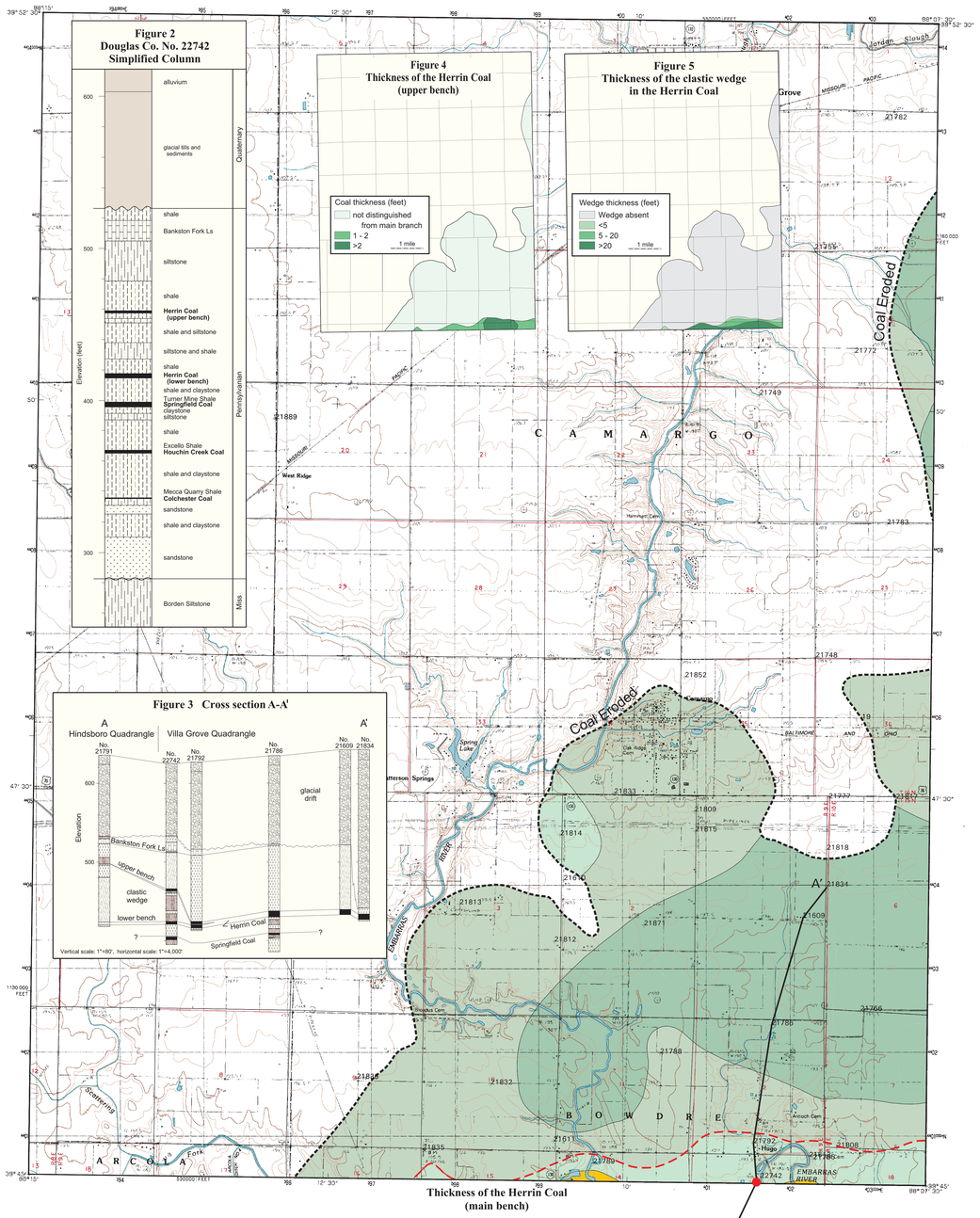
Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Villa Grove-CR
William W. Shilts, Chief
1999

COAL RESOURCES MAP AND AVAILABILITY FOR MINING

Villa Grove Quadrangle, Douglas County, Illinois

C. G. Treworgy



DISCLAIMER: This map is based on interpretations of available data obtained from a variety of sources. Most locations of data are not verified and interpretations based upon them are not guaranteed by the ISGS. This map was prepared as part of a project for geologic mapping, resource evaluation, and planning, and does not replace the need for detailed site-specific studies. The slight skewness in the orientation of the map is due to map projection. Public Land Survey township lines in this part of the state do not run true north-south or east-west.

For furthur information about this map contact:
ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody
Champaign Illinois 61820-6964

(217)244-2414

http://www.isgs.uiuc.edu

Released by the authority of the State of Illinois: 1999

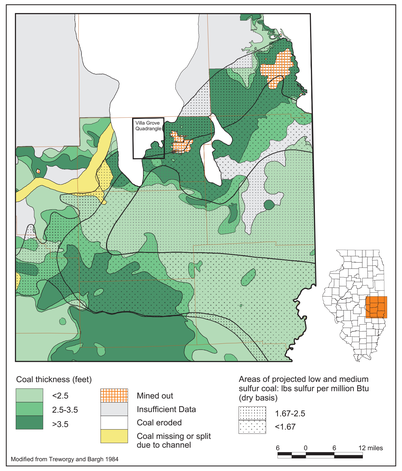


Figure 1
Thickness of the Herrin Coal in east-central Illinois

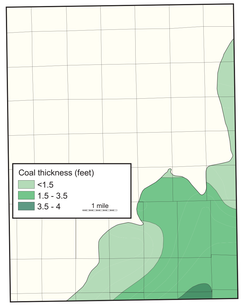


Figure 6
Thickness of the Springfield Coal

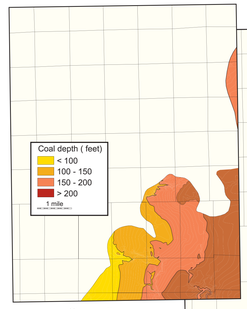


Figure 7a
Depth to top of the Herrin Coal (main bench)

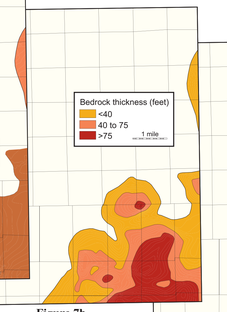


Figure 7b
Thickness of the bedrock above the Herrin Coal (main bench)

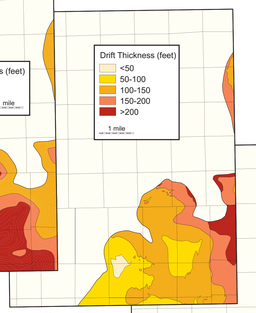


Figure 7c
Thickness of the drift above the Herrin Coal

Figure 7 The thickness and composition of earth materials overlying the Herrin Coal. The Springfield Coal lies 15 to 25 feet below.

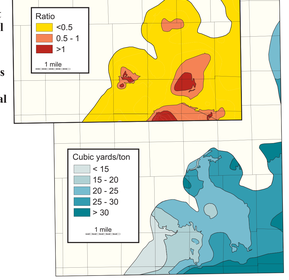


Figure 7d
Ratio of the thickness of bedrock to drift above the Herrin Coal (main bench)

Figure 7e
Stripping ratio of the Herrin Coal (both benches)

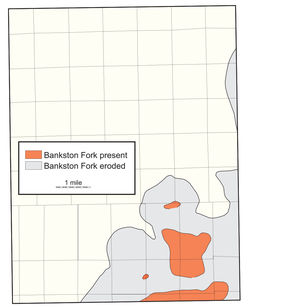


Figure 7f
Areas of Herrin Coal overlain by Bankston Fork Limestone

Coal Resources in the Villa Grove Quadrangle

The Villa Grove Quadrangle is on the northwest edge of the largest known remaining deposit of low- to medium-sulfur coal in the state (fig. 1). Analysis of a core drilled by the Illinois State Geological Survey (ISGS) confirmed the low sulfur content of the Herrin Coal in the quadrangle (table 1). The area of lowest sulfur coal is believed to extend for several miles south and east of the quadrangle. More than 100 million tons of Herrin Coal are present in the eastern and southern parts of the Villa Grove Quadrangle, but adverse geologic conditions may make the coal uneconomical to mine using current technology. The best conditions for underground mining are in the southeastern part of the quadrangle and probably extend to the south. Although the depth and thickness of the seam are favorable for surface mining, the thickness of glacial and alluvial overburden relative to bedrock overburden is considerably more than that of any surficial material previously stripped in the state.

Table 1 Analyses of coal from ISGS core hole #22742 (as-received basis).

	Herrin (upper bench)	Herrin (lower bench)	Springfield
Moisture (%)	9.27	10.94	8.71
Ash (%)	12.78	9.14	18.67
Volatile matter (%)	34.72	31.47	31.53
Fixed carbon (%)	43.22	48.44	41.09
Sulfur (%)	4.42	1.09	7.71
Heating Value (Btu/lb)	10,926	10,222	11,451

The southeastern half of the quadrangle is underlain by at least three other seams: the Springfield, Houchin Creek, and Colchester Coals. Data on these coals are limited, and only the Springfield coal resources have been mapped. The Springfield Coal is too thin for underground mining, but surface mining may be economical in a limited area near the center of the south edge of the quadrangle.

The maps and figures on the left side of this sheet depict the geology of the Herrin and Springfield Coals. Those on the right side show the factors that affect the availability of the Herrin Coal for mining and assessments of the availability of the Herrin and Springfield resources for mining using current methods.

Coal Resources

Coals are present in the quadrangle in the Pennsylvanian-aged rocks of the Carbondale and Tradewater Formations. The ISGS core hole on the southeast edge of the quadrangle went through 243 feet of Pennsylvanian strata, including four seams: the Herrin, Springfield, Houchin Creek, and Colchester Coals (fig. 2). These units thin to the northwest as they lap onto the La Salle Anticline. Subsequent erosion removed much or all of the Pennsylvanian rock from the crest of the anticline and pre-Pleistocene bedrock valleys. Data available for this area are sufficient only for mapping resources of the Herrin and Springfield Coals. The other two seams are believed to be too thin to be of economic interest at this time. Coal resources were mapped using records from coal and oil test holes drilled in and adjacent to the quadrangle.

Herrin Coal The Herrin Coal has been eroded from all but the southeast quarter and east edge of the Villa Grove Quadrangle (see map, *Thickness of the Herrin Coal {main bench}*). Along the southern margin of the quadrangle, the Herrin Coal is split into two benches separated by a wedge-shaped deposit of siltstone and shale (figs. 3, 4, and 5). The split begins as a parting a few inches thick, but thickens abruptly from a few inches to more than 35 feet over a distance of a 1/4 mile. The upper bench of coal, approximately the upper third of the seam, can be traced as much as 2 miles beyond the south edge of the quadrangle. The lower, or main bench of coal, is present over an area of thousands of square miles in east-central Illinois.

Previous studies have shown that the formation of pyritic sulfur in coal is limited if thick accumulations of clastic sediments were deposited on the peat before or shortly after transgression of the coal swamp by marine water (Gluskoter and Simon 1968). The Herrin Coal in this quadrangle, as well as in much of east-central Illinois, is overlain by gray shale and siltstone (Treworgy and Jacobson 1985). Although the depositional setting represented by these sediments has not been determined, they apparently were deposited early enough to limit the formation of pyritic sulfur in the coal. The sulfur content of the Herrin Coal below this deposit is commonly 1% to 2.5%, compared with greater than 2.5% in areas where clastic sediment does not overlie the coal. The main bench of coal beneath the sediment wedge had minimal exposure to marine waters because an analysis of the ISGS core showed the main bench to have a sulfur content of just over 1% (table 1). The upper bench had a sulfur content of 4%. Where both benches were together in the mine nearby, the coal has a sulfur content of about 2%.

Springfield Coal The Springfield Coal is present 15 to 25 feet below the Herrin Coal. Although 3.75 feet thick in the ISGS core, other drilling records indicate that the Springfield is commonly less than 3 feet thick throughout its area of occurrence in the quadrangle (fig. 6). The Springfield Coal in the ISGS core had a sulfur content of 7.7%, which is probably on the high side for the Springfield Coal in this area. The coal throughout the quadrangle is expected to have a sulfur content in the range of 3% to 5%.

Availability of Coal Resources for Mining

Millions of tons of coal resources remain in and adjacent to the Villa Grove Quadrangle. When, or whether, these resources will be mined depends on a variety of interrelated factors including the land use and geologic characteristics of the resources, as compared with other coal resources, demand for coal, cost and supply of coal from existing mines, cost and supply of competing fuels, environmental regulations, transportation infrastructure, coal quality, mining technology, and land ownership. Many factors change over time in ways that either enhance or reduce the attractiveness of resources for mining, and most of these factors are beyond the scope of this report. A starting point for understanding the potential for mining these resources is to examine their land use and geologic characteristics, as compared with the characteristics of coal resources currently being mined in the state. This indicates the availability of these resources for mining with current technology and market conditions.

Criteria for Available Coal

Criteria for the restrictions that limit the availability of the Herrin and Springfield Coals for mining in the Villa Grove Quadrangle were developed from interviews with engineers and geologists from companies active in the Illinois mining industry (table 2). Criteria vary depending on the method used to extract the coal. Some shallow resources may be minable by either surface or underground methods. Restrictions to mining fall into two categories: land use and technological.

Land use restrictions are commonly surface development or environmental features that are either specifically protected from mining by law or typically too expensive for mining companies to disturb. For example, State law allows surface mining within 100 feet of dwellings, but because of the cost of mitigating the effects of dust, noise, and vibrations from mining, most companies choose to keep operations at least 1/2 mile from towns. In the Villa Grove Quadrangle, the only major land use restriction is the town of Camargo. Roads, railroads, cemeteries, and pipelines restrict minor amounts of resources.

Technological restrictions are geologic conditions (e.g. seam thickness, size of mining block, type of overburden; table 2) that, given current technology and mining practices, significantly raise the cost of mining. Companies may mine under these conditions in limited areas. In the Villa Grove Quadrangle, the major technological restrictions are related to the overburden (figs. 7a-f).

Surface mining can be restricted by thick deposits of glacial drift or other unlithified sediment because of their potential to slump into the pit, fail under the weight of large draglines, or allow excessive groundwater flow into the pit. A minimum amount of bedrock overburden ensures that the coal is not weathered and provides stable material to hold the toe of the spoil pile.

Underground mining requires adequate bedrock overburden to support the mine roof and seal the mine against water seepage down from the surface. The amount of bedrock overburden required depends on the composition of the bedrock and the thickness of the overlying unconsolidated sediments. Less bedrock is necessary if competent strata such as limestones are present. More bedrock is necessary if the unconsolidated material is thick. Underground mines in areas of thick unconsolidated and thin bedrock overburden experience roof falls, floor squeezes, and influxes of water into the mine. Other technological factors in the Villa Grove Quadrangle are the stripping ratio, size of mining block, and thickness of the seam.

Resources that meet the technological and land use criteria in table 2 are classified as "available" for mining. (Note that this classification is not meant to imply that the landowner is willing to sell or lease the property for mining.) Some resources meet the criteria, but have other limiting conditions. These resources are classified as "available with conditions"; for example, some resources are available for surface mining only if the Herrin and Springfield Coals are mined simultaneously from the same pit. This limitation may render mining of either coal impractical because of the variation in quality (particularly sulfur content) between the two coals. In areas of weak roof strata, some resources are available for underground mining only if larger pillars are left and less of the resource is extracted.

Table 2 Criteria for Assessing the Availability of Coal for Mining

Surface Mining
Technological Restrictions
* Minimum seam thickness
  Main seam: 1 ft
  Overlying seams: 0.5 ft
* Maximum depth: 200 ft
* Maximum unconsolidated overburden
  Coal < 100 ft deep: 2/3 of total overburden
  Coal > 100 ft deep: 1/2 of total overburden
* Minimum bedrock cover: 10 ft
* Stripping ratio (cubic yards of overburden per ton of raw coal)
  Maximum: 25:1
  Maximum average: 20:1
* Minimum size of mine reserve (raw tons in place)
  Individual block: 600 thousand
  Total tonnage: 12 million

Land Use Restrictions
* No mining within 100 ft:
  Cemeteries
  Railroads
  Federal and state highways
  Churches
  Pipelines
* No mining within 0.5 mi. of towns

Underground Mining
Technological Restrictions
* Minimum seam thickness: 3.5 ft
* Minimum bedrock cover:
  If Bankston Fork Limestone present: 40 ft
  If Bankston Fork Limestone absent: 75 ft
  Reduced extraction if bedrock > minimum thickness but bedrock/drift ratio < 1
* Minimum size of mining block: 40 million tons in place

Land Use Restrictions
* No mining within 200 ft:
  Towns
  Cemeteries
  Churches

Available Resources

Of the 107 million tons of resources in the quadrangle, about 6 million tons (6%) are available for mining and another 13 million tons (13%) are available with conditions (table 3, fig. 8). Land use restricts 7 million tons (7%) of the resources, and technological factors restrict 81 million tons (75%) of the resources. Almost all the available resources are in the main bench of the Herrin Coal.

A few thousand tons of the resources of the upper bench of the Herrin Coal and of the Springfield Coal are available for surface mining, but only if mined in combination with the main bench of the Herrin Coal.

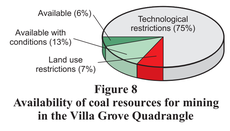


Figure 8
Availability of coal resources for mining in the Villa Grove Quadrangle

About 63 million tons of the resources in the quadrangle are less than 200 feet deep and therefore potentially surface minable. However, only 3 million tons (5%) of these are available for surface mining and an additional 1 million tons (2%) are available with the condition that they are mined in combination with another seam (fig. 9). The remainder are restricted primarily by thickness of the unconsolidated overburden (58%), high stripping ratio (14%), and towns (15%).

Almost 101 million tons of the resources are at least 2.3 feet thick and considered minable by underground methods. Of these, about 3 million tons (4%) are available for underground mining (fig. 10); another 12 million tons (12%) are available with conditions that reduce the amount of coal that can be extracted. Although these resources meet the criteria of minimal thickness for bedrock overburden, the ratio of bedrock to drift overburden is less than 1:1, so it may be necessary to leave larger pillars or mine smaller rooms to prevent mining problems. The remaining resources (71%) are restricted primarily by thin bedrock cover.

Table 3 Availability of coal resources for mining in the Villa Grove Quadrangle; thousands of tons and (percent of original resources)

	Herrin Upper bench		Herrin Main bench		Springfield		Total	
Original	428		86,010		20,846		107,283	
Available			6,071	(7)			6,071	(6)
Available with conditions[1]	26	(6)	12,999	(15)	417	(2)	13,443	(13)
Land use restriction	42	(10)	4,547	(5)	2,607	(13)	7,196	(7)
Technological restriction	360	(84)	62,394	(73)	17,821	(85)	80,574	(75)
Surface minable (0 to 200 ft deep)								
Original	316		56,000		6,751		63,067	
Available			2,967	(5)			2,967	(5)
Available with conditions[2]	26	(8)	942	(2)	417	(6)	1,386	(2)
Land use restriction	7	(2)	9,994	(18)	2,607	(39)	12,608	(20)
Technological restriction	283	(90)	42,097	(75)	3,726	(55)	46,106	(73)
Land use restrictions								
Towns			7,592	(14)	2,062	(30)	9,654	(15)
Cemeteries			87	(<1)	18	(<1)	105	(<1)
Highways	7	(2)	1,145	(2)	234	(3)	1,386	(2)
Pipelines			936	(2)	231	(3)	1,167	(2)
Railroads			234	(<1)	61	(1)	295	(<1)
Technological restrictions								
Stripping ratio	83	(90)	7,426	(13)	1,010	(15)	8,718	(14)
Block size			1,104	(2)	3	(<1)	1,106	(2)
Unconsolidated overburden			33,567	(60)	2,714	(40)	36,281	(58)
Underground minable (>40 ft deep)								
Original	397		86,010		14,341		100,747	
Available			3,484	(4)			3,484	(4)
Available with conditions[3]			11,791	(14)			11,791	(12)
Land use restriction	42	(11)	4,547	(5)	146	(1)	4,735	(5)
Technological restriction	355	(89)	66,187	(77)	14,195	(99)	80,737	(80)
Land use restrictions								
Towns			4,291	(5)			4,291	(4)
Cemeteries	42	(11)	235	(<1)	127	(1)	403	(<1)
Churches			21	(<1)	19	(<1)	40	(<1)
Technological restrictions								
Coal <3.5 ft thick	355	(89)	80	(<1)	2,519	(18)	2,598	(3)
Thin bedrock			65,161	(76)	6,006	(42)	71,168	(71)
Block size			946	(1)	5,670	(40)	6,971	(7)

[1]See specifics for surface minable or underground minable resources.
[2]Available for surface mining only if mined in combination with another seam.
[3]Bedrock to drift ratio of less than 1; difficult mining conditions may be encountered.

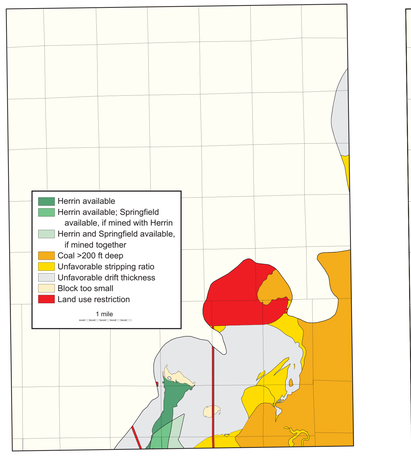


Figure 9
Availability of the Herrin and Springfield Coals for Surface Mining

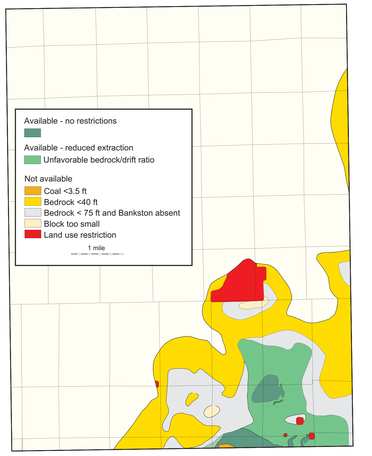


Figure 10
Availability of the Herrin Coal for underground mining

References

Gluskoter, H.J., and J.A. Simon, 1968, Sulfur in Illinois Coals: Illinois State Geological Survey Circular 432, 28 p.

Treworgy, J.D., and M.H. Bargh, compilers, 1984, Coal Resources of Illinois, Herrin (No. 6) Coal: Illinois State Geological Survey map, 1:500,000 scale.

Treworgy, C.G., and R.J. Jacobson, 1985, Paleoenvironments and Distribution of Low-Sulfur Coal in Illinois, *in* A.T. Cross, editor, Compte Rendu of the Ninth International Congress on Carboniferous Stratigraphy and Geology, 1979, v. 4, Economic Geology, Coal Oil and Gas: Southern Illinois University Press, Carbondale, p. 349-359.

Acknowledgments This map is one of a series prepared for the USGS 7.5-minute Villa Grove Quadrangle by a multidisplinary team of geologists from the Illinois State Geological Survey. This series characterizes surface landscapes; surface, bedrock, and engineering geology; and delineates coal, and sand and gravel resources. Zakaria Laserri and Donald G. Mikulic were the Project Coordinators, and funding for the project was by the Illinois State Geological Survey. The criteria and methodology for assessing the availability of coal resources were developed through a series of projects funded by the U.S. Geological Survey (1434- 92A-0940, 93A-1137, 94A-1266, 95A-01346, HQ96AG-01460, HQ97AG-01759). Pamella Carrillo did the design and layout of the map sheet. Phillip J. DeMaris compiled the simplified column of hole No. 22742. Map reviewers included Heinz H. Damberger and C. Pius Weibel.