1,112	0	0
	48	0	62,979	0	1,132	0	786
	60	5,146	43,785	0	3,298	0	0
	72	12,646	0	0	0	0	0
	Total	17,792	106,764	11,689	5,542	0	786

Table D3 *continued*

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T9S, R10E	36	0	0	14,313	0	0	0
	48	0	68,038	5,683	3,135	0	0
	60	0	15,003	0	0	0	0
	72	10	0	0	0	0	0
	Total	10	83,041	19,996	3,135	0	0
T9S, R11E	36	0	0	857	0	0	0
	Total	0	0	857	0	0	0
T10S, R8E	36	0	0	10,810	0	0	0
	48	0	56,186	0	0	2,538	0
	Total	0	56,186	10,810	0	2,538	0
T10S, R9E	36	0	0	7,088	0	72	0
	48	0	67,510	0	0	4,221	0
	60	0	21,880	0	0	0	0
	72	93	0	0	0	0	0
	Total	93	89,390	7,088	0	4,293	0
T10S, R10E	48	0	3,508	0	0	0	0
	Total	0	3,508	0	0	0	0
T11S, R9E	48	0	6	0	0	0	0
	Total	0	6	0	0	0	0
T11S, R10E	48	0	741	0	0	0	0
	Total	0	741	0	0	0	0
	County total	32,026	951,713	180,460	20,683	8,594	44,323

Table D4 Development potential of Davis Coal in Saline County.

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T7S, R5E	36	0	0	9,007	0	0	183
	48	0	23,886	27,054	315	0	2,104
	60	0	19,699	0	30	0	3
	Total	0	43,585	36,061	345	0	2,290
T7S, R6E	36	0	0	22,812	98	0	580
	48	0	42,192	4,037	17	0	213
	60	0	6,936	0	0	0	0
	Total	0	49,128	26,849	115	0	793
T7S, R7E	36	0	0	9,118	0	0	0
	48	0	65,631	0	214	0	0
	60	0	6,649	0	0	0	0
	Total	0	72,280	9,118	214	0	0
T8S, R5E	36	0	0	11,907	107	0	66
	48	0	97,997	0	2,984	0	1,375
	60	0	50,517	0	1,133	0	752
	72	5,381	0	0	27	0	0
	Total	5,381	148,514	11,907	4,251	0	2,193
T8S, R6E	36	0	0	27,519	1,544	150	358
	48	0	107,516	0	3,185	0	1,602
	60	0	17,653	0	223	0	552
	72	74	0	0	0	0	0
	Total	74	125,169	27,519	4,952	150	2,512
T8S, R7E	36	0	0	14,165	2,106	0	539
	48	0	106,900	0	10,345	0	6,226
	60	0	16,489	0	1,616	0	1,718
	72	37	0	0	0	0	0
	Total	37	123,389	14,165	14,067	0	8,483
T9S, R5E	36	0	0	4,453	0	0	0
	48	0	131,348	0	7,241	0	0
	60	0	28,054	0	190	0	0
	Total	0	159,402	4,453	7,431	0	0
T9S, R6E	36	0	0	4,555	192	0	0
	48	0	124,798	0	30,442	0	0
	60	1,768	7,178	0	531	0	0
	72	1,117	0	0	0	0	0
	Total	2,885	131,976	4,555	31,165	0	0
T9S, R7E	36	0	0	9,030	0	43	0
	48	0	117,082	0	134	298	0
	60	3,296	18,413	0	0	0	0
	Total	3,296	135,495	9,030	134	341	0

Table D4 *continued*

Township and range	Thickness (in.)	Tonnage (in thousands)					
					Restricted classes		
		High	Moderate	Low	Urban	Public land	Oil
T10S, R5E	36	0	0	9,248	0	0	0
	48	0	23,637	0	3,360	0	0
	60	1,092	0	0	0	0	0
	Total	1,092	23,637	9,248	3,360	0	0
T10S, R6E	36	0	0	5,586	0	0	0
	48	0	23,626	0	421	0	0
	60	1,301	0	0	0	0	0
	Total	1,301	23,626	5,586	421	0	0
T10S, R7E	36	0	0	408	0	0	0
	48	0	19,495	0	0	1,102	0
	60	561	0	0	0	0	0
	Total	561	19,495	408	0	1,102	0
	County total	14,627	1,055,696	158,899	66,455	1,593	16,271

APPENDIX E
CHEMICAL ANALYSES OF COAL SAMPLES

Table E1 Chemical analyses of coal samples—Davis Coal.

Location (section, township, range)	Company/mine name	Lab. no.	Date	As received												
				Proximate				Ultimate						Sulfur, moisture free	Btu/lb moist, mineral free	Chlorine, moisture free
				Moist.	Volatile matter	Fixed C	Ash	S	H	C	N	O	Btu/lb			
10-10S-4E	Peabody/Will Scarlet	C-15337	1968	3.9	37.9	44.5	13.7	3.8					11,979	4.0	14,193	
10-10S-4E	Peabody/Will Scarlet	C-15401	1968	4.2	35.6	42.3	17.8	4.4					11,435	4.6	14,139	
10-10S-4E	Peabody/Will Scarlet	C-15402	1968	4.1	36.2	44.3	15.4	4.0	4.7	65.8	1.4	8.7	11,826	4.1	14,331	0.07
10-10S-4E	Peabody/Will Scarlet	C-18351	1974	4.2	37.7	43.4	14.7	3.8	5.2	66.5	1.1	8.7	11,970	4.0	14,353	1.10
23-10S-7E	Colbert	A-5529	1921	3.4	33.3	55.2	8.1	4.3					13,400	4.4	14,831	
20-10S-5E	Pat Ross Co.	A-17122	1927	3.3	35.1	52.1	9.4						12,913		14,374	
35-10S-9E	Country Bank	A-23424		3.4	35.2	52.5	8.9	2.9					13,193	3.0	14,697	
20-10S-5E	Saxton Cc/ New Castle	C-8717	1954	5.6	36.2	49.7	8.5	2.8					12,739	3.0	14,112	
20-10S-5E	Saxton Cc/New Castle	C-8718	1954	6.6	37.1	48.5	7.8	3.1					12,751	3.3	14,022	
20-10S-5E	Saxton Cc/New Castle	C-8719	1954	7.8*	33.7	47.9	10.6	3.7					12,099	4.0	13,770	
20-10S-5E	Saxton Cc/New Castle	C-8720	1954	6.7	35.5	48.8	9.1	3.2	5.4	69.3	1.4	11.6	12,497	3.4	13,946	
4-10S-7E	Youngs Cc/Somerset	C-13825	1965	7.0	36.7	48.5	7.8	3.4					12,591	3.7	13,849	
5-10S-7E	Saxton Cc/Somerset	C-11200	1959	4.2	37.6	50.4	7.9	3.0					12,904	3.2	14,193	
5-10S-7E	Saxton Cc/Somerset	C-11201	1959	6.8	36.5	48.5	8.2	3.2					12,471	3.5	13,774	
5-10S-7E	Saxton Cc/Somerset	C-11202	1959	4.9	37.5	49.4	8.3	3.7					12,720	3.8	14,078	
5-10S-7E	Saxton Cc/Somerset	C-11203	1959	5.4	36.7	49.8	8.1	3.3	5.4	70.2	1.8	11.2	12,705	3.4	14,026	
28-10S-9E	Peabody/Eagle Strp	C-18085	1973	2.9	37.1	51.3	8.7	2.5					13,185	2.5	14,642	
28-10S-9E	Peabody/Eagle Strp	C-18086	1973	4.2	36.3	51.8	7.7	2.0					13,189	2.0	14,442	
28-10S-9E	Peabody/Eagle Strp	C-18087	1973	4.5	36.6	48.7	10.2	3.0					12,711	3.2	14,386	
28-10S-9E	Peabody/Eagle Strp	C-18088	1973	4.0	36.3	51.2	8.5	2.5	4.8	71.6	1.5	11.1	13,008	2.6	14,411	
23-10S-7E	Sterling Mid	C-9185	1955	1.9	32.9	52.2	13.0	4.7	4.8	70.4	1.3	5.8	12,784	4.8	15,060	
23-10S-7E	Sterling Mid	C-9377	1956	3.1	32.0	55.3	9.6	3.3					13,286	3.4	14,940	

* Samples with unusually high moisture content.

Table E2 Chemical analyses of coal samples—Dekoven Coal.

Location (section, township, range)	Company/mine name	Lab. no.	Date	As received												
				Proximate				Ultimate								
				Moist.	Volatile matter	Fixed C	Ash	S	H	C	N	O	Btu/lb	Sulfur, moisture free	Btu/lb moist, mineral free	Chlorine, moisture free
18-10S-5E	Stonefort Cc/Will Scarlet	C-8733	1954	11.2*	34.0	44.4	10.4	2.1	5.4	61.7	1.2	19.1	10,933	2.4	12,359	0.20
10-10S-4E	Peabody/WillScarlet	C-15332	1968	4.2	39.4	43.4	13.0	5.1					12,076	5.3	14,221	
10-10S-4E	Peabody/Will Scarlet	C-15333	1968	4.2	39.6	39.4	16.9	5.5					11,445	5.8	14,183	
10-10S-4E	Peabody/Will Scarlet	C-15334	1968	4.7	41.2	42.7	11.4	4.0					12,352	4.2	14,221	
10-10S-4E	Peabody/Will Scarlet	C-15335	1968	4.5	41.6	42.4	11.5	5.3					12,232	5.6	14,129	
10-10S-4E	Peabody/Will Scarlet	C-15336	1968	4.5	40.6	41.4	13.6	4.8	5.6	66.1	1.3	8.7	11,976	5.0	14,189	0.08
10-10S-4E	Peabody/Will Scarlet	C-18349	1974	3.8	42.7	43.6	9.9	4.5	5.3	67.1	1.2	11.9	12,814	4.7	14,503	0.06
10-10S-4E	Peabody/Will Scarlet	C-18350	1974	3.9	40.6	42.3	13.3	5.4	5.2	67.0	1.1	8.0	12,347	5.6	14,613	0.20
20-10S-5E	Saxton Cc/New Castle	C-8777	1954	11.8*	32.3	47.9	8.0	1.7					11,101	1.9	12,186	
20-10S-5E	Saxton Cc/New Castle	C-8778	1954	4.5	37.5	46.1	11.8	4.9					12,323	5.1	14,289	
20-10S-5E	Saxton Cc/New Castle	C-8779	1954	5.8	36.5	44.2	13.6	4.1					11,863	4.4	14,031	
20-10S-5E	Saxton Cc/New Castle	C-8780	1954	4.3	37.5	44.9	13.3	5.0					12,085	5.2	14,278	
20-10S-5E	Saxton Cc/New Castle	C-8781	1954	6.6	35.6	46.0	11.8	4.0	5.1	65.0	1.3	12.9	11,817	4.2	13,652	
4-10S-7E	Youngs Cc	C-13821	1965	5.8	37.7	48.4	8.1	3.2					12,765	3.3	14,083	
4-10S-7E	Youngs Cc	C-13822	1965	6.6	36.3	47.8	9.2	3.4					12,444	3.7	13,926	
4-10S-7E	Youngs Cc	C-13823	1965	5.6	37.4	47.9	9.2	3.0					12,588	3.1	14,059	
4-10S-7E	Youngs Cc	C-13824	1965	6.1	36.9	48.3	8.7	3.2	5.1	68.2	1.4	13.3	12,591	3.4	13,998	
28-10S-9E	Peabody/Eagle Strip	C-18089	1973	2.4	28.7	59.3	9.6	2.3	4.9	72.8	1.6	8.8	13,157	2.4	14,754	
30-10S-6E	Brown Bros.	C-17599	19x0	14.1*	30.5	47.3	8.1	1.3					10,283	1.6	11,283	
10-10S-6E	Jader Fuel/Jader	C-18302	1974	2.4	39.4	46.8	11.4	4.4					12,728	4.5	14,672	
10-10S-6E	Jader Fuel/Jader	C-18303	1974	2.3	40.1	47.3	10.3	4.1					12,912	4.2	14,661	
10-10S-6E	Jader Fuel/Jader	C-13804	1974	2.4	39.5	47.4	10.6	4.1	5.4	70.2	1.1	8.5	12,865	4.3	14,679	
23-10S-7E	Sterling Mid	C-9378	1956	3.3	33.0	50.0	13.7	2.7					12,557	2.8	14,844	

* Samples with unusually high moisture content.