FINAL TECHNICAL REPORT
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Project Title: **MAPPING THE USABLE CLAY AND SHALE RESOURCES IN THE PEORIA AREA FOR POTENTIAL FLY ASH BRICK MANUFACTURING PLANTS**

ICCI Project Number: 02-1/US-3
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ABSTRACT

Manufacture of high-quality bricks from fly ash requires blending with low-sulfur, non-calcareous shale and fireclay, resources that need to be near the manufacturing site to make the development profitable. The main objective of this project was to map the presence and distribution of suitable shale and fireclay near the Edwards utility site in Peoria County for use in a brick manufacturing plant under consideration. Additionally, the study was expanded to include a preliminary assessment of shale resources near the Meredosia Power Plant in Morgan County. To delineate shale deposits having economic potential within a 15-mile radius of the utility sites, the Illinois State Geological Survey reviewed published and unpublished reports and examined about 2,000 well records. Previous published ISGS work indicated that many shales in the coal-bearing Pennsylvanian Series in the area have the right composition and firing properties for brick manufacture. To better constrain the distribution of near-surface shales, the data compiled from the well records were used to develop contour maps of the depth to top of usable shales (overburden thickness) and shale thickness using a PC-based Geographic Information System (GIS) software. Overburden thickness provided the best guide for delineating areas having the greatest potential for mining these shales where urbanization and other restrictions on mining are limited. Several areas were identified as having thin overburden and limited restrictions and thus high potential for mine development in both the Peoria and Meredosia areas.

EXECUTIVE SUMMARY

Mapping in the Peoria and Meredosia areas has identified potential shale resources that could serve as raw materials to be blended with fly-ash from coal-fired power plants and used to make bricks. Ready access to nearby shale resources, as revealed in this study, improves the opportunity for building a new brick manufacturing plant. Development of a brick manufacturing industry using fly ash can provide a host of economic benefits to the coal and brick industries including: 1) utilization of significant amounts of fly ash now landfilled or stock-pilled in ponds, 2) new business opportunities to commercially produce bricks from fly ash, and 3) new jobs to stimulate the local and state economy.

The original objective of this study was to seek out and map the location and distribution of suitable shale and fireclay deposits near the Edwards utility site in Peoria for use as a raw material to be blended with fly ash from the Edwards Power Plant and used to make bricks. The overall project goal was to concentrate on identifying shale and fireclay resources within 15 miles of the utility site. The original study area later was expanded to include mapping of shale resources within 15 miles of another power plant along the Illinois River valley near Meredosia in Morgan County. The rocks of the Pennsylvanian Series in both the Peoria and Meredosia areas contain abundant shale layers, many of which were historically utilized for making bricks here and elsewhere in the state. Available and published mineralogical and chemical data as well as firing test results indicate that many of these shale deposits are excellent raw material for making red bricks and other red ceramic products.

The project had 3 main tasks. In task 1, available data on the mineralogical composition range and firing properties of shales from the Peoria area were compiled. In task 2, information on shale and fireclay resources in published and unpublished reports on file at the ISGS was reviewed and relevant information was extracted and recorded in a database. In task 3, well records on file at the ISGS for the Peoria area were examined, data on the shale depth (overburden thickness) and shale thickness were compiled, and maps and illustrations showing shale depth, shale thickness, and areas favorable for mining were prepared. Maps and illustrations like those for the Peoria area also were prepared for the Meredosia area. The ISGS's extensive well records and published and unpublished data were essential for the successful completion of this project.

For the Peoria area, more than 1,200 well records from coal and petroleum test borings, water wells, and engineering, stratigraphic and structure test borings were examined. An additional 700 well records were searched for the Meredosia area shale resource assessment. An Excel® spreadsheet was built to record the data on the well location, general lithology, shale depth, shale thickness, and other relevant information extracted from the well records. Additionally, a computer program developed at the ISGS was used to calculate the latitude and longitude for the wells from the township and range legal descriptions in the well records. The spreadsheet data were then imported into a PC-based Geographic Information System (GIS), which was used to map various attributes of the shale resources. Various GIS files such as county and state boundaries, bedrock geology, infrastructure, municipalities, mined out areas (for coal), etc., were extracted from the

ISGS database and a base map was constructed for the areas of interest near the Edwards and Meredosia power plants. The Peoria (Edwards) area study included the western part of Tazewell County, the southern third of Peoria County, and the northeastern corner of Fulton County. The Meredosia study area included parts of Brown, Cass, Morgan, Pike, and Scott Counties within 15 miles of the Meredosia Power Plant.

Shale is a major component of the rocks of the coal-bearing Pennsylvanian Series that occur throughout the area studied. However, to be economically feasible for mining, the shale deposit needs to be near the ground surface. Depth to top of the usable shale, or overburden thickness, is an important factor in defining areas that are suitable for mining. Overburden as defined in this report included the combined thicknesses of unconsolidated surficial sediments, plus any coal, black shale, sandstone, or limestone layers present above the shale layers suitable for brick manufacture. Mining feasibility also is affected by cultural and environmental restrictions such as residential and industrial development, parks, and wetlands, among others.

For this project, maps showing features that limit the availability of shale for mining (municipalities, wetlands, parks, residential developments, etc.) were prepared in addition to the maps of shale depth and shale thickness for both the Peoria and Meredosia areas. The maps have identified several areas that have thin overburden and thus high potential for mine development. Many areas in the following townships: T7N-R6E, T7N-R7E, T8N-R5E, T8N-R6E, and T8N-R7E in Peoria County and T6N-R5E and T7N-R5E in Fulton County, have relatively thin overburden and are potential targets for exploration. These areas are relatively close to the Edwards Power Plant and have the least amount of cultural and environmental restrictions that could limit mine development. The Pennsylvanian Carbondale and Modesto Formations, which form the bedrock surface, underlie the surficial deposits in the area. Both the Carbondale and Modesto contain relatively thick shale layers that have been worked as raw material for manufacturing red bricks in the past.

Our mapping also located several areas near the Meredosia power plant that contain abundant shales in the rocks of Pennsylvanian Series and older formations. The Pennsylvanian rocks that form the bedrock surface in the Meredosia area are the Spoon and Carbondale Formations. Only the Carbondale contains thick shale suitable for brick. The Spoon Formation, which underlies the Carbondale, is quite sandy and the shales in it are generally thin or poor quality for making bricks. Pre-Pennsylvanian rocks are also abundant in the area but the shales in them are too calcareous (limey) to be suitable for making bricks. Excessive carbonate in shales used to make bricks can cause crumbling or “pops” in the bricks that lead to deterioration and structural failure.

The maps produced in this study will be helpful in guiding further investigation of areas identified as having economic shale deposits. To better constrain resources in an area of interest, a site-specific study involving a detailed coring program and sampling will be necessary prior to any exploration activity to determine shale reserves and quality.

OBJECTIVES

The specific goals of the project during the contract period were as follows:

1. Determine the compositional range and firing properties of shale and fireclay needed for the planned shale-fly ash brick plant.
2. Compile information from published and unpublished reports on file at the Illinois State Geological Survey on previous studies of shale and fireclay distribution and the history of past mining in the area.
3. Compile subsurface stratigraphic and lithologic data in the Peoria and Meredosia area and map the distribution of shale and fireclay resources within 15 miles of the Edwards and Meredosia Power Plants.

Evaluation of shale resources near Meredosia Power Plant was not part of the original proposal. It was included in the proposed study later at the ICCI's request.

INTRODUCTION AND BACKGROUND

Recent investigations by the ISGS, funded by the Illinois Clean Coal Institute, have demonstrated that using fly ash, a by-product from coal-burning power plants, as a raw material in bricks is both feasible and economically attractive. There is considerable interest in building a new commercial brick manufacturing plant near an existing power plant, particularly the Edwards utility site in Peoria. However, manufacture of high-quality bricks requires that the fly ash be blended with low-sulfur, non-calcareous shale and fireclay. Resources of these materials must be available near a power plant if the proposed brick plant is to be profitable.

The project originally focused on identifying potential shale and fireclay resources near the Edwards utility site in Peoria, the source of the fly ash for the brick manufacturing plant. The project was later expanded to include mapping of shale resources near Meredosia Power Plant in Morgan County. The database used for this project was compiled from 1) published and unpublished reports by ISGS scientists, 2) ISGS archived well records, and 3) ISGS well and GIS (Geographic Information System) databases. Published and unpublished reports provided previous field-based information that identified areas generally having economic shale resources, chemical and mineralogical analyses, firing properties of clay and shale samples collected in the vicinity, and locations of now abandoned shale pits and brick plants.

Geologically, the Peoria area is characterized by the presence of coal-bearing Pennsylvanian bedrock strata beneath the surficial deposits. Glacial sediments (drift or diamicton), most of which were deposited less than 250,000 years ago, comprise the bulk of the surficial deposits. The thickness of the surficial deposits is an important factor in determining whether mining for shale is economically feasible. Farther downstream from Peoria, especially in the Meredosia area, pre-Pennsylvanian shale and limestone form the bedrock surface in some areas.

Pennsylvanian bedrock in the area consists of alternating layers of sandstone, underclays, coals, shales, and limestone, mostly deposited in repetitive cyclical successions, called cyclothems (Wanless and Weller, 1932) that represent repeated cycles of marine invasion and retreat. Sandier cyclothems are more typical of lower Pennsylvanian strata, whereas clay- and shale-rich cyclothems are more abundant in middle and upper Pennsylvanian strata (Fig. 1). Pre-Pennsylvanian rocks in the Meredosia area consist of limestone and shale. The shale contains too much carbonate material to be suitable for brick manufacturing.

The overall goal of this study was mapping the availability, thickness and distribution of shale and fireclay resources in the rocks of the Pennsylvanian Series and assessing the economic feasibility of mining these deposits. As a result of the project, several areas were identified as having economic shale resources. This will increase the chances for building a new shale-fly ash brick manufacturing plant in the region studied. If built, the new brick manufacturing industry would not only increase utilization of an otherwise unused resource, fly ash, it would also create new jobs, benefiting the State and local economy.

RESULTS AND DISCUSSION

Task 1. Compositional Range and Firing Properties of Shale and Fireclay

For this task we compiled available compositional data from published and unpublished reports and databases on file at the ISGS. A few new shale samples also were analyzed for this project. Mineralogical data are critical because the minerals in the shale strongly affect the type and the amount of shale and fly ash that are required to be used for making bricks.

Mineralogical data and firing properties for a number of shale samples (see Fig. 2 for sample locations) from the Peoria area are given in Table 1A-C. X-ray diffraction data indicates that the clay and shale in Peoria and Tazewell Counties primarily consist of illite, chlorite, kaolinite, and mixed-layer illite-smectite. Quartz is the chief nonclay mineral in the clays and shales. Some samples contained minor amounts of pyrite, siderite, and gypsum. Calcite is especially abundant in the surficial deposits (glacial sediments). These data indicate that the shale in the Peoria area has the right composition for brick manufacture. Laboratory tests in the published reports further indicate that the shales have the proper plasticity and firing properties to be used as raw material for red-burning bricks.

The fireclays and shales in the Pennsylvanian are well suited for use as raw materials for brick manufacture. Ideally, raw materials used to make bricks must contain both enough refractory and generally larger particles (kaolinite and quartz) to maintain the shape of the body during firing, and enough lower-melting point minerals (feldspars, chlorite, and Fe-rich illite) to melt and form a steel-hard body that will have very low water absorption. In some instances, a single shale deposit may contain just the right combination of minerals but, in most cases, fireclay and/or quartz may have to be added to the raw materials either to achieve enough green strength of the body, or to control the color of the fired product. Fireclays are used in the Illinois industry both to lighten the fired color of the body and to increase the strength and fire rating of the body. Because they melt at higher temperatures, kaolinite and mixed-layered kaolinite/expandable clay minerals are the main refractory, framework minerals in fireclays. Quartz and the remaining illite, mixed-layered illite/smectite, and chlorite act as "melters" to harden the body and make it impermeable. Shales that contain abundant expandable clay minerals (mixed-layered illite/semectite) are not good for brick making. Fireclays and shales need to have enough clay minerals for plasticity and green strength and enough sand- and silt-size nonclay minerals to "open" the body for quick firing. The particle size of shales above Illinois coals coarsen upward, which allows producers to blend materials mined from different benches and fireclays to reach an optimal balance between green properties, firing rate and color.

Task 2. Shale and Fireclay Distribution and Past Mining History

Pennsylvanian shale and claystone have been extensively utilized for brick manufacture in the Peoria area and in other regions along the Illinois River valley. Shale was especially used in the manufacture of common, facing, paving, and patio bricks over many decades. Southwest of East Peoria, two major plants utilized the local Pennsylvanian shales to manufacture millions of red bricks for local and distant markets. Brick production continued there until 1982 when the operation closed. The shale used at the plants was taken from pits in small ravines to the east of the plants. A sandy shale under the Herrin Coal in the Carbondale Formation (Fig. 1) furnished the largest part of the raw materials.

The loess (wind-blown, glacial deposits) and associated clay material (ancient soil) in the glacial drift were used to make bricks in the Peoria area and elsewhere in the early days of brick making. The loess was either mixed with shale (1 part loess and 3 parts shale) or used alone to make red bricks. Loess also was blended with shale to add silt and sand to enhance the firing characteristics ("open the body") and to make light-weight bricks. The plants that used loess and ancient clay soil from the glacial drift for brick manufacture included one about half a mile southwest of Bartonville (south of Peoria), one in East Peoria, and another a mile east of Pekin (Udden, 1912).

In general, the glacial deposits and many pre-Pennsylvanian shales are unsuitable for brick manufacture. The glacial deposits cause problems because they typically contain calcite and dolomite, other rock fragments, and sulfur-rich pyrite/marcasite grains. Calcareous materials (calcite or dolomite) convert to lime upon firing and cause crumbling or "pops" in the brick after exposure to moistures. Pyrite and marcasite release SO_2 upon firing and require extra expenses to control sulfur emission. The pre-Pennsylvanian shales tend to have narrower firing temperature ranges because of the abundance of koalinitic clays, they generally do not contain the range of clay minerals required for optimum plasticity and firing, and they also commonly contain excessive amounts of calcareous minerals (Hughes et al., 1987).

In a study published by the ISGS, Odom (1973) described the clay and shale resources in Peoria and Tazewell Counties. This study, which was based on field data, delineated several areas as having potential near-surface shale resources. Compositional data and firing tests showed that many of these shales were suitable for making red bricks (Tables 1A-C). The areas delineated by Odom as having potential near-surface shale resources, their stratigraphic occurrence, and the description of the shales are given in Figure 3 and Table 2. Some of the resources delineated by Odom are no longer available for mining due to urban encroachment, but subsurface mapping for this study based on well records has shown that these shale resources are present over a much broader area than originally mapped (see task 3).

Task 3 Shale Resource Evaluation Using Well Records

To better constrain the areas having economic shales deposits we examined the available records from wells in southern Peoria, western Tazewell and northeastern Fulton Counties in the Peoria area and from the parts of Brown, Cass, Pike, Morgan, and Scott Counties within a 15-mile radius of the Meredosia Power Plant. GIS software was used to compile maps of overburden thickness (depth to top of usable shale units), shale thickness, and cultural and environmental restrictions that limited the prospects for mine development. Because shale is present throughout the area studied, overburden thickness and restrictions provide the best guide for delineating areas having the most potential for mine development. A number of areas near the Edwards and Meredosia utility sites were identified as having thin overburden and limited restrictions, making mine development economically feasible.

Database and methodology

This project primarily relied on data from the ISGS well records to map the shale resources. These records contain descriptions of geologic materials penetrated by wells drilled for water, for coal and petroleum exploration, and for engineering, stratigraphic and structural geology tests. In the Peoria study area, records for approximately 1200 wells, generally within 15 miles of the Edwards power plant, were examined. An additional 700 records near another power plant in the Meredosia area also were studied. Data on the depth to the top of usable shale, shale type and thickness, and other relevant information were compiled in an Excel spreadsheet. A computer program developed at the ISGS was used to convert the legal descriptions for the well locations into latitude and longitude coordinates for the wells. The data were then imported into GIS to prepare the final maps. Various other information such as the boundaries of municipalities, roads, streams, wetlands, mined out areas (coal), etc., in the ISGS's GIS database were used to create base maps for the project, show infrastructures, and delineate restrictions to mining.

During the early phase of the project, the data were used to determine mining feasibility. Areas where the shale was deemed not to be available because of urbanization or excessively thick glacial drift were eliminated. The ISGS statewide drift thickness map, which shows the thickness of unconsolidated glacial sediments (called drift) above the bedrock, was used to restrict the areas around the two power plants to be mapped. In the Peoria area, the drift thickness map showed that the areas to the east and south and areas beyond 10 miles north of the Edwards power plant contained thick glacial deposits and thus were eliminated from further investigation. The heavily urbanized areas in Peoria and the surrounding communities were also eliminated because of the restrictions they posed to mining. In the Peoria area, this confined the mapping to within 10 miles of the power plant in some areas rather than 15 miles as originally proposed. On the other hand, because of a relatively thin glacial drift and limited restrictions to the west, northwest, and southwest of the power plant the study area was extended beyond the 15-mile radius (up to 20 miles).

Task 3A. Peoria area shale resources

Mapping in the Peoria area has identified suitable near-surface shale resources that could serve as raw materials for making bricks blended with fly ash from the coal-fired power plant. The shales, which occur in the rocks of Pennsylvanian-Series, are present throughout the area studied and have been utilized in the past to make red bricks at several major plants in the area. Millions of bricks made from these shales were shipped to local and distant markets until 1982 when the last operation closed in East Peoria.

For mining to be economically feasible, the shale must be near the surface. Overburden thickness or shale depth is, therefore, an important factor in defining areas with available shale resources. Overburden as defined in this report includes the combined thickness of unconsolidated glacial drift plus Pennsylvanian rocks such as sandstone, limestone, coal, and black shale. The other major factor that limits shale availability for mining is restrictions such as commercial and residential developments, urbanization, parks, wetlands, etc.

To delineate the areas with shale deposits that have economic potential, maps were generated from the information compiled from ISGS databases and well records. Information mapped includes such features as well location, state coordinate system, cultural and environmental restrictions, infrastructure, mined out areas (coal), overburden thickness (shale depth), and shale thickness when available. These maps and related illustrations are given in Figures 4 to 12 at the end of this report.

The overburden map, along with cultural and environmental restrictions (Fig. 5, 6) provides a useful guide to prospecting for usable shale deposits in the Peoria area. The map shows that thick overburden (more than 50 feet) primarily occurs in the East Peoria, Pekin, and Morton areas. Shale resources are buried too deeply in these areas to be economically mineable. Overburden is thin in some locations in a strip from East Peoria to the southern part of Pekin. However, this area is currently heavily urbanized and the shale there is no longer available for mining. Mapping has identified several other places in the Peoria area having relatively thin overburden cover and limited restrictions, thus making mine development for shale economically feasible (Fig. 7). Areas to the west of the Edwards Power plant particularly deserve further investigation. These essentially include the areas mapped thus far in the southern third of Peoria County and the northeastern part of Fulton County. These areas are underlain by the Pennsylvanian Carbondale and Modesto Formations both of which contain relatively thick shale beds that have been historically utilized for brick manufacture along the Illinois River valley.

Figure 9 shows the minimum shale thickness for the same area. The data for total shale thickness are more sporadic because many drill holes did not penetrate the full length of the shale-bearing Pennsylvania section. In many wells, particularly water wells, drilling stopped few feet below the bedrock surface. The available data do show that areas with thin overburden (< 35 feet) generally contain at least 15-40 feet of usable shale.

The shale resources in the Peoria area belong to the Pennsylvania Carbondale and Modesto Formations (Fig. 10, 11). The interval between the Colchester (No. 2) Coal and the Lonsdale Limestone within these formations (Fig 11) contains several thick shale layers that are suitable raw material for brick manufacturing. These shales include the Purington Shale above the Colchester Coal, the Canton Shale above the Springfield Coal, the Lawson Shale above the Herrin Coal, and the Farmington Shale above the Danville Coal. The geologic map of the bedrock surface exposed below the unconsolidated sediments (Fig. 10) can be used as a general guide to determine which shales are present near the surface in the area. The Farmington Shale and younger shale units could be the targets for exploration where the Modesto Formation forms the bedrock surface and overburden is relatively thin. In some areas, the Lawson shale, above the Herrin Coal, may also be shallow enough to be minable as well. However, the other major shale units (the Canton and Purington Shales) may lie too deep to be economically mineable. Where the Carbondale Formation forms the bedrock surface, only the Lawson Shale, Canton Shale, or Purington Shale are available for mining where overburden is relatively thin. Representative columnar sections are shown in Figure 12 to illustrate the available shale type and thickness in several areas having potential for mine development.

Task 3B (New Task). Meredosia area shale resources

In response to ICCI's request, the project area was expanded at no extra cost to include evaluation of shale resources near the Meredosia Power Plant in Morgan County. About 700 records from wells within a 15-mile radius of the Meredosia power plant, covering the parts of Brown, Cass, Morgan, Pike, and Scott Counties, were examined for this pilot study. Depth to top of usable shale (overburden thickness), shale thickness, and other relevant information were compiled and maps like those for the Peoria area were prepared using GIS software. These maps and other related illustrations are given in Figures 13-19. Because mapping in the Meredosia area is ongoing, the results presented here are still preliminary. The Meredosia project will be completed as part of the present ICCI-funded project to evaluate shale resource regionally. One goal of the current project is to expand the mapping of shale resources along the Illinois River valley to include areas between the Edwards Power Plant in Peoria and the Meredosia Power Plant in Morgan County by the end of the contract period.

As shown in Figure 15, several areas near the Meredosia Power Plant contain usable shales for brick manufacture. Here the bedrock surface below the unconsolidated sediment includes the Pennsylvanian Spoon and Carbondale formations and Mississippian and older limestones and shales (Fig. 17). The shales in the Carbondale Formation (Fig. 18), especially the Purington Shale, the Canton Shale, and the Lawson Shale, are generally the only ones suitable as raw material for making bricks. Although thick shale layers also are present in the pre-Pennsylvanian rocks, the shales are too calcareous or do not have the right firing properties for brick-making.

CONCLUSIONS AND RECOMMENDATIONS

The shales in the Pennsylvanian Carbondale and Modesto Formations have been historically utilized for brick manufacture in the Illinois River valley. The maps prepared in this study have revealed several areas of shale deposits with relatively thin overburden and minimal restrictions that deserve further consideration. In the vicinity of the Edwards Power Plant, the areas with the highest potential for prospecting include the southern third of Peoria County and the northeastern part of Fulton County. Mapping of the Meredosia area is still ongoing but preliminary results have revealed several areas with potential near-surface shale and clay resources near the Meredosia Power Plant.

Because the available well data are not sufficient to provide site-specific details, these maps should be used only as a general guide for selecting areas where further investigation is likely to produce favorable results. Once a location has been selected for further study, a detailed exploratory program that consists of core drilling and sampling is needed to assess shale thickness and depth and to evaluate mineralogical and physical properties of the shale to be used for brick. Such study must precede land acquisition for potential siting of a new pit to assure that an adequate quantity of suitable shale is available for the potential brick plant.

It should be noted that the well records used for this study were provided by drilling companies and the quality of the information provided varies considerably. The majority of the records are probably accurate, especially those from coal and petroleum test borings. In addition, there could be problems with the accuracy of well locations for some the drill holes used for this study, especially the water wells. Because of time constraints, the well locations were not field-verified. This can be done, however, once a specific location has been decided by the interested parties for further investigation.

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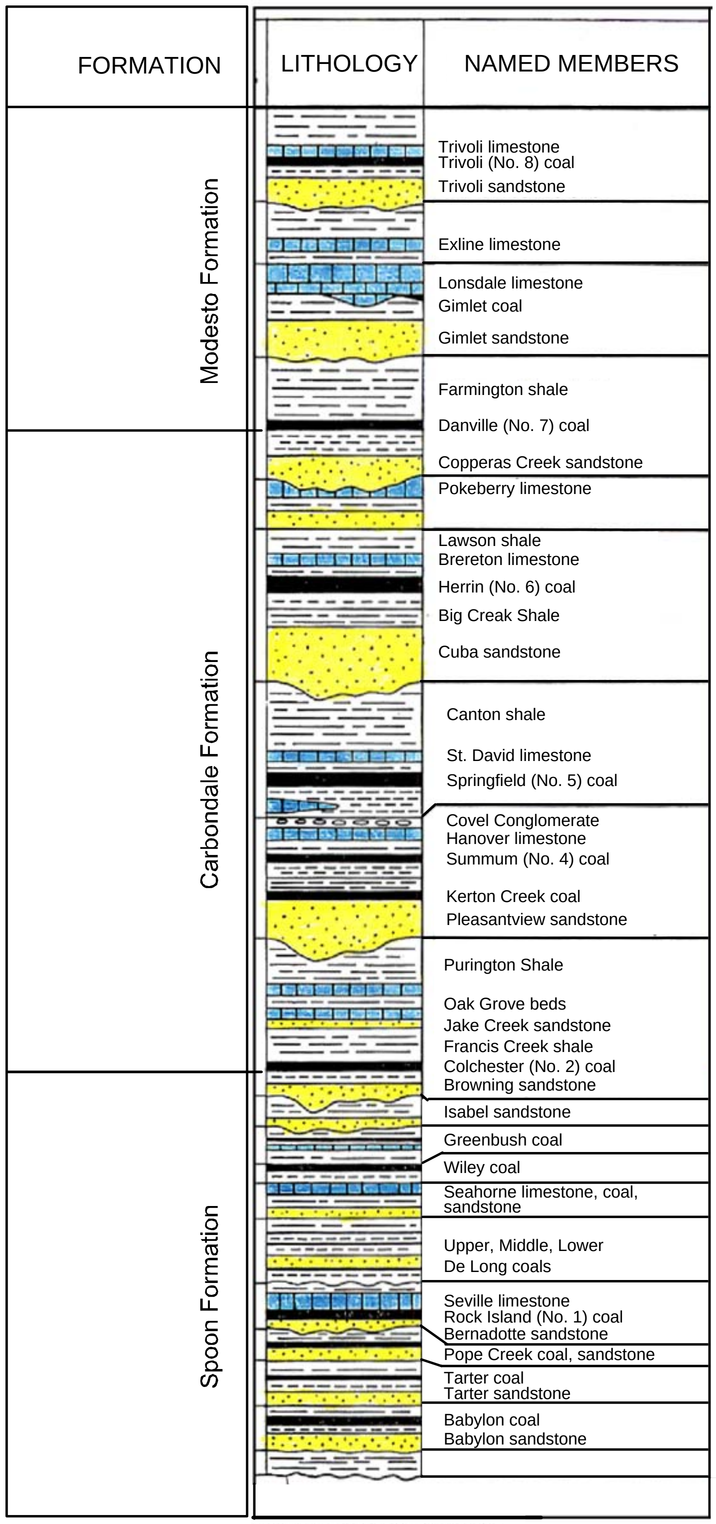

Figure 1 Generalized columnar section of Pennsylvanian strata (from Wanless 1957).

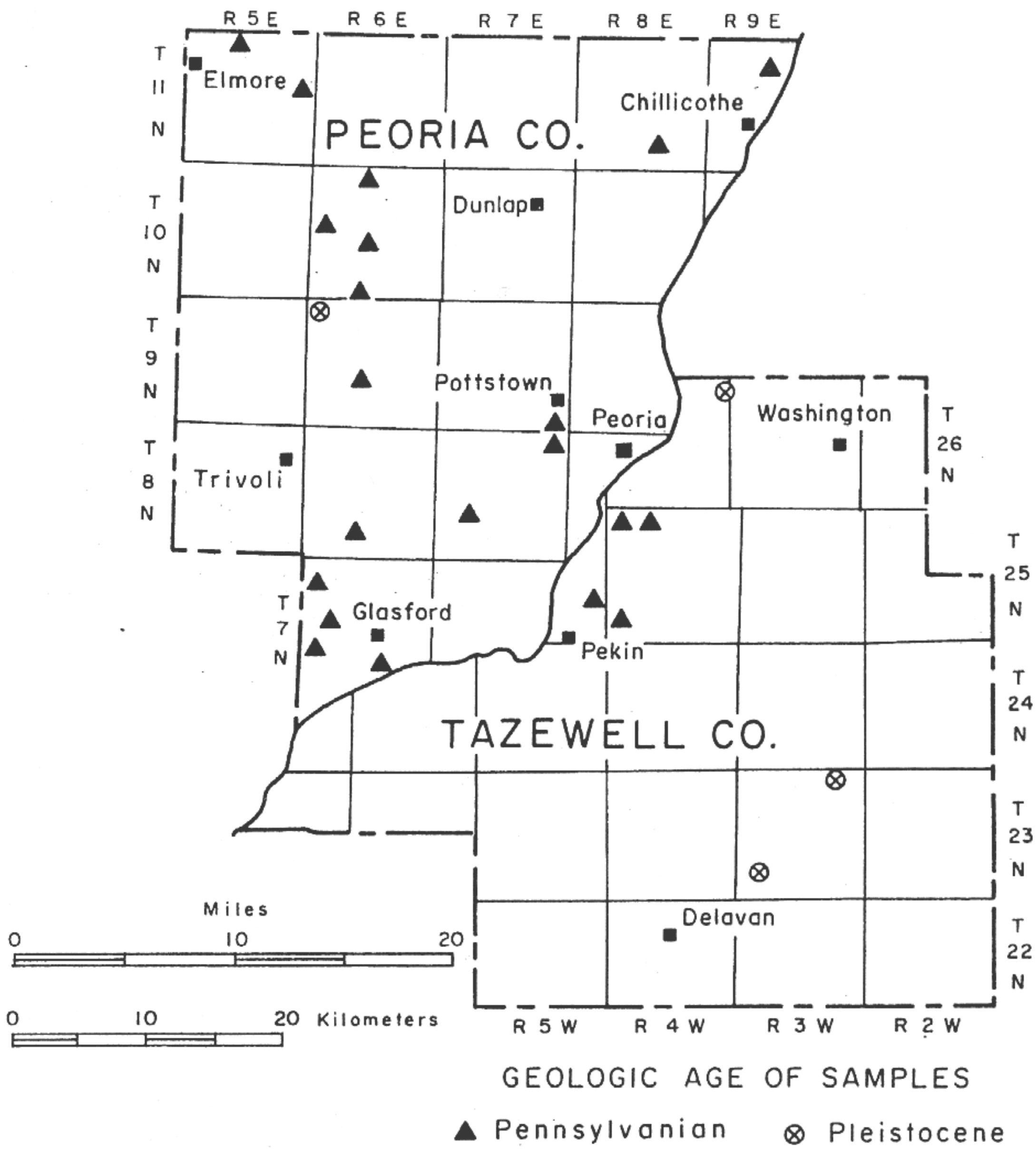

Figure 2 Locations from which samples of clay and shale were taken for testing in Peoria and Tazewell Counties. See Tables 1A-C for details (from Odom, 1973).

TABLE 1A — Properties of Clay and Shale from the Peoria Area

Sample	Location						Lithology	Thickness of unit (ft)	Workability	Water of Plasticity (%)
	1/4	1/4	1/4	Sec.	T.	R.				
PEORIA										
2580	SW	NE		7	7N	6E	Shale	15+	Good	20.5
2581	SW	NW	NW	19	7N	6E	Shale	12+	Good	19.6
2582	NW	SW	SE	27	7N	6E	Shale	12+	Good	22.5
2583	NW	SW	SE	27	7N	6E	Shale	15	Good	22.2
2584	NE	NW		17	7N	7E	Clay	2	Good	27.0
2585	NE	NW		17	7N	7E	Shale	15	Good	21.4
2586	SW	SE	NW	1	8N	7E	Clay	3	Good	23.8
2587	SW	SE	NW	1	8N	7E	Shale	39+	Good	20.6
2588	SW	SE	NW	1	8N	7E	Shale	10+	Good	20.8
TAZEWELL										
2574	NW	SW	SW	30	25N	4W	Clay	2	Good	26.9
2575	NW	SW	SW	30	25N	4W	Shale	6	Good	25.1
2576	SE	SE	NE	24	25N	5W	Shale	7	Good	23.2
2577	SE	SE	NE	24	25N	5W	Clay	2	Good	26.9
2578	SE	SE	NE	24	25N	5W	Shale	6	Good	22.4
2579	NW	NE	NE	6	25N	4W	Shale	25+	Good	20.0
2621	NW	SW	NE	5	25N	4W	Shale	---	Good	19.3

TABLE 1B — Properties of Clay and Shale from the Peoria Area

	Percent clay mineral composition			
Sample	Illite	Chlorite	Kaolinite	Mixed-layer clay
PEORIA				
2580	40	20	20	20
2581	42	22	35	---
2582	50	20	20	10
2583	50	20	10	20
2584	30	---	30	40
2585	46	28	26	---
2586	27	---	52	20
2587	42	12	25	19
2588	55	15	20	10
TAZEWELL				
2574	30	---	10	60
2575	30	---	20	50
2576	40	12	12	36
2577	23	---	27	50
2578	50	26	15	10
2579	49	22	18	10
2621	50	20	17	13

TABLE 1C — Properties of Clay and Shale from the Peoria Area

Sample	Linear drying shrinkage (%)	Firing temperature in degrees Fahrenheit: Linear firing shrinkage 1832°	1922°	2012°	Total linear shrinkage 1832°	1922°	2012°	Fired color 1832°	1922°	2012°
PEORIA										
2580	2.2	4.5	4.5	6.8	6.7	6.7	9.0	red	red	red
2581	2.2	6.8	6.8	9.1	9.0	9.0	11.3	red	red	red
2582	4.4	7.0	7.0	11.5	11.4	11.4	15.9	red	red	red
2583	4.4	11.5	11.5	11.5	15.9	15.9	15.9	red	red	red
2584	6.7	2.1	2.1	4.8	8.8	8.8	11.5	red	red	red
2585	2.2	2.3	4.5	6.8	4.5	6.7	9.0	red	red	red
2586	4.4	2.3	2.3	2.3	6.7	6.7	6.7	buff	buff	buff
2587	2.2	4.5	6.8	6.8	6.7	9.0	9.0	red	red	red
2588	2.2	4.5	6.8	9.1	6.7	9.0	11.3	red	red	red
TAZEWELL										
2574	11.0	7.5	7.5	7.5	18.5	18.5	18.5	red	red	red
2575	11.0	5.0	5.0	5.0	16.0	16.0	16.0	red	red	red
2576	6.7	9.5	9.5	*	16.2	16.2	*	red	red	*
2577	11.0	5.0	5.0	7.5	16.0	16.0	18.5	red	red	red
2578	4.4	7.0	7.0	9.3	11.4	11.4	13.7	red	red	red
2579	4.4	2.3	4.6	9.1	6.7	9.0	13.5	red	red	red
2621	5.5	4.7	7.0	7.2	10.2	12.5	12.7	red	red	brown

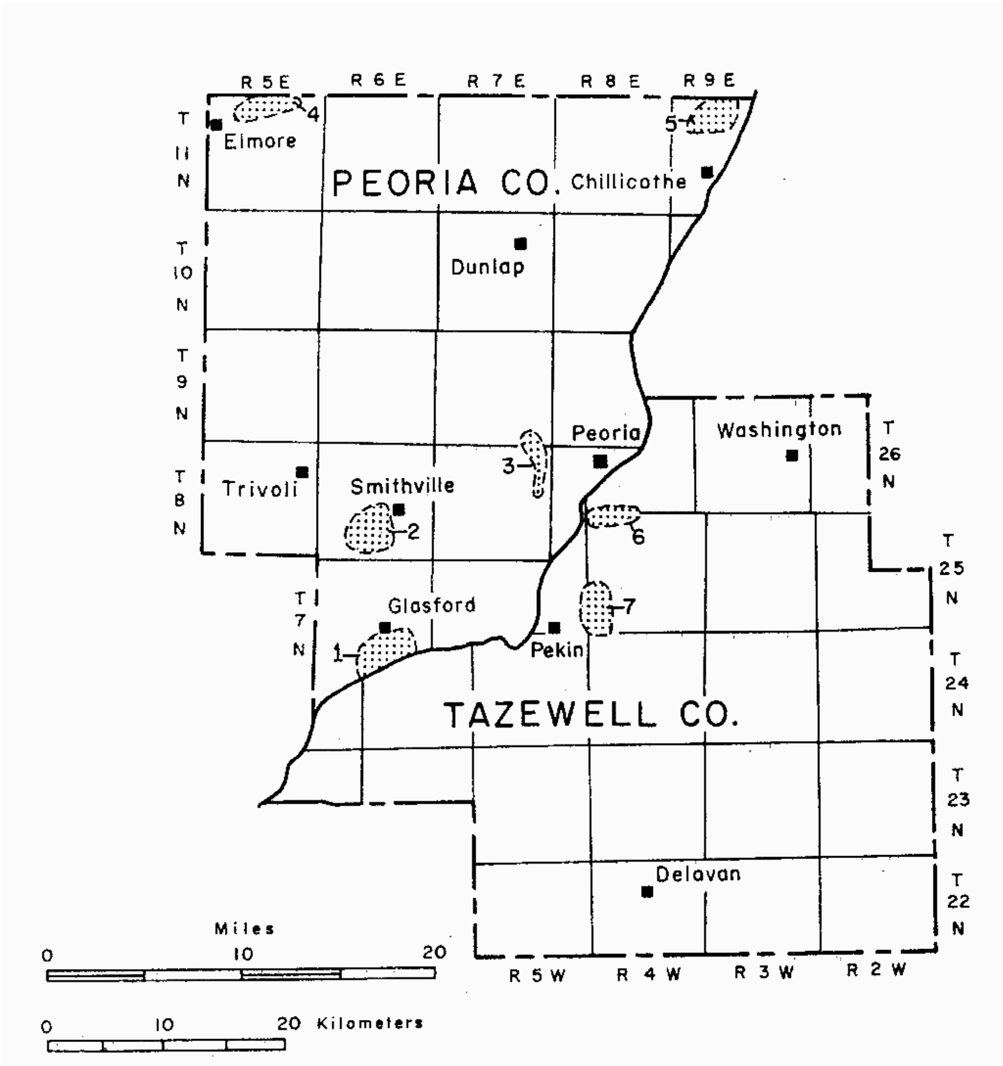

Figure 3 Areas thought to contain bedrock shale or clay deposits of economic potential. The information is based on field data (from Odom, 1973). Areas 6 and 7 are heavily urbanized and no longer available for mining. See Table 2 for details.

TABLE 2

Areas in Peoria County Previously Delineated Having Economic Shale Deposits (data from Odom, 1973; see Figure 3 in this report for details)

Area 1, Figure 3: Secs. 26 and 27, T. 7 N, R. 6 E; Samples 2582 and 2583

Area 1, which is located south of Glasford, contains more than 27 feet of shale that may be used for red clay products. In some places overburden is less than 25 feet thick, but in others overburden could be more than 50 feet thick.

Area 2, Figure 3: Secs. 21, 22, 27, and 28, T. 8 N, R. 6 E; Sample 2620

Area 2 is west and southwest of Smithville, and it contains shale more than 22 feet thick that is suitable for red clay products. Overburden is thin, averaging about 25 feet.

Area 3, Figure 3: Secs. 1 and 2, T. 8 N, R. 7 E; Samples 2586 and 2588

Area 3 lies along Kickapoo Creek Valley south of Pottstown. This area has more than 40 feet of shale suitable for making red clay products. Overburden averages approximately 30 feet.

Area 4, Figure 3: Secs. 3 and 4, T. 11 N, R. 5 E; Samples 2614

Area 4, northeast of Elmore, contains shale more than 25 feet thick that is suitable for making red clay products. Overburden averages 20 to 30 feet thick.

Area 5, Figure 3: Secs. 4, 5, 8 and 9, T. 7 N, R. 9 E; Samples 2624-2627

Area 5 lies along the Illinois River Valley north of Chillicothe. It contains shales more than 30 feet thick that are suitable for making red clay products. There is also up to 8 feet of clay in the area that is suitable for making buff or tan clay products. Overburden varies from 10 to more than 100 feet.

PEORIA AREA SHALE RESOURCES

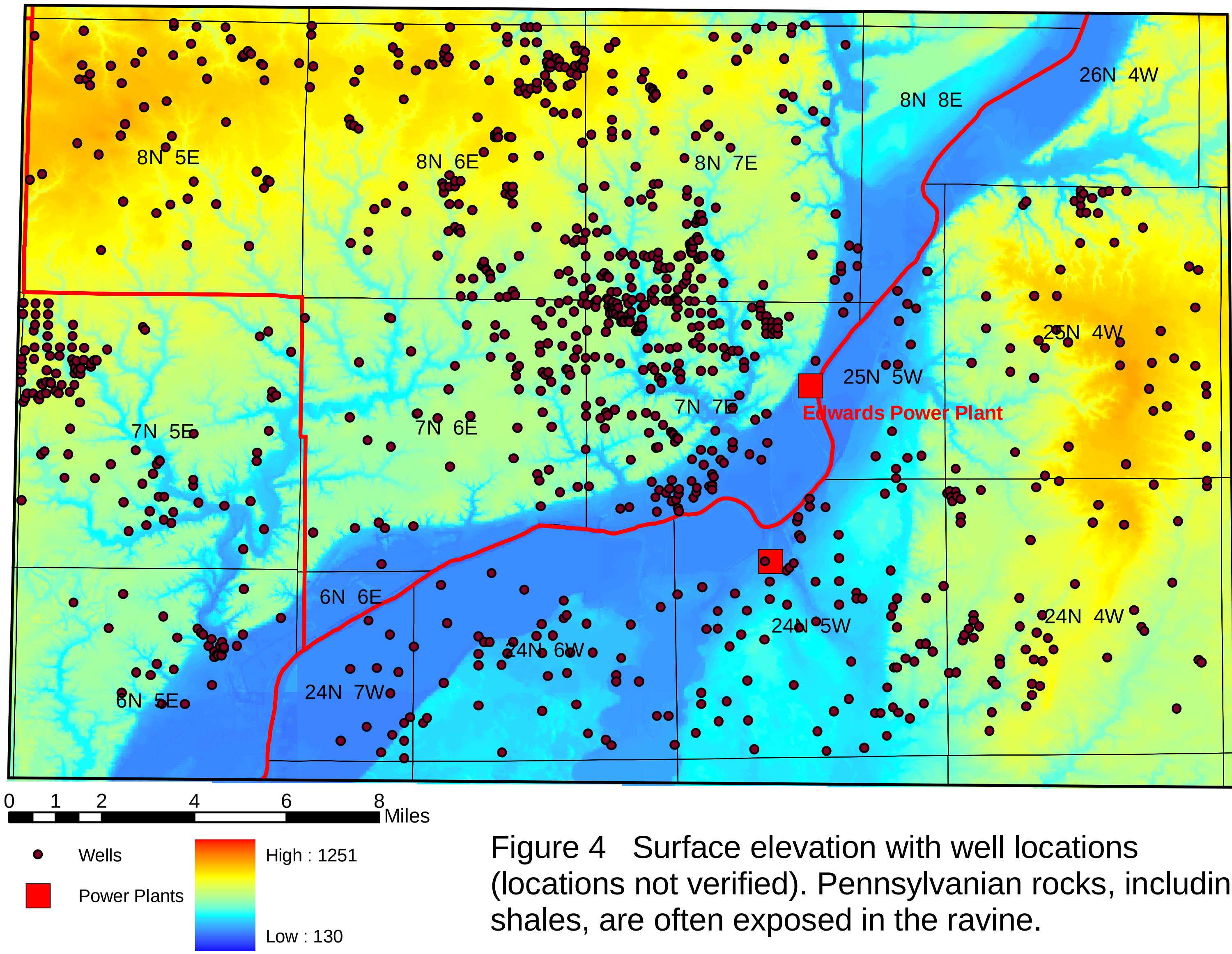

Figure 4 Surface elevation with well locations (locations not verified). Pennsylvanian rocks, including shales, are often exposed in the ravine.

PEORIA AREA SHALE RESOURCES

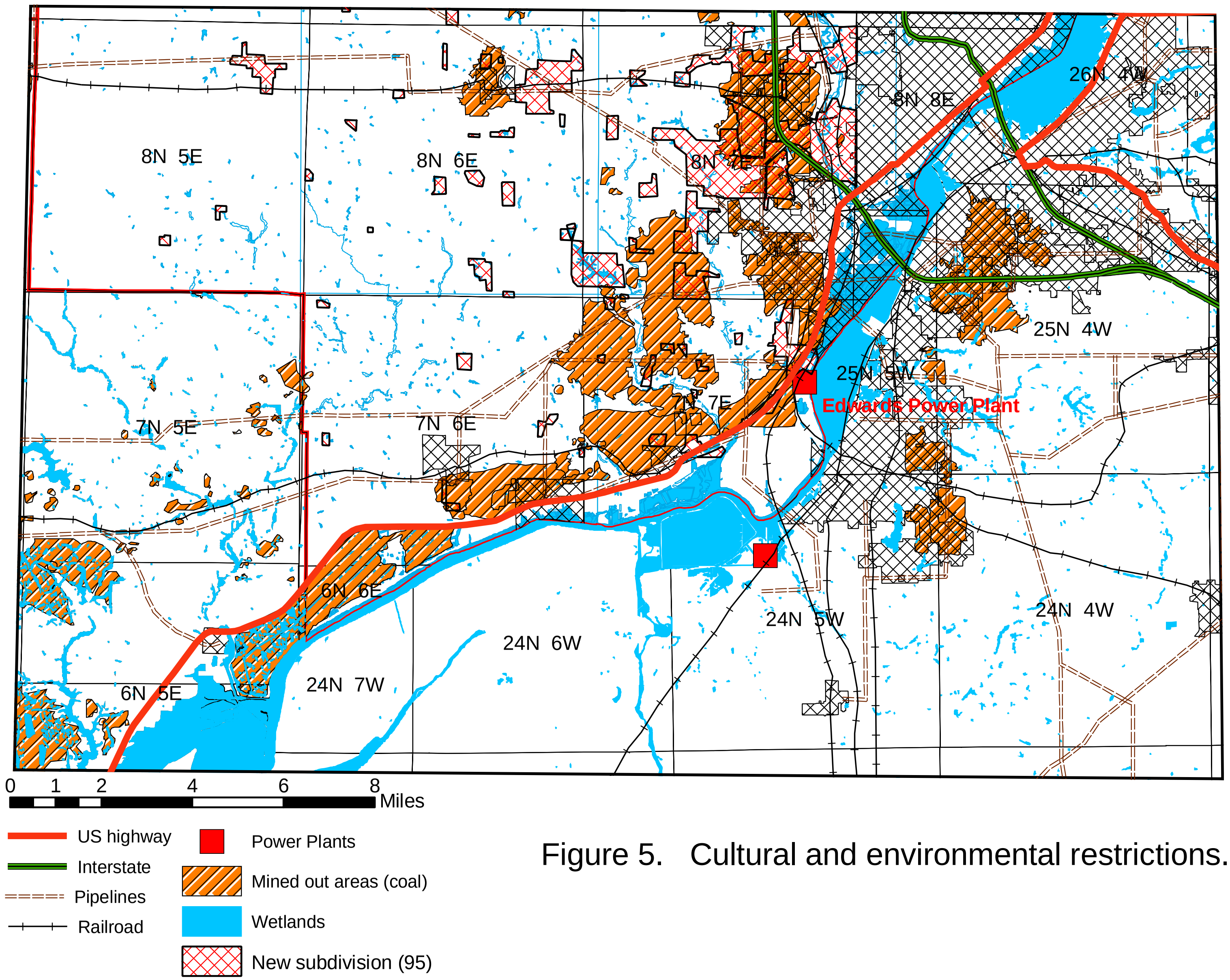

Figure 5. Cultural and environmental restrictions.

PEORIA AREA SHALE RESOURCES

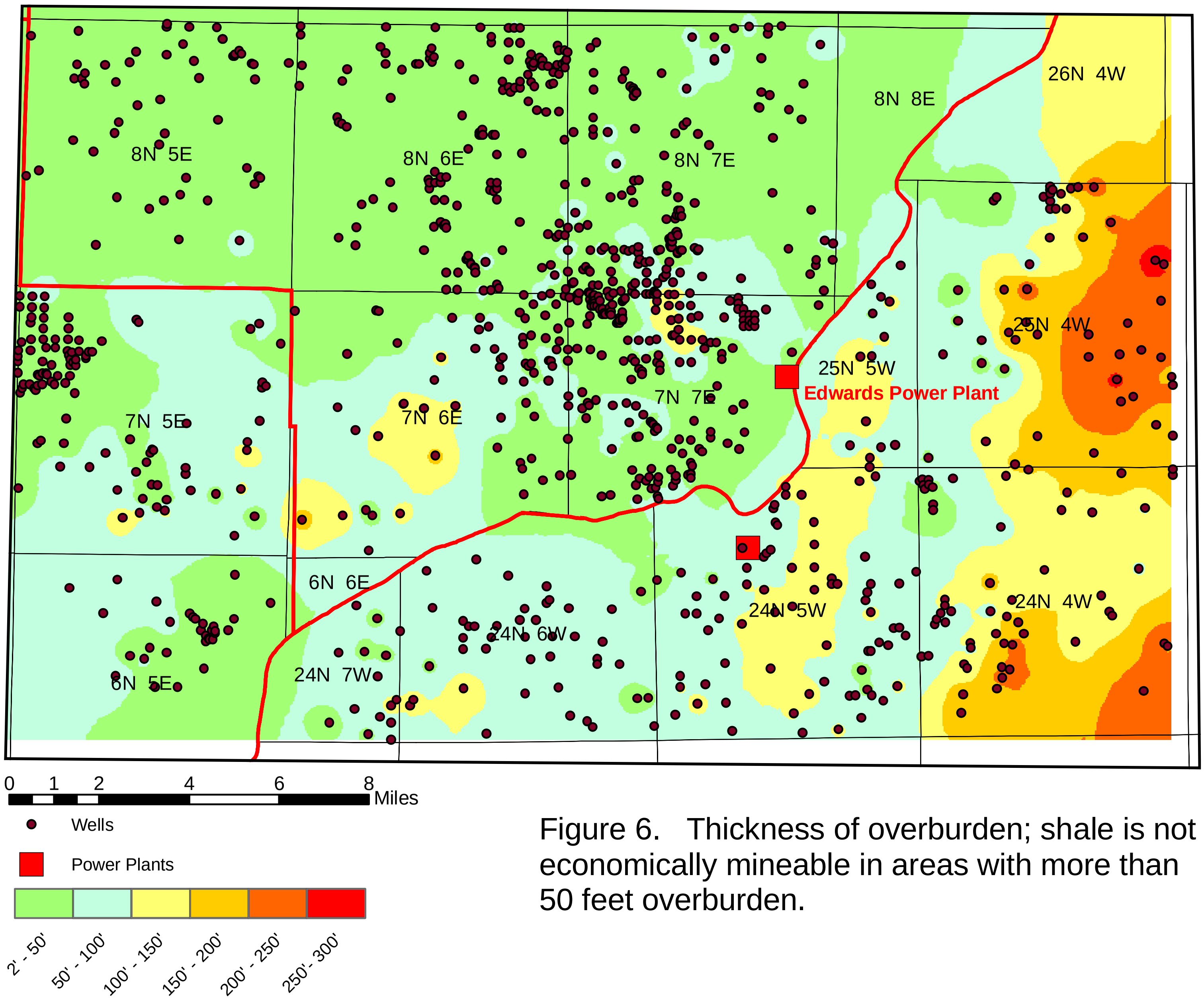

Figure 6. Thickness of overburden; shale is not economically mineable in areas with more than 50 feet overburden.

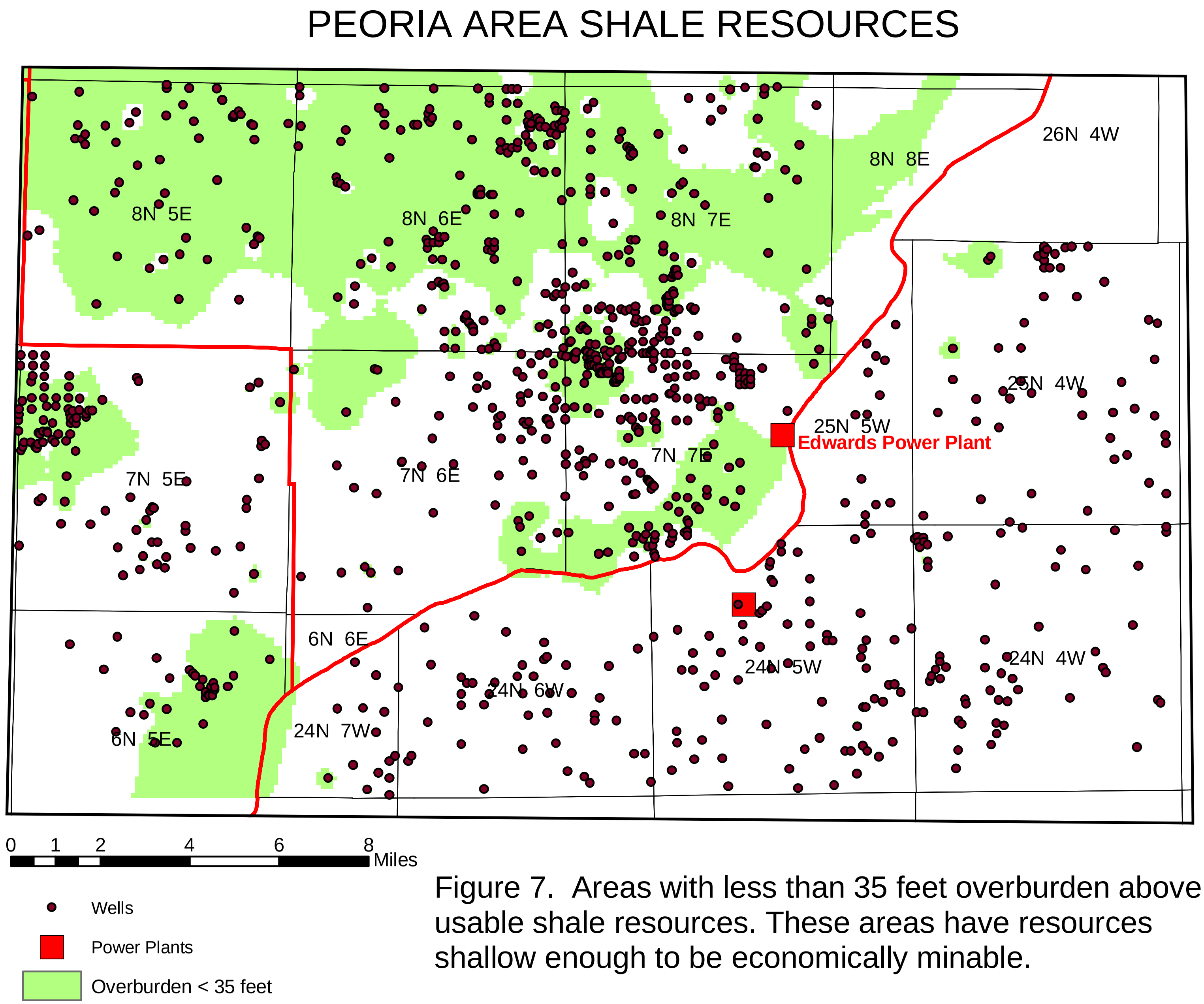

Figure 7. Areas with less than 35 feet overburden above usable shale resources. These areas have resources shallow enough to be economically minable.

PEORIA AREA SHALE RESOURCES

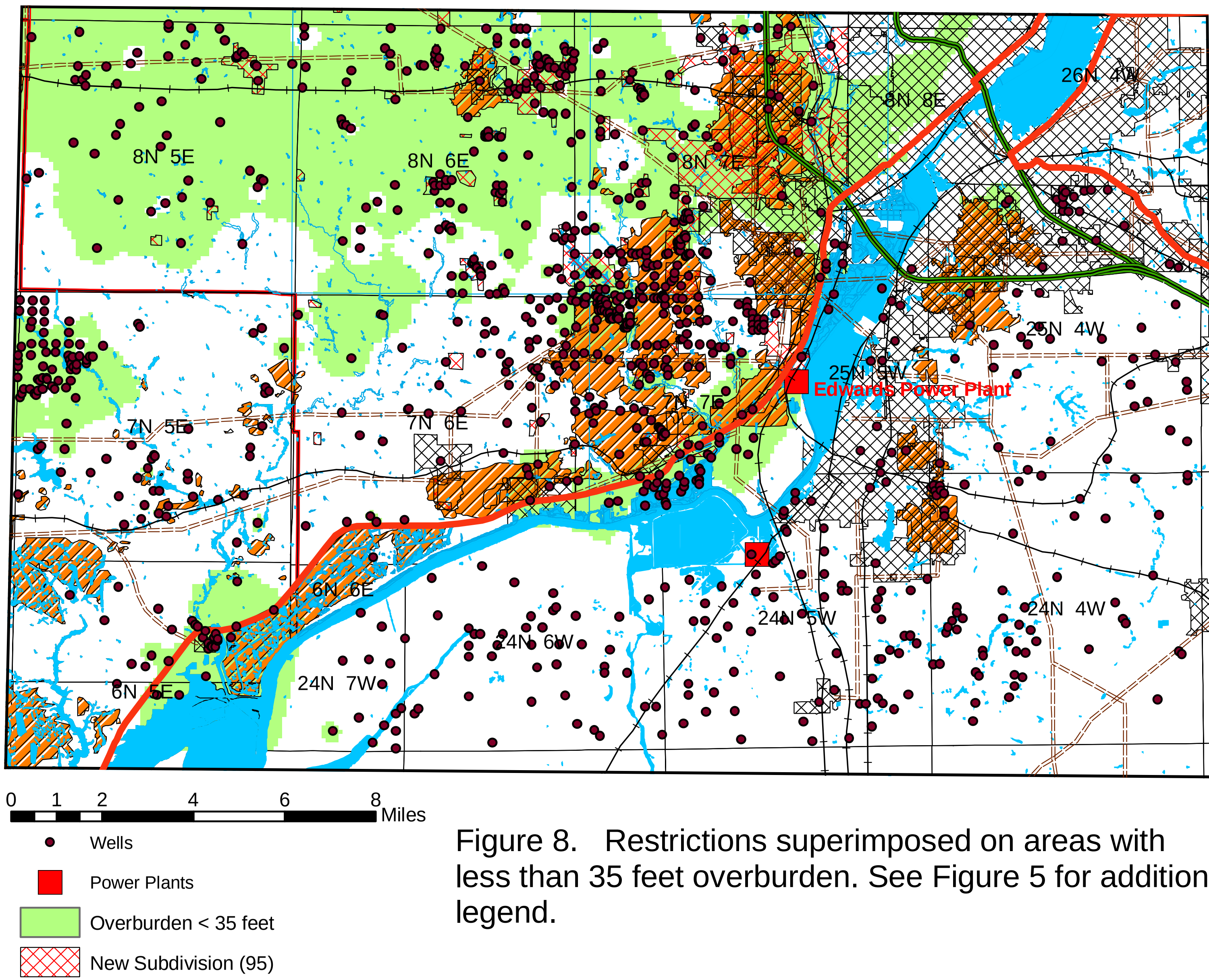

Figure 8. Restrictions superimposed on areas with less than 35 feet overburden. See Figure 5 for additional legend.

PEORIA AREA SHALE RESOURCES

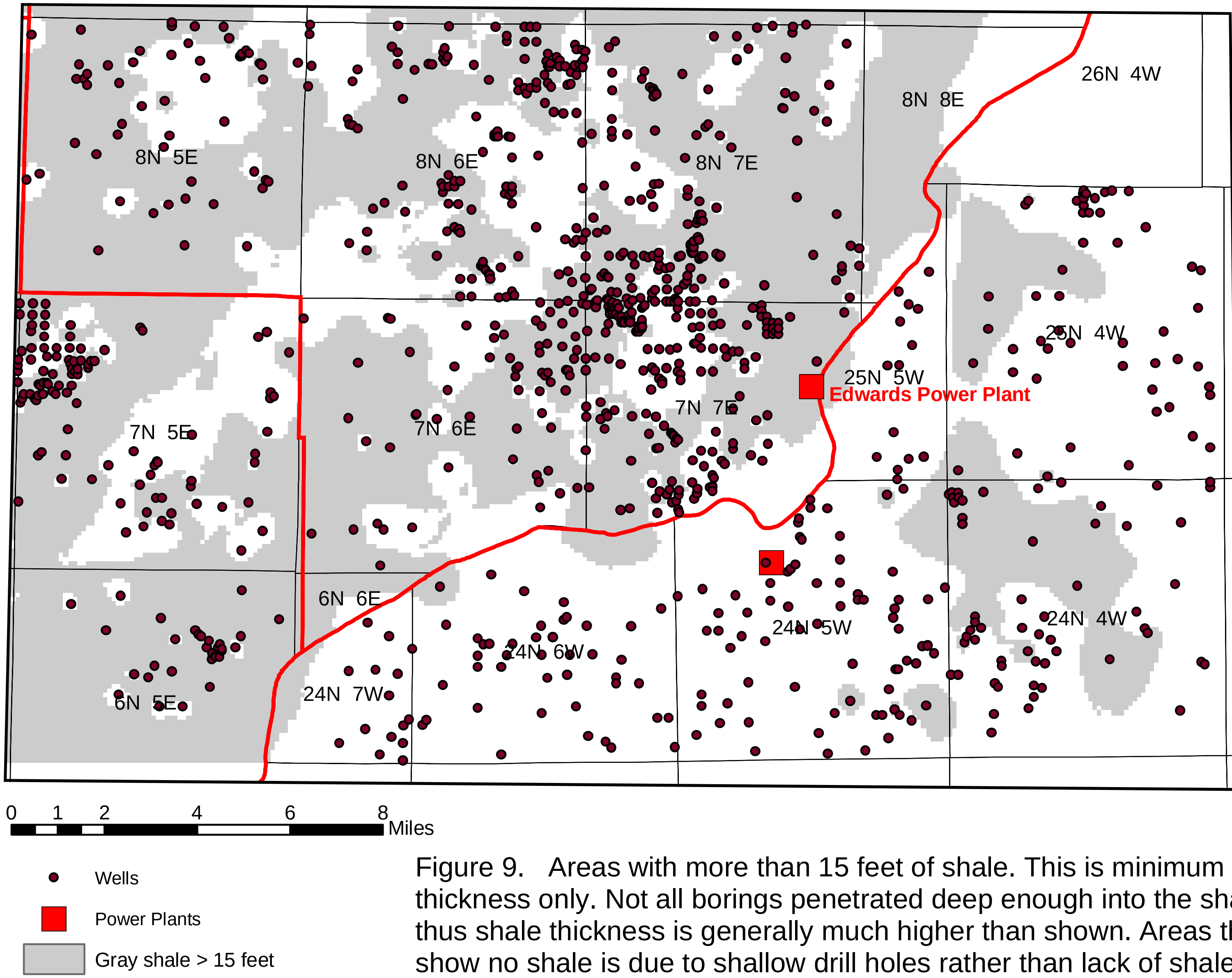

Figure 9. Areas with more than 15 feet of shale. This is minimum thickness only. Not all borings penetrated deep enough into the shale, thus shale thickness is generally much higher than shown. Areas that show no shale is due to shallow drill holes rather than lack of shale.

PEORIA AREA SHALE RESOURCES

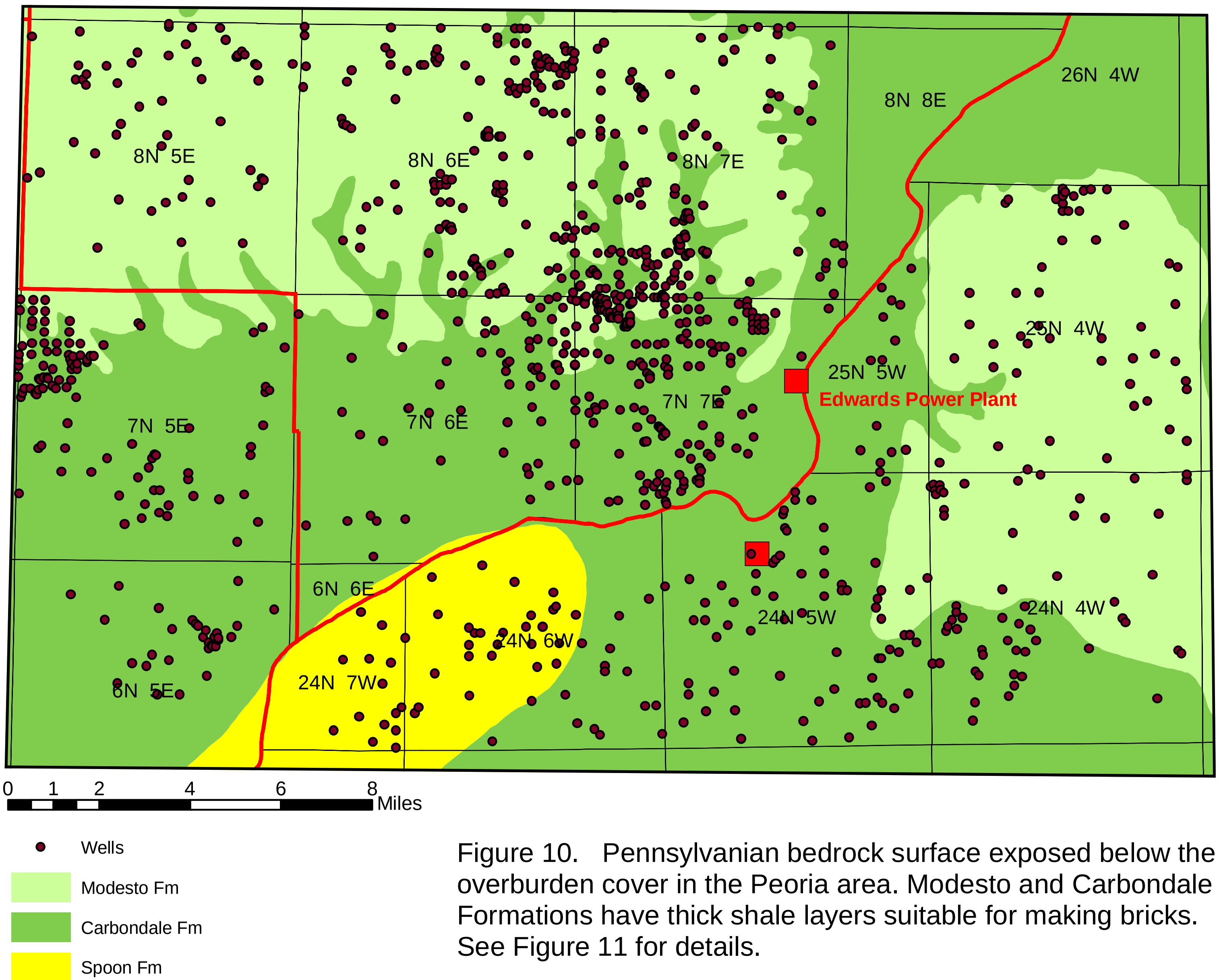

Figure 10. Pennsylvanian bedrock surface exposed below the overburden cover in the Peoria area. Modesto and Carbondale Formations have thick shale layers suitable for making bricks. See Figure 11 for details.

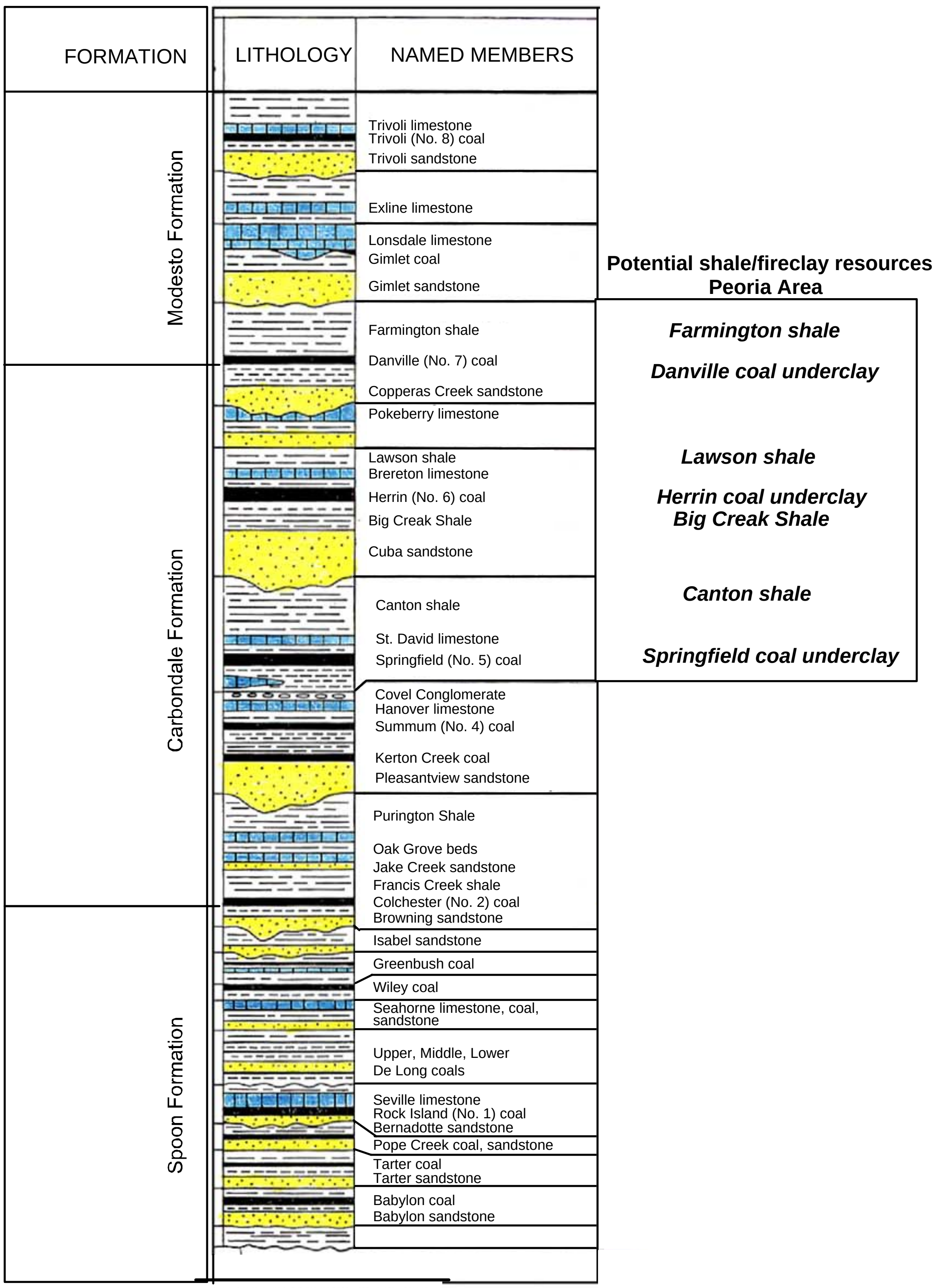

Figure 11 Generalized columnar section of Pennsylvanian strata and shale resources in the Peoria area (modified from Wanless, 1957).

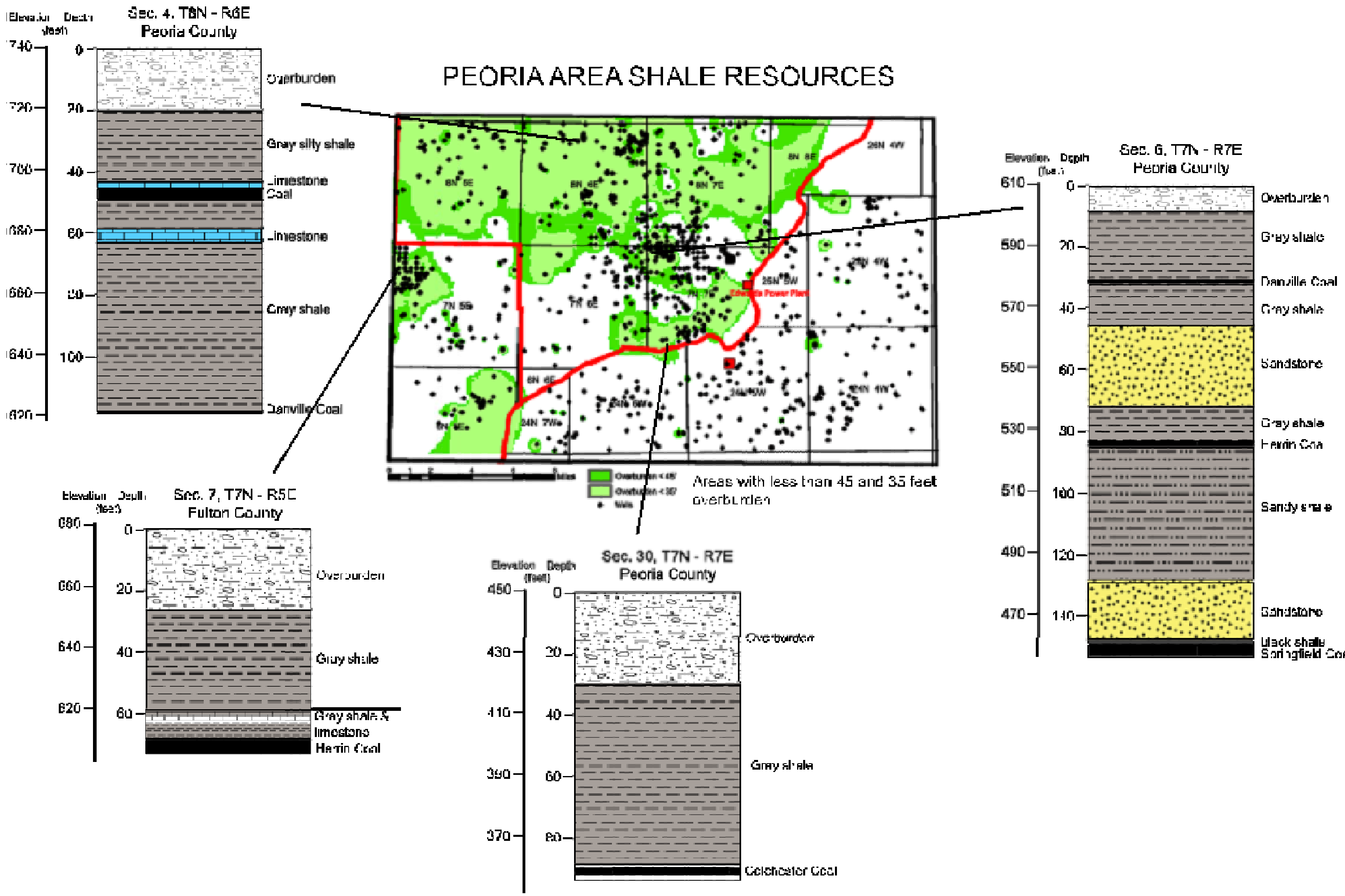

Figure 12 Low overburden areas with type columnar sections showing vertiacl distribution of shale in the Peoria area.

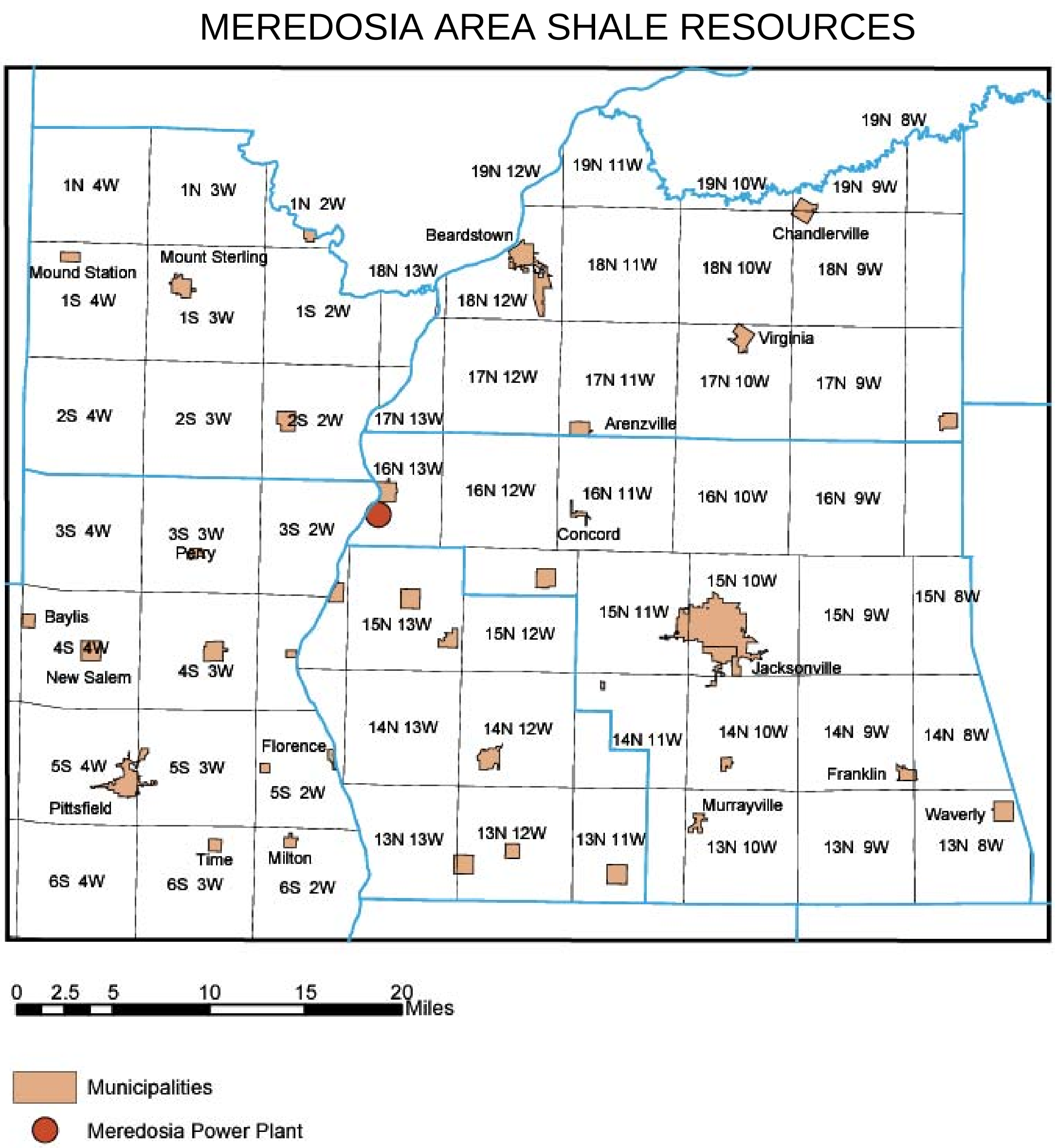

Figure 13 The Meredosia area basemap

MEREDOSIA AREA SHALE RESOURCES

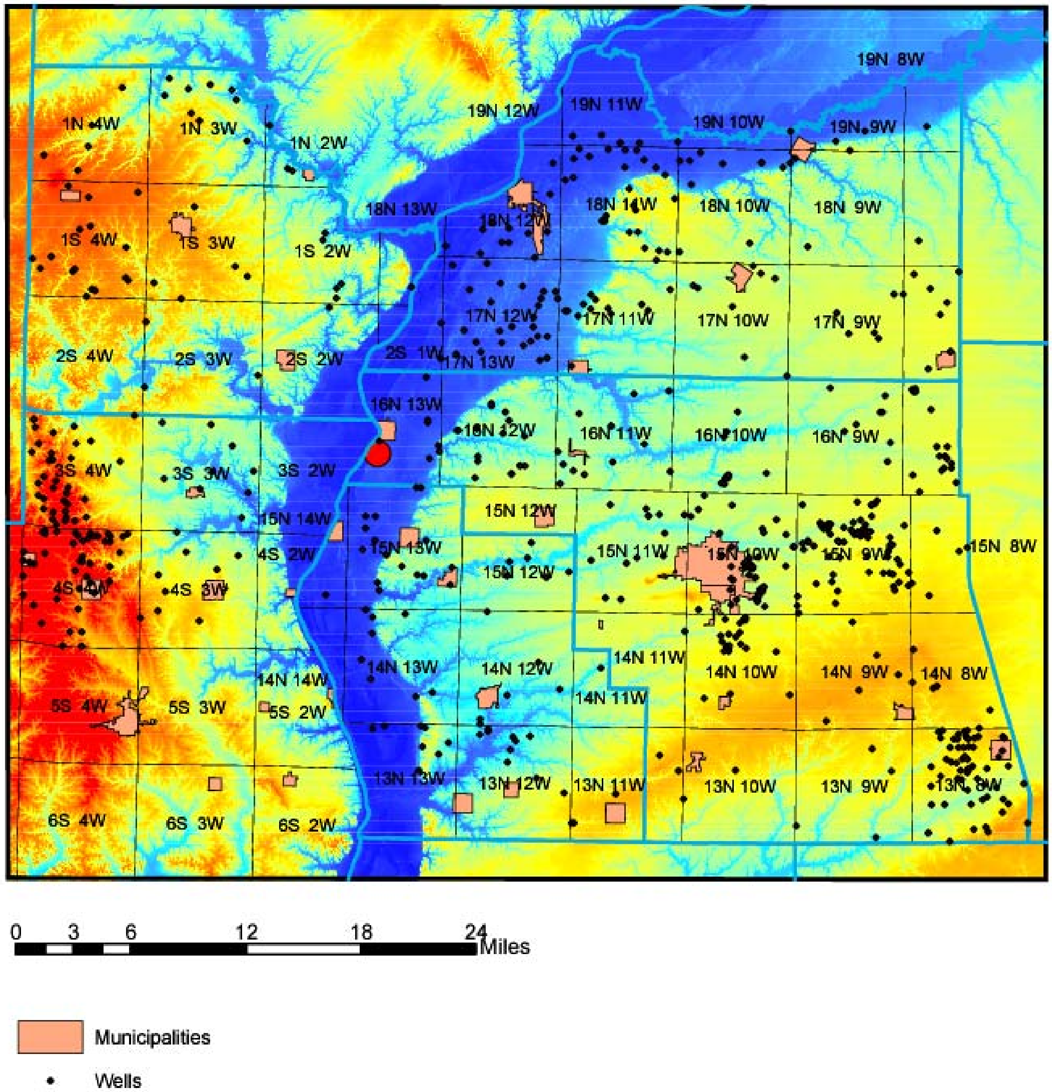

Figure 14 Surface eleveation map with well locations (locations not verified). Areas with highest surface elevation is shown in red.

MEREDOSIA AREA SHALE RESOURCES

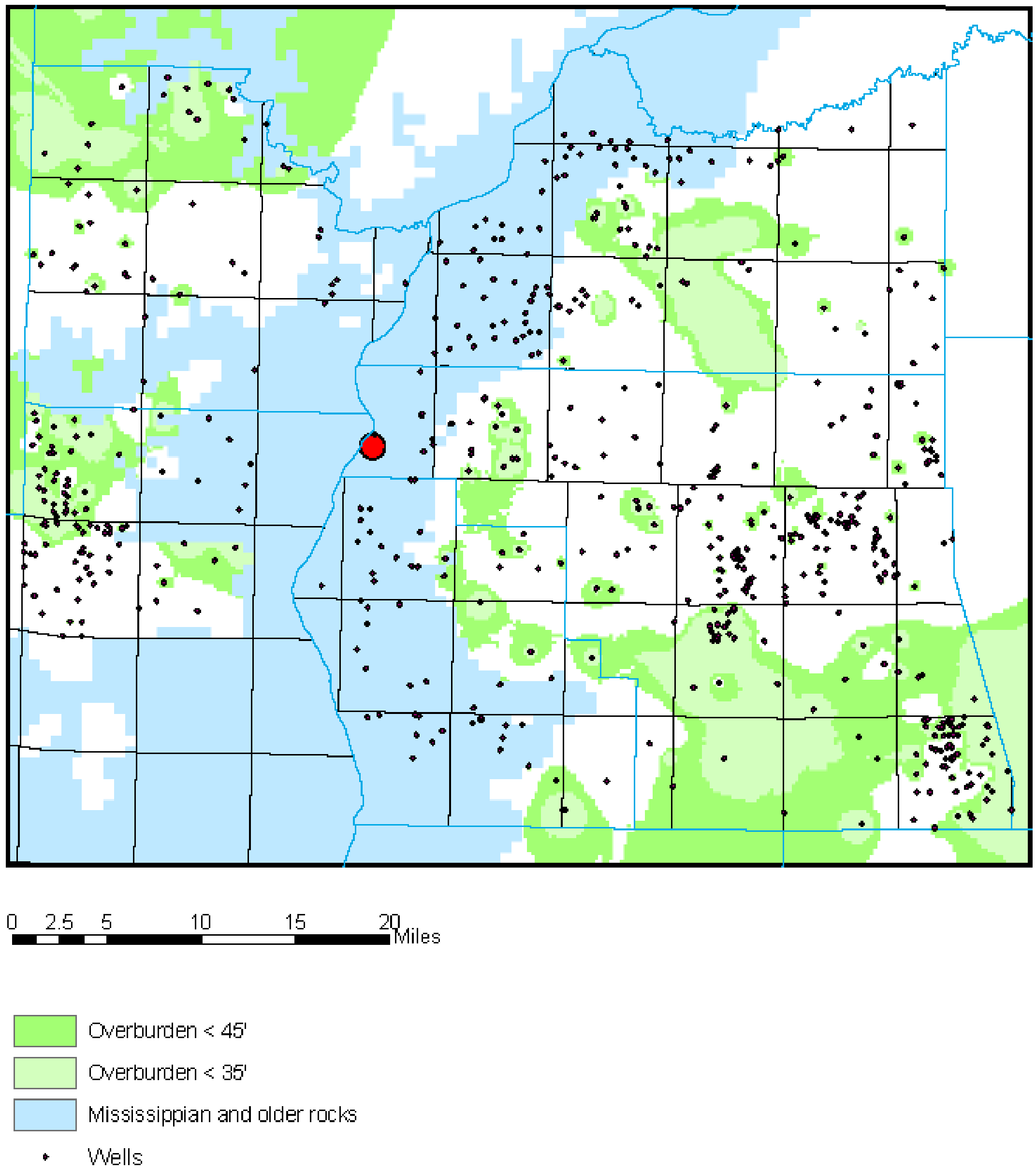

Figure 15 Thickness of overburden cover over shale resources in the Meredosia area.

MEREDOSIA AREA SHALE RESOURCES

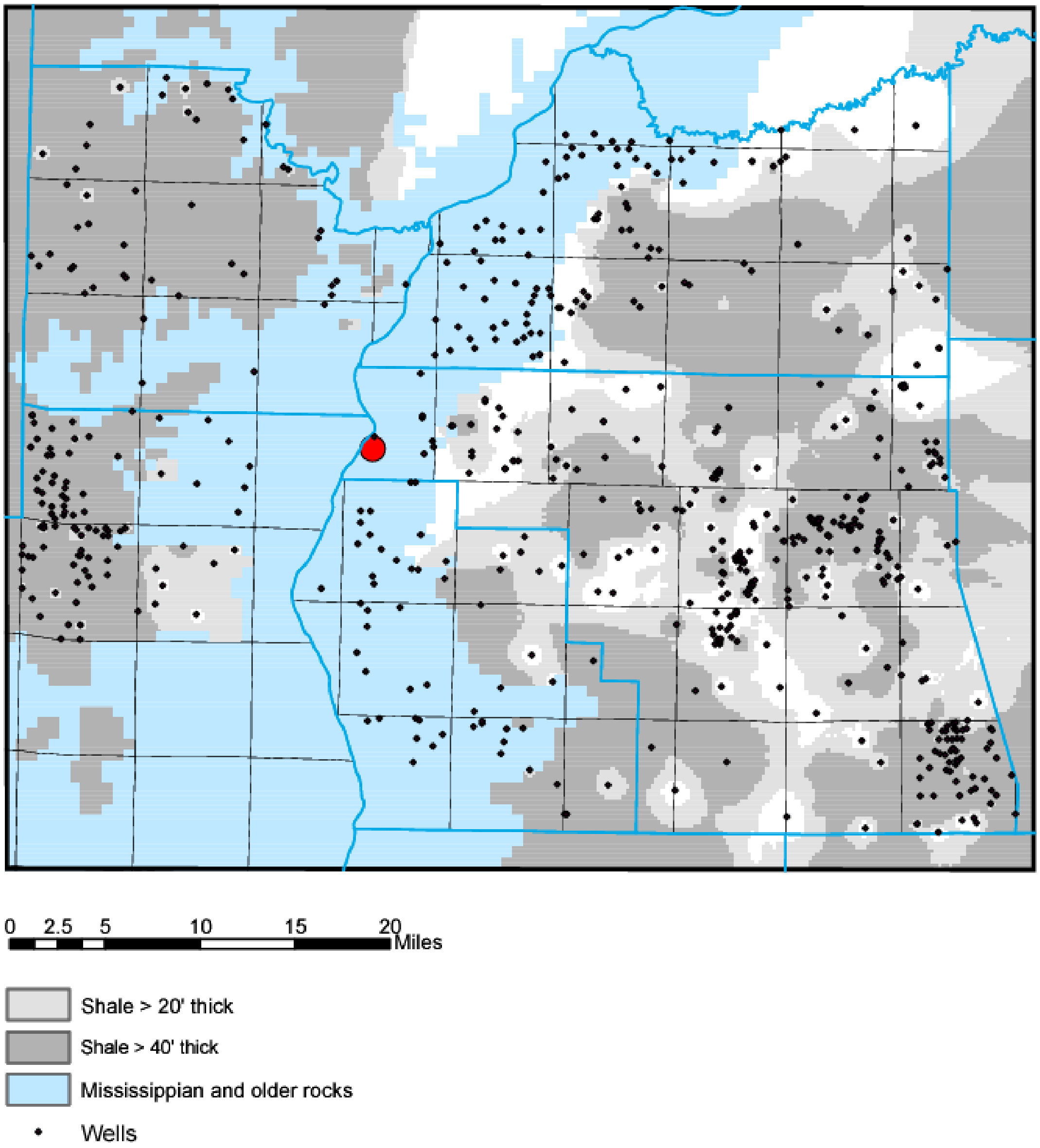

Figure 16 Shale more than 20 and 40 feet thick in the Meredosia area.

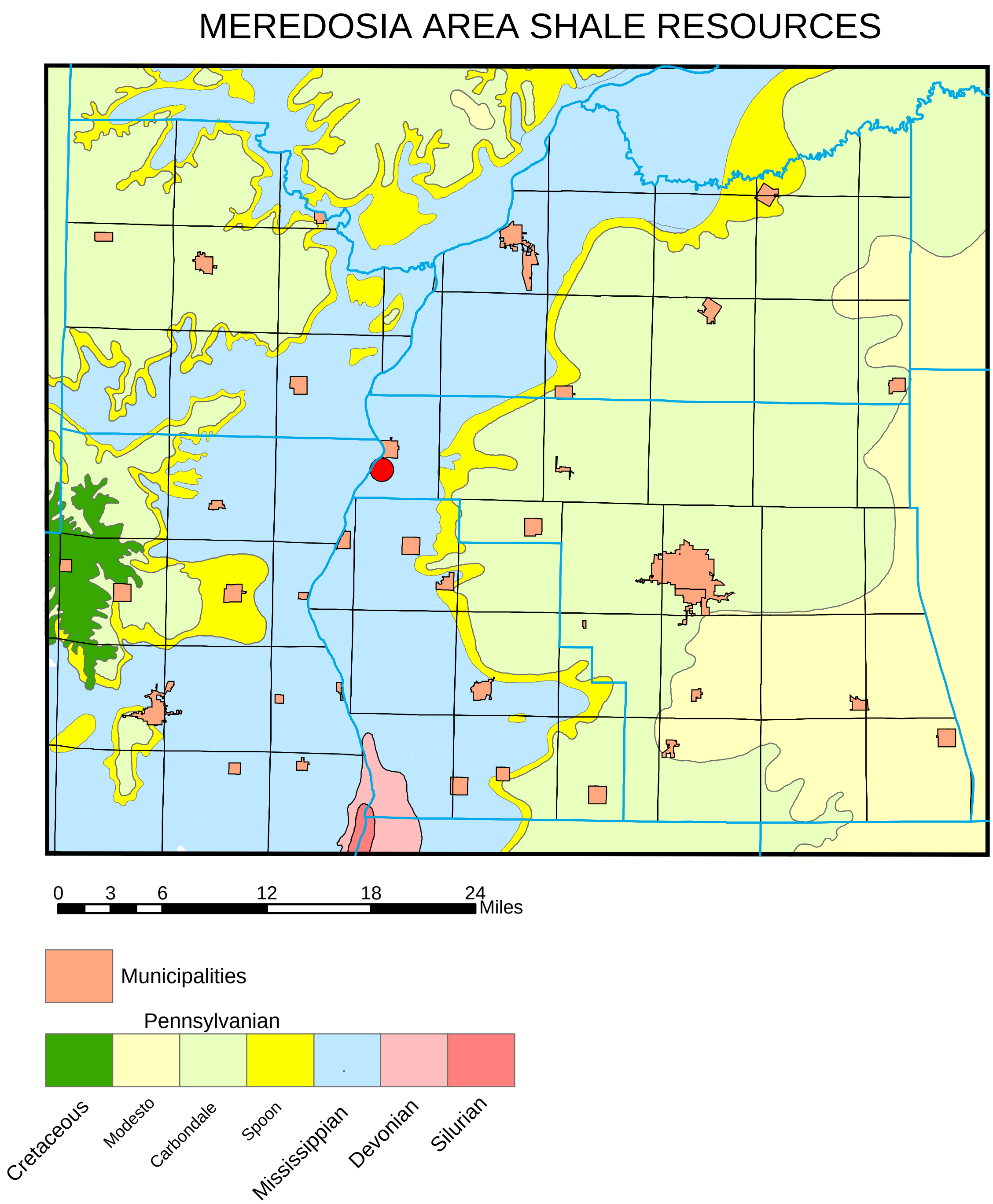

Figure 17 Bedrock surface exposed beneath the overburden; only the Pennsylvanian bedrock contains suitable shales for brick.

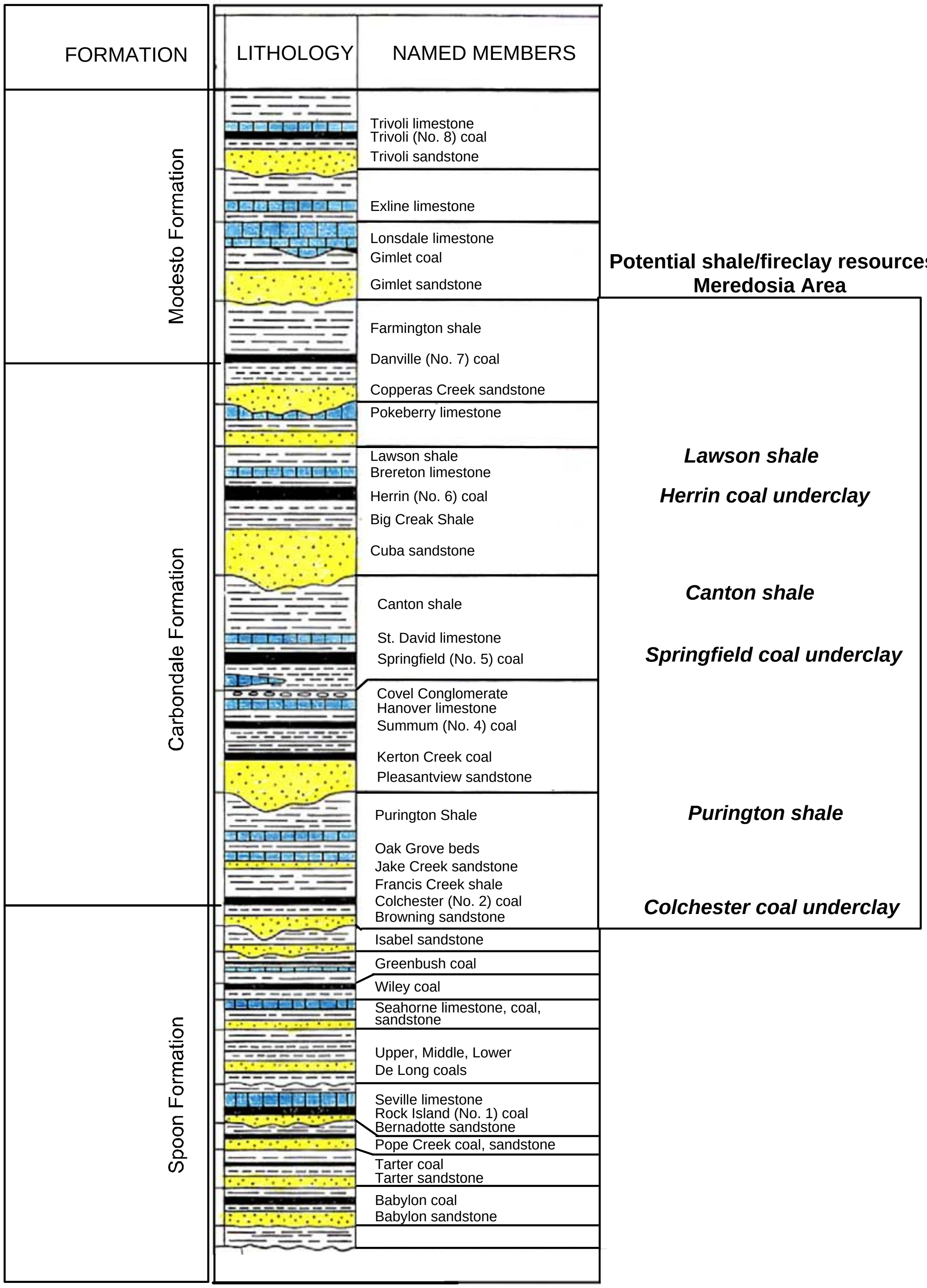

Figure 18 Generalized columnar section of Pennsylvanian strata and shale resources in the Meredosia area (modified from Wanless, 1957).

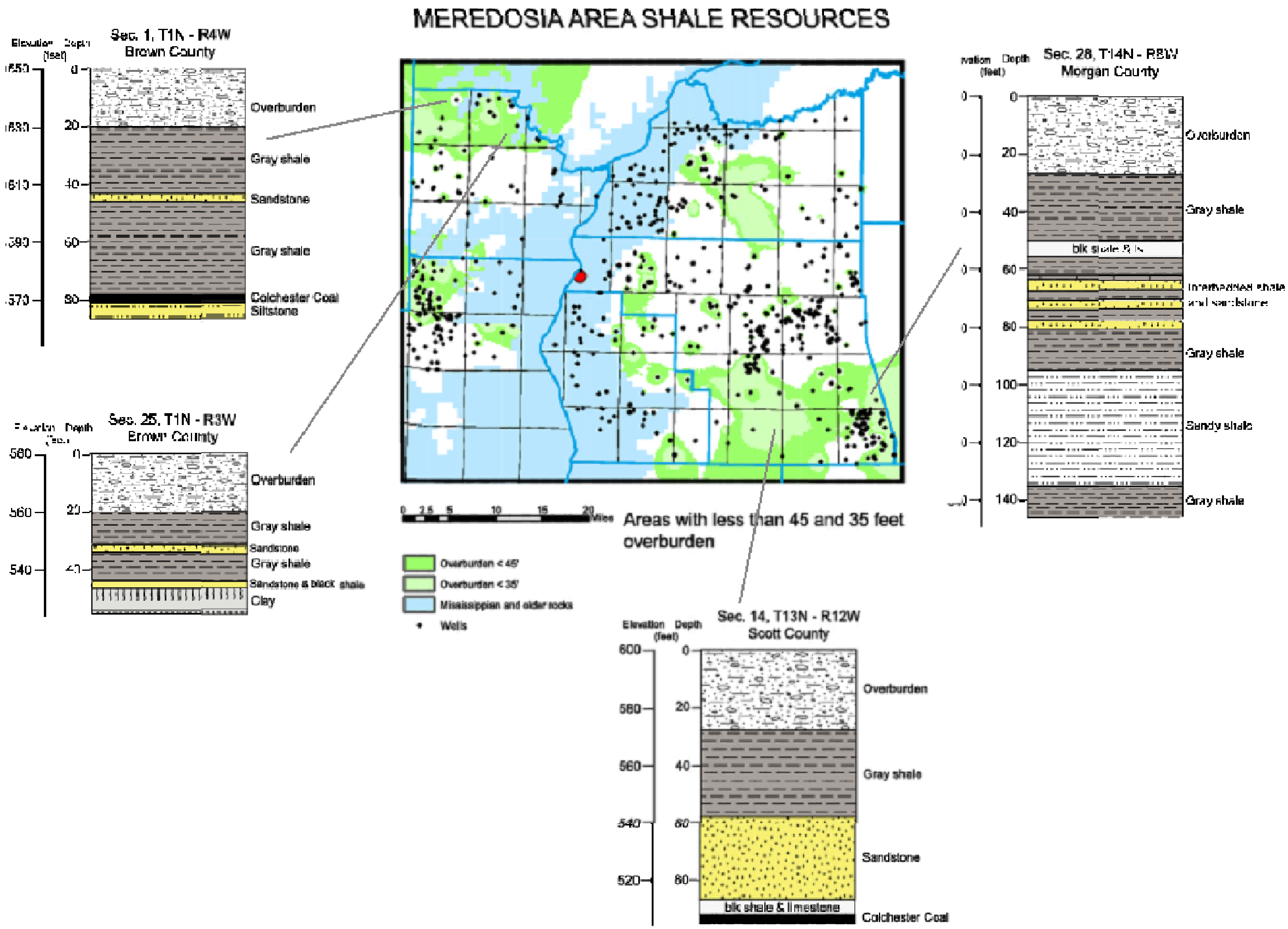

Figure 19 Meredosia area shale resources with example columnar sections.