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Paleoenvironments and Distribution of Low-Sulfur Coal in Illinois

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ABSTRACT: Previous studies have shown that coal overlain by a thick sequence of nonmarine strata is generally lower in sulfur content than adjacent areas of the same seam overlain by marine strata. These nonmarine sediments are interpreted to be of fluvial origin and consist primarily of crevasse-splay deposits. Two patterns of occurrence of crevasse-splay deposits associated with low-sulfur coal have been recognized in the Pennsylvanian rocks of Illinois. These are (1) localized splay deposits distributed at intervals along the trend of rivers that flowed through the peat swamp, and (2) clusters of splay deposits which are part of a deltaic lobe that prograded over the peat swamp. Both types of deposits are represented in the stratigraphic record as clastic wedges of sediment. However, the distribution of low-sulfur coal underlying them differs. Individual splay deposits distributed along the trend of ancient river channels generally cover no more than a few hundred square kilometers. The splay sediments were deposited in a fresh- or brackish-water environment; consequently most of the underlying coal has a low sulfur content. Exploration for additional low-sulfur coal associated with deposits of this type should be carried out along the course of ancient river channels. In some cases, as the peat swamp subsided, a deltaic lobe was deposited at the swamp margin and prograded seaward over the submerged peat. Delta lobes may cover several thousand square miles of coal. Most of the deltaic sediments were deposited in a marine environment, after the peat had been inundated by marine water. Low-sulfur coal is found underlying the landward side of the deltaic lobe, where splay sediment covered the peat while still in a brackish-water environment. Untested potentially low-sulfur coals delineated by this study include the Herrin (No. 6) Coal Member in parts of Christian, Shelby, Moultrie, Cumberland, Coles, Douglas, Clark, Edgar, and Vermilion counties; the Danville (No. 7) Coal Member in Clark, Crawford, and Lawrence counties; and the Murphysboro Coal Member in Jackson County. Other coals included in the study are the Harrisburg (No. 5) and Colchester (No. 2) coal members; no new potential low-sulfur areas are outlined for these two coal seams.

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INTRODUCTION

An understanding of the paleoenvironments associated with deposits of low-sulfur coal in Illinois and knowledge of the distribution of these environments at the time of peat accumulation are an aid to exploration for low-sulfur coal. The major minable coals in Illinois generally have sulfur contents ranging from 3 to 5%. However, in scattered areas, the sulfur content of individual seams is lower, ranging from 0.5 to 2.5% (dry basis). This paper describes the paleoenvironments associated with known low-sulfur coals. Untested areas of coal with similar depositional environments are outlined.

Previous studies have shown that coal overlain by a thick sequence of nonmarine strata is generally lower in sulfur content than adjacent areas of the same seam overlain by marine strata (Williams and Keith, 1963; Gluskoter and Simon, 1968; Gluskoter and Hopkins, 1970; and others). The explanation for this is that the nonmarine sediments shielded the peat from contact with sulfate-bearing marine water. In areas where peat was not covered by a sufficient thickness of nonmarine sediment, the marine water served as a major source of sulfur for the formation of sulfur in coal (Gluskoter and Hopkins, 1970; Horneet al., 1978).

A key to exploring for low-sulfur coal in Illinois is to find areas of coal that were covered by nonmarine sediments before marine transgression inundated the peat swamp. These nonmarine sediments are interpreted to be of fluvial origin and consist primarily of crevasse-splay deposits.

Two patterns of occurrence of crevasse-splay deposits associated with low-sulfur coal have been recognized in the Pennsylvanian rocks of Illinois. These are (1) localized splay deposits distributed at intervals along the trend of rivers that flowed through the peat swamp, and (2) clusters of splay deposits which are part of a deltaic lobe that prograded over the peat swamp (fig. 1).

The pattern of occurrence of splay deposits is probably related to the paleotopography and the rate of marine transgression. While seasonal flooding could have created

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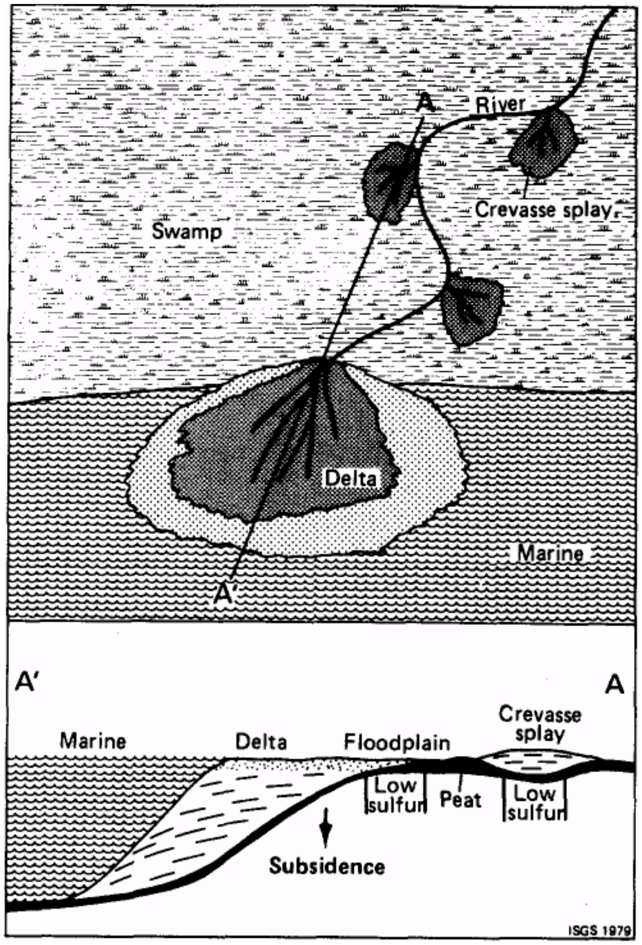

FIGURE 1. Two patterns of occurrence of low-sulfur coal: *top*, underlying splay deposits along a river flowing through the swamp; *bottom*, underlying splay deposits on landward margin of a delta.

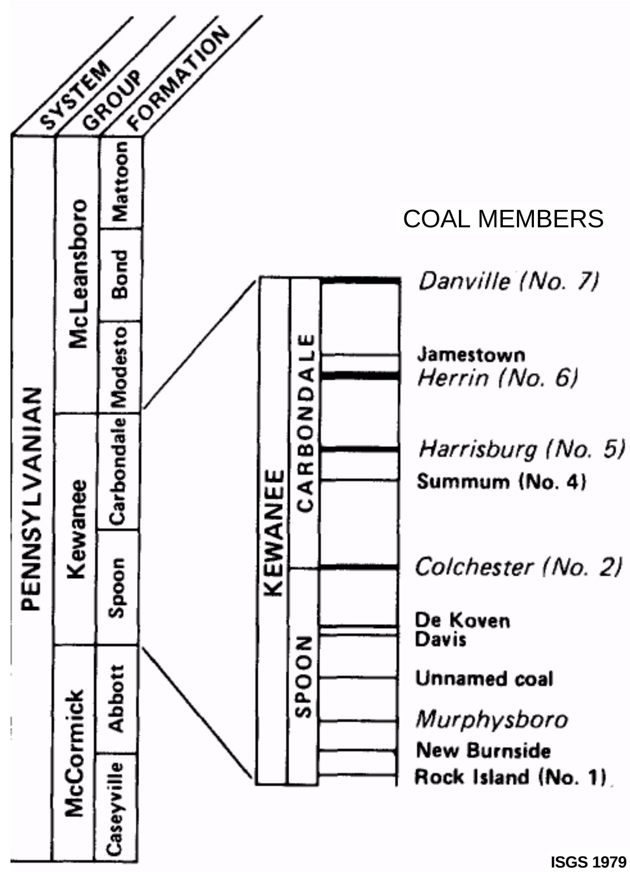

FIGURE 2. Stratigraphic section of selected coals in Kewanee Group. Low-sulfur coals discussed in this report are in italics.

splay deposits at any point along a river flowing through the swamp, the thickest accumulation of sediment probably took place as marine transgression brought a rise in base level, causing massive flooding of the river. If the paleotopography was very flat, the rate of transgression would be rapid and development of an individual splay would be short lived. Drowning of the river would cause abandonment of the downstream splays and development of splays progressively further upstream. Splay deposits would be localized in occurrence and confined to the trend of the river. Significant topographic irregularities (such as a structural high) would cause the rate of marine transgression to be interrupted for a time. A river flowing into the low, partially flooded shore area would develop a network of distributaries. Splays would be deposited by this network over a wide area of the shore, and a delta would prograde seaward over the submerged peat.

Both types of deposits are represented in the stratigraphic record as clastic wedges. However, the distribution of low-sulfur coal underlying them differs. Individual crevasse-splay deposits distributed along the trend of ancient river channels generally cover no more than a few hundred square kilometers. The splay sediments were deposited in a fresh- or slightly brackish-water environment; consequently most of the underlying coal has a low sulfur content. Delta lobes may cover several thousand square kilometers of coal. Most deltaic sediments were deposited in a marine environment, after the peat had been inundated by marine water. Low-sulfur coal may be found underlying the landward side of deltaic lobes, where splay sediment covered the peat while still in a brackish water environment.

FORMATION OF SPLAY DEPOSITS

Crevasse-splay deposits are well-known features of modern fluvial and deltaic systems. They have been described by many investigators, including Coleman and Gagliano (1964), Coleman (1969), and Saxena (1976). Splay deposits form when a river breaks (crevasses) its natural levee and deposits a fan-shaped wedge of clastic sediments. The flow of water through this break may last for only a few weeks or months, or the break may divert the channel and lead to the development of a major subdelta. Crevasse splays may form in response to seasonal flooding or a regional rise in sea level.

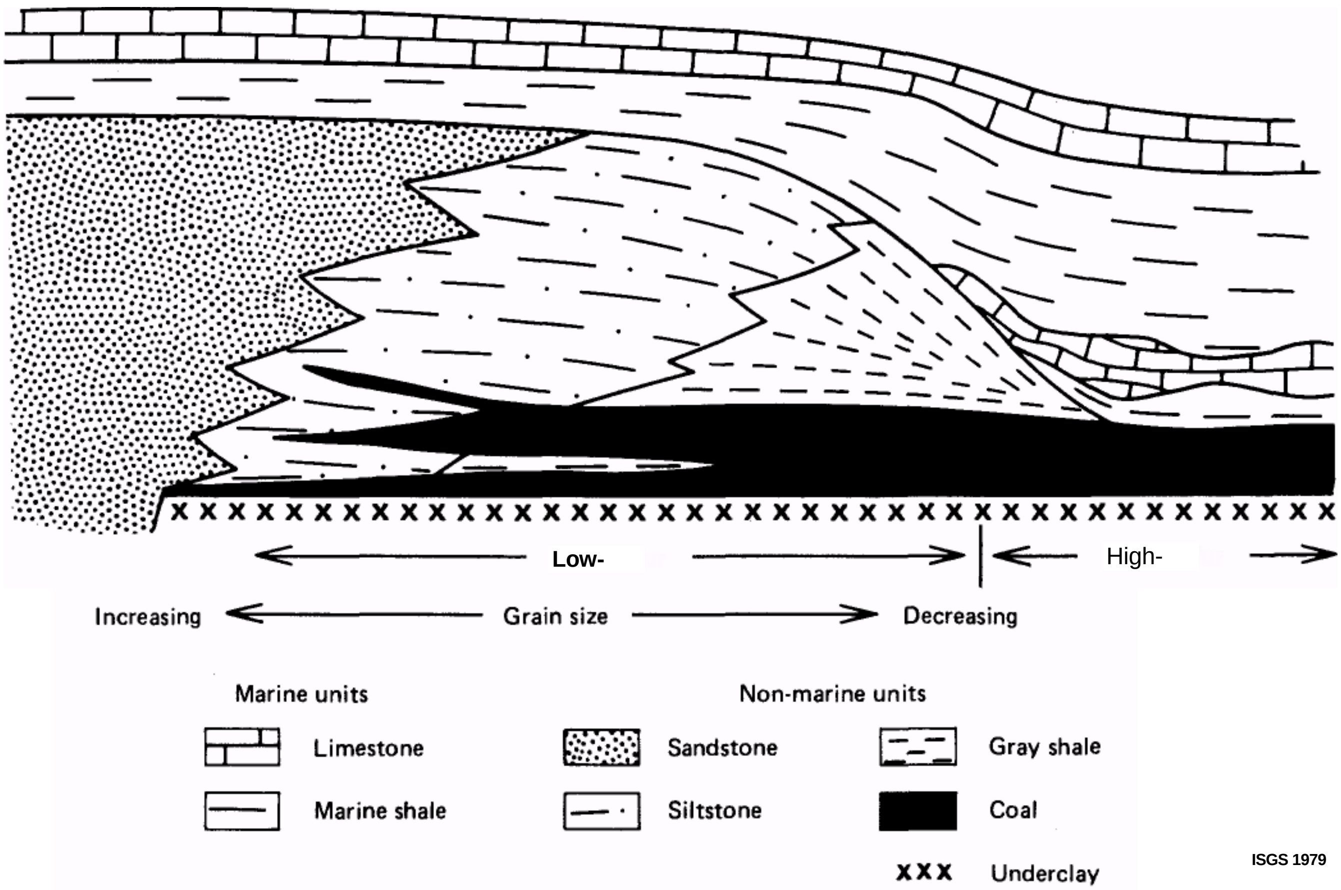

FIGURE 3. Schematic cross section of a splay deposit.

Regardless of their size, splay deposits usually exhibit many of the features of a large delta system. Sediments become finer horizontally away from their source and become coarser upward in the sediment column. A network of small distributary channels may develop across the splay. Splay deposits are noted for their rapid horizontal and vertical buildup. The active life of historically documented splays on the Mississippi River delta ranges from 88 to 140 years (Coleman and Gagliano, 1964). During this time, the sediments prograded 8tol6km(5-10mi) from the original crevasse.

LOW-SULFUR COAL ALONG PEAT-CONTEMPORANEOUS RIVERS

Three coal members, the Herrin (No. 6), Harrisburg (No. 5), and Murphysboro coals (fig. 2) are low in sulfur in areas overlain by splay deposits from ancient rivers that flowed through peat swamps. Most of these deposits are similar in character: lobate-shaped clastic wedges extending outward from a major channel-fill sandstone. The clastic wedges are relatively local in occurrence. Adjacent areas of the same coal are generally overlain by marine black shales or limestone and have a significantly higher sulfur content.

Figure 3 is a schematic cross section through an ancient splay deposit. The heart of the deposit is the channel fill of the peat-contemporaneous river. This deposit usually consists of sandstone and siltstone occupying the coal interval. The upper and lower stratigraphic boundaries of channels vary, depending on the length of time the channel was active before and/or after the time of the peat swamp. The splay sediments are generally thickest adjacent to the channel and thin rapidly at their distal margins. The boundary between the channel-fill sediment and splay sediment is gradational and difficult to recognize in the geological record. Adjacent to the channel, the splay consists of more sandstone and siltstone; the splay grades away from the channel into siltstone interbedded with shale, and then into shale. The distribution of facies within splay deposits is complex. Cut-and-fill structures and extensive interbedding of sediment in splays indicate repeated pulses of sedimentation and migration of drainage during deposition of the sediments. Fine-grained levee and overbank deposits may be found adjacent to the channel fill. These also interfinger with splay deposits. The fossil content of the splay sediment near the channel generally consists of carbonaceous debris and plant fragments. Brackish water to marginal marine organisms may be found at the distal margin of the splay.

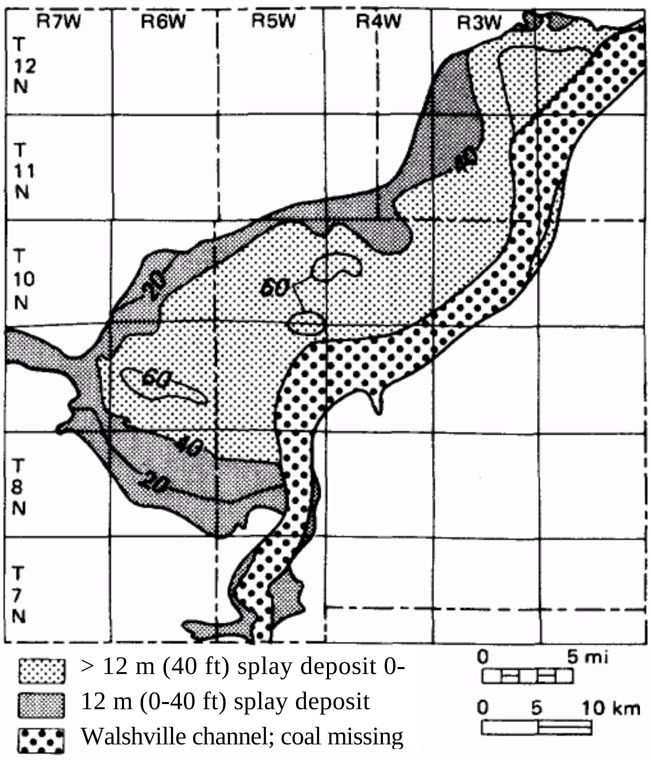

FIGURE 4. Geometry of splay deposits (Energy Shale Member) overlying Herrin (No. 6) Coal Member, west-central Illinois (from Johnson, 1972). See index map, figure 6.

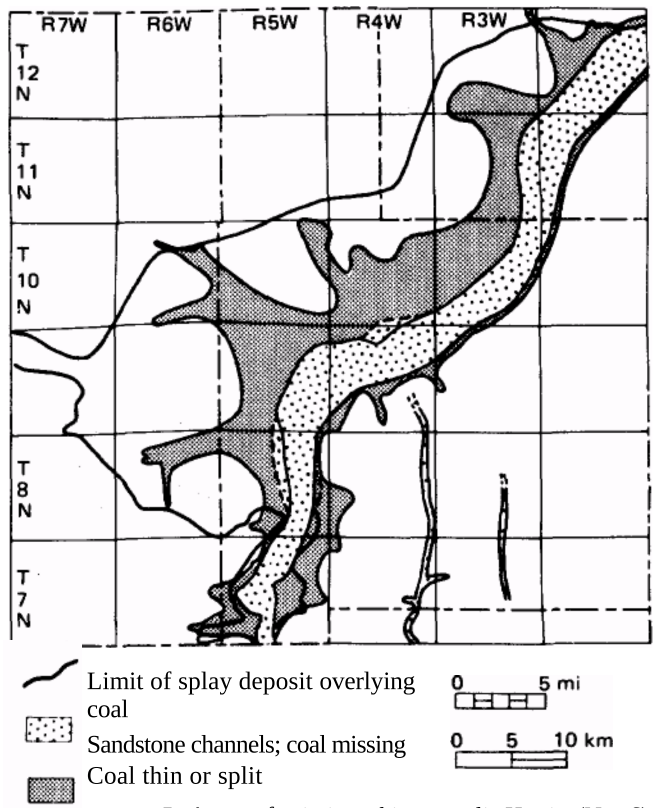

FIGURE 5. Areas of missing, thin, or split Herrin (No. 6) Coal Member, west-central Illinois(from Johnson, 1972). Two smaller channels in lower right are younger channels (Anvil Rock Sandstone Member) which cut down through the Herrin Coal and several feet of roof strata. Split coal is not found along these younger channels.

Splay deposits are found in a great range of sizes. They range in maximum thickness from 1 m to more than 30 m (100 ft). The deposits are lobate to linear in areal form. They are known to extend more than 30 km (20 mi) from the channel and to cover several hundred square kilometers. The larger splay deposits may represent the coalescence of two or more smaller splays.

The coal underlying the splay usually contains significantly less sulfur than adjacent areas of coal overlain by marine rock. Studies of the Herrin (No. 6) Coal show that the lowest sulfur values are found where at least 6 m (20 ft) of splay sediment overlies the coal (Gluskoter and Simon, 1968; Gluskoter and Hopkins, 1970; Allgaier and Hopkins, 1975). However, this figure is not as certain for other coals (Hopkins, 1968; Hopkins and Nance, 1970).

Coal is often significantly thicker in areas near (3-5 km; 2-3 mi) the contemporaneous channel. Either the channel created favorable conditions for peat formation, or regional conditions that determined the position of the channel influenced peat accumulation, or both.

Adjacent to the channel, the coal is often split by clastic partings. As the partings thicken toward the channel, the coal pinches out. Rolls, carbonized trunks, and stumps are commonly found along the roof of the coal underlying splays (Krausse et al., 1979; unpublished mine notes of the Illinois State Geological Survey).

The marine shales and limestones that normally overlie the high-sulfur coal lap onto the splay deposits. Where the splay deposit is thick (>12 m; >40 ft), the lower marine units pinch out on its flanks.

A transitional zone between nonmarine and marine roof rocks is generally found around the large splays overlying the Herrin Coal. Lenticular pods of splay material, usually gray shale, overlie the coal scattered throughout this zone. Marine shales and limestones overlie the gray shale or, where the gray shale is absent, rest directly on the coal. The lower marine units often thin over the top of these pods of gray shale. Similar transitional conditions are found around the splay deposits associated with the Harrisburg Coal (John Nelson, pers. com.).

HERRIN (NO. 6) COAL MEMBER

The Herrin Coal, because of its sizable reserves, has been extensively mined and studied. Most of the areas of low-sulfur Herrin Coal are associated with splay deposits from the peat-contemporaneous Walshville channel (see fig. 6).

However, a large tongue of elastics overlying low-sulfur Herrin Coal in east-central Illinois differs markedly from the other splay deposits in size, geometry, and relationship to the Walshville channel. This deposit may represent a freshwater delta deposited by a different distributary system.

Low-sulfur coal deposits associated with the Walshville channel. Johnson (1972), in his study of the Herrin Coal and associated strata, was the first to report clastic wedges overlying the coal as splay and overbank deposits. He based his interpretation on their lobate form and relationship to a major channel occupying the stratigraphic position of the coal (fig. 4). This channel, which he named the Walshville channel, was interpreted to be contemporaneous with peat accumulation because of the zone of missing, thin, or split coal found along its margins (fig. 5). The crevasse-splay sediments, consisting of shales, siltstones, and sandstone, are named the Energy Shale Member (Allgaier and Hopkins, 1975). The two smaller channels in the lower right of figure 5 are younger channels (Anvil Rock Sandstone Member), which cut down through the Herrin Coal and several feet of roof strata. Split coal is not found along these channels, and the sulfur content of the coal is high.

The Walshville channel has been mapped fora distance of more than 370 km (230 mi) across the Herrin Coal swamp (fig. 6). Lobate splay deposits cover the coal at a number of localities along this channel. Individual splay deposits range in area from 13 to 520 km^2 (5->200 mi^2). The splay deposits in the central part of the state are about 18 m (60 ft) thick, whereas the large splays in southern Illinois are more than 30 m (100 ft) thick.

The Herrin Coal generally contains 3 to 5% sulfur (dry basis) where it is overlain by marine rocks. Chemical analyses of coal from abandoned mines overlain by two of the splay deposits indicate that the sulfur content is consistently less than 2.5% and sometimes as low as 0.5% (fig. 6). The Illinois State Geological Survey has no available analyses of coal underlying the other splay deposits.

Low-sulfur coal associated with the New Goshen channel. Low-sulfur Herrin Coal underlies a tongue of elastics in east-central Illinois. This clastic deposit differs from other splay deposits in size, geometry, and relationship to the Walshville channel. The deposit covers more than 3900 km^2 (1500 mi^2). It pinches out along its southern and northern margins. It thins and narrows westward and appears to merge with splay deposits from the Walshville channel. The deposit thickens and broadens eastward into Indiana. The maximum thickness of the unit in Illinois is about 30 m (100 ft). The age and drainage relationships of the clastic wedge to the Walshville channel are not yet clear.

The clastic deposit consists of shale, siltstone, and sandstone. Data from geophysical borehole logs indicate a general coarsening upward of sediments, but no facies

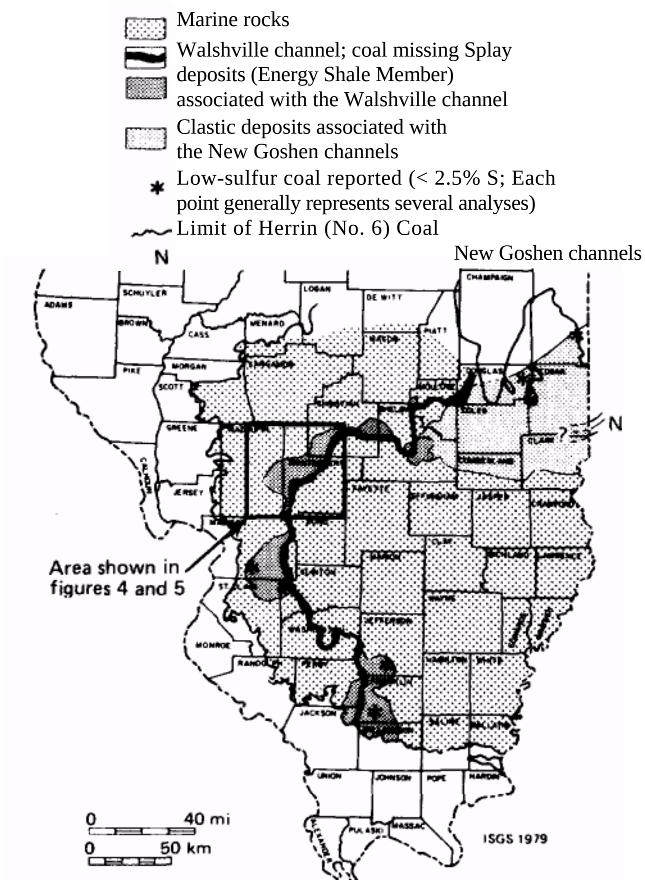

FIGURE 6. Distribution of types of rocks overlying the Herrin (No. 6) Coal Member (modified from Krausse et al., 1979; Smith and Stall, 1975).

trends have been mapped. A channel system has not been recognized in this deposit in Illinois, and erosion of the Herrin Coal by channels has not been observed.

Three small sandstone-filled channels have been mapped in this stratigraphic interval across the border in Indiana (Friedman, 1960). Called the New Goshen channel, the main channel is about 11 km (7 mi) long, as much as 1500 m (5000 ft) wide, and contains sediment more than 24 m (80 ft) thick. The channels appear to extend southwestward into Illinois; however, data in Illinois are insufficient to confirm their presence. The channels are probably part of a network which deposited the clastic tongue during and after the time of the Herrin peat swamp.

Accumulation of the Herrin peat was contemporaneous with the early part of the buildup of the clastic wedge. The Herrin Coal is as much as 2 m (6 ft) thick underlying areas of the northern and southern margins of the clastic deposit. The coal is split toward the center of the clastic deposit and is thin or absent under much of the central and eastern portions.

The shape and position of the clastic wedge conforms markedly with an area of extreme thinning of the interval between the Herrin Coal and the underlying Harrisburg

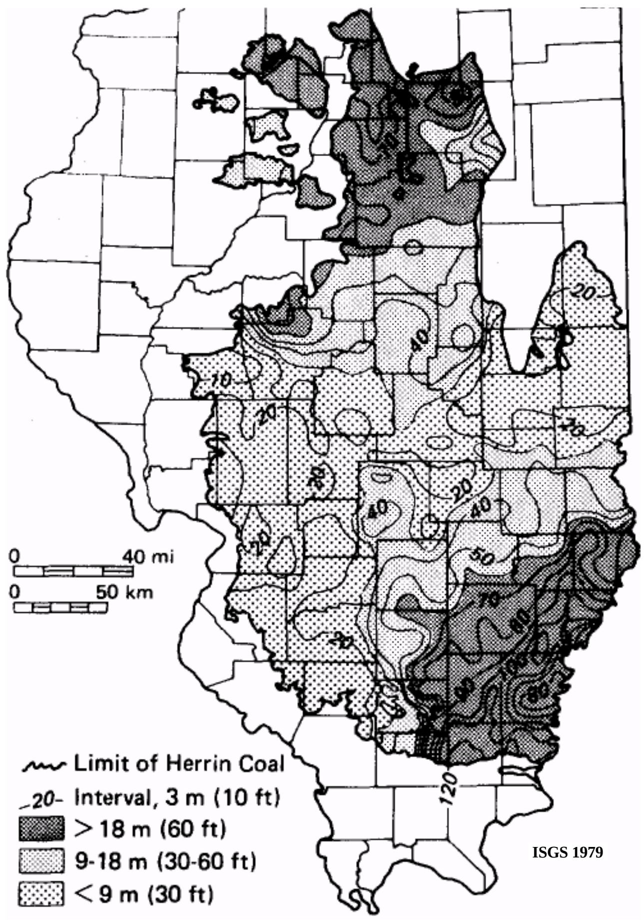

FIGURE 7. Thickness of interval between Herrin and Harrisburg Coal members (modified from Smith and Stall, 1975; Bauer, 1979).

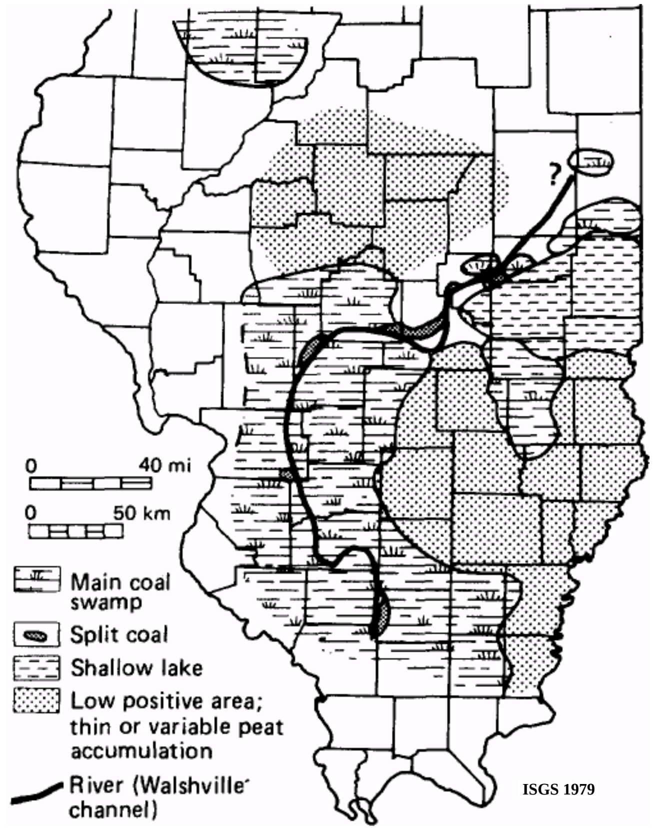

FIGURE 8. Paleogeography at time of Herrin Coal swamp.

Coal (fig. 7). We suggest that this was a low area, possibly a shallow lake or flood basin. Structural movement along the La Salle Anticlinal Belt, the Mattoon Anticline, and the Louden Anticline, which border on or traverse the western portion of this area, may have impeded local drainage. Peat accumulated along the margins of the lake but water depth and/or sediment deposition prevented significant peat accumulation in the center portions. Sediment carried into the area from the east gradually built up a clastic wedge. As surrounding areas of peat subsided or were compacted, the sediment wedge prograded westward over them, creating a barrier to sulfur contamination.

History of the Herrin Coal and contemporaneous channels. The following history of the Herrin Coal and Walshville channel has been inferred from our interpretation of regional geologic observations. It is intended as a working model for coal exploration and continued research.

Prior to development of the Herrin Coal swamp, two large clastic wedges developed in southeastern and northern Illinois (fig. 7). These wedges represent at least two episodes of deltaic progradation from the north and east (Wanless et al., 1963, 1969, 1978). The area between the wedges was a broad shelf. Following marine regression, the Walshville channel and the main part of the Herrin swamp developed on the broad shelf area (fig. 8). Regionally, the thick coal is on the shelf area, and locally, the thickest coal is adjacent to the channel. Peat accumulations on the two clastic wedges were generally thinner and patchy, indicating conditions less favorable for peat accumulation. During periods of seasonal flooding, small splay and overbank deposits locally covered the peat. Swamp growth reestablished itself on some of these flood deposits, resulting in split coal.

In east-central Illinois, structural uplift, combined with the slight topographic high created by the clastic lobes, may have blocked drainage on the shelf and formed a shallow lake or flood basin. Peat accumulated primarily along the north and south shores of the low area, which acted as a catch basin for sediment flowing in from the east. As the lake silted up, sediment was periodically washed into the swamp along the margins, resulting in split coal. The Walshville channel may have received drainage from the lake, but most of the channel's drainage was probably from areas to the northeast (fig. 8).

Marine transgression from the south or west into Illinois brought an end to the peat swamp. As the water base-level rose, extensive flooding of the Walshville channel initiated crevassing in the channel's levees, and splay

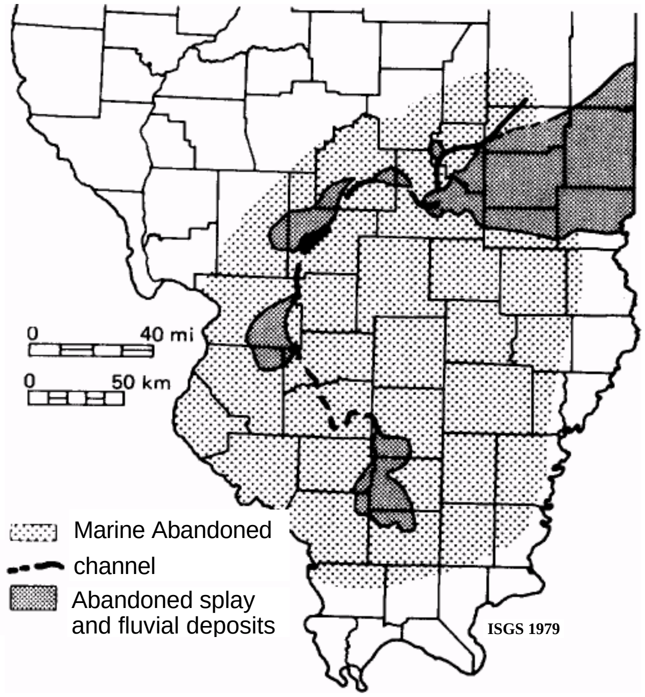

FIGURE 9. Paleogeography shortly after time of Herrin Coal swamp.

sediments were deposited over the adjacent peat (fig. 9), shielding it from sulfur contamination by marine waters. Therefore, probably the best potential for discovery of large areas of low-sulfur Herrin Coal is along the trend of the Walshville channel to the north and east of Douglas County. However, this possibility appears slight, because the coal is largely eroded in these areas.

HARRISBURG (NO. 5) COAL MEMBER

Splay deposits called the Dykersburg Shale Member (Hopkins, 1968) overlie low-sulfur Harrisburg (No. 5) Coal in southern Illinois (fig. 10). These deposits lie along the 160-km- (100-mi-) long trend of the peat-contemporaneous Galatia channel (Hopkins et al., 1979). Wanless et al. (1969) suggested that the channel was located in a broad "alluvial valley" in which conditions were favorable for thick peat accumulation. Though the Harrisburg (No. 5) Coal is not as well studied as the Herrin Coal and its associated splays, the same general lithologic and structural features seem to be present. Unlike the Energy Shale splays which occurred as distinct lobes, the Dykersburg Shale forms a belt 5 to 24 km (3-15 mi) wide, continuous for more than 80 km (50 mi) along the channel. Extensions of the channel and splay deposits have been mapped in southern Indiana (Eggert, 1978). Elsewhere in Illinois the Harrisburg Coal is overlain by marine black shale and limestone and has a sulfur content of 3% or greater. The most likely areas of discovery of low-sulfur Harrisburg Coal are the areas in north-central and east-central Illinois where the Harrisburg Coal is not well known.

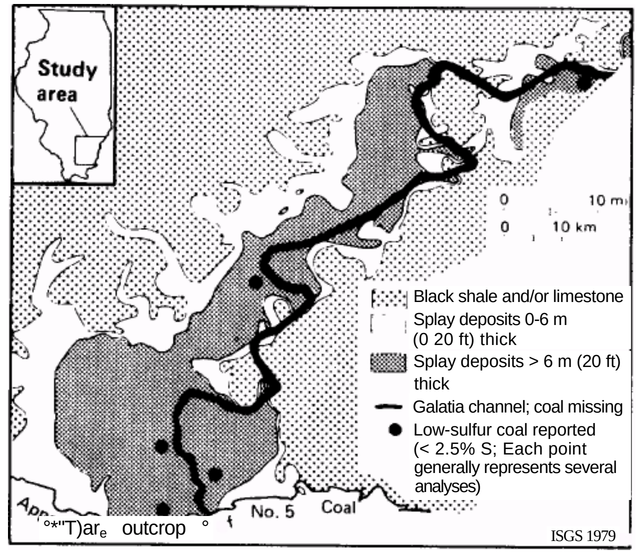

FIGURE 10. Distribution of splay deposits (Dykersburg Shale Member) overlying Harrisburg (No. 5) Coal Member (from Hopkins, 1968).

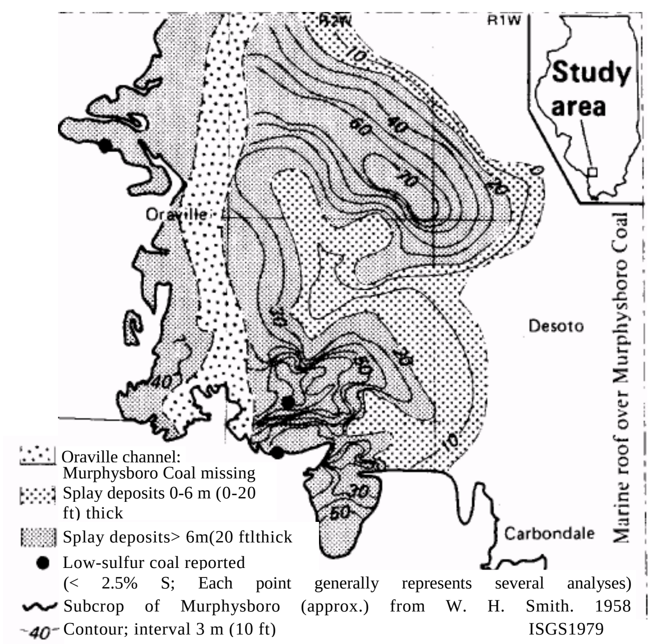

FIGURE 11. Thickness of splay deposits overlying Murphysboro Coal Member in part of Jackson County, Illinois.

MURPHYSBORO COAL MEMBER

The Murphysboro Coal (Spoon Formation, fig. 2) is known to be low in sulfur in one area in Jackson County in southern Illinois. In Williamson County and parts of Jackson County, the coal is overlain by marine black shales and limestone and has a sulfur content of 3.5 to 5.5%. In Jackson County, the coal is missing along a 2-km-wide, sandstone-filled channel, herein named the Oraville channel after the town of Oraville (fig. 11). Areas of split Murphysboro Coal are found along the channel, indicating that the channel developed contemporaneously

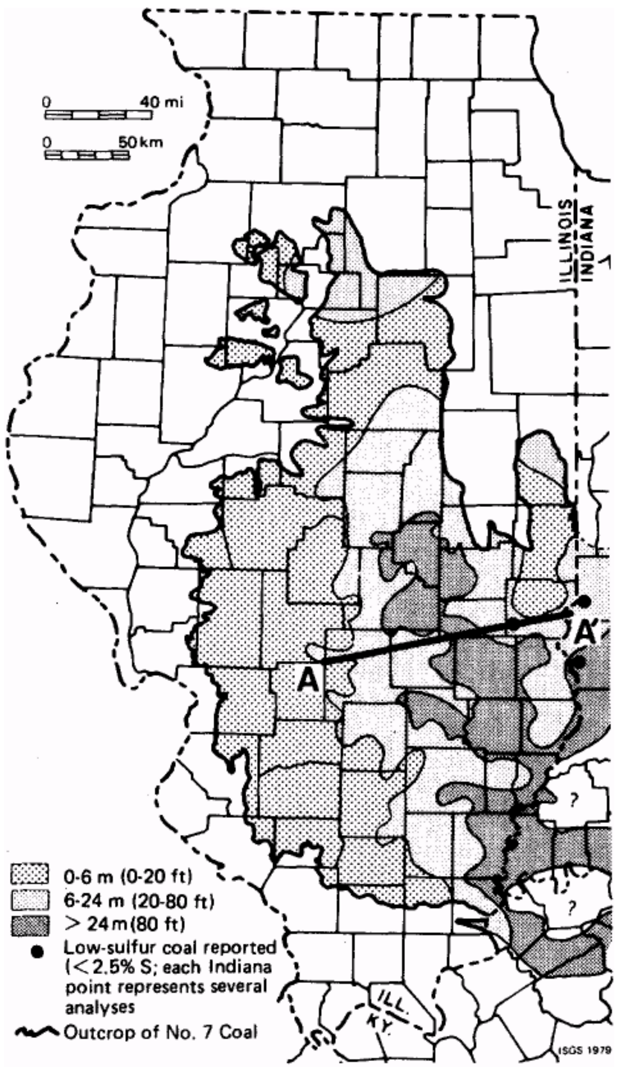

FIGURE 12. Interval between Danville (No. 7) Coal Member and Piasa or West Franklin Limestone members (from Manos, 1967). A-A' section shown in figure 13.

with the peat. Crevasse-splay deposits of siltstone and shale overlie the coal on both sides of the channel. These deposits are as much as 24 m (80 ft) thick and extend more than 11 km (7 mi) from the channel. The sulfur content of the coal underlying the splay deposits ranges from less than 1% to 2.5%.

Additional low-sulfur Murphysboro Coal might be found to the north along the course of the channel. The coal has not been mapped north of Jackson County because of lack of data.

LOW-SULFUR COAL ASSOCIATED WITH MAJOR DELTA LOBES

The Danville (No. 7) and Colchester (No. 2) coals are low in sulfur content in areas overlain by clusters of splay deposits that are part of large deltaic lobes. Deltaic lobes are clastic wedges that overlie large areas of coal. However, much of this sediment was deposited after marine waters inundated the peat swamp. Low-sulfur coal may be found underlying the landward side of deltaic lobes, where splay sediment covered the peat while still in a fresh- or brackish-water environment. The boundary between low- and high-sulfur areas of coal has not been well defined. However, the areas of known low-sulfur coal are overlain by siltstone and sandstone and are located on the high side of the La Salle Anticlinal Belt.

DANVILLE (NO. 7) COAL MEMBER

The Danville Coal has a relatively low sulfur content in Clark County, east-central Illinois, and western Indiana. The coal has a high sulfur content in northern and western Illinois. No analyses of the coal in central Illinois are available. Unlike the coals previously discussed, which were generally overlain by marine black shales and limestones but locally overlain by splay deposits, the Danville Coal in eastern Illinois is overlain by a large lobe of elastics covering more than 26,000 km^2 (10,000 mi^2) (fig. 12). The lobe is thickest in Indiana and thins westward into Illinois.

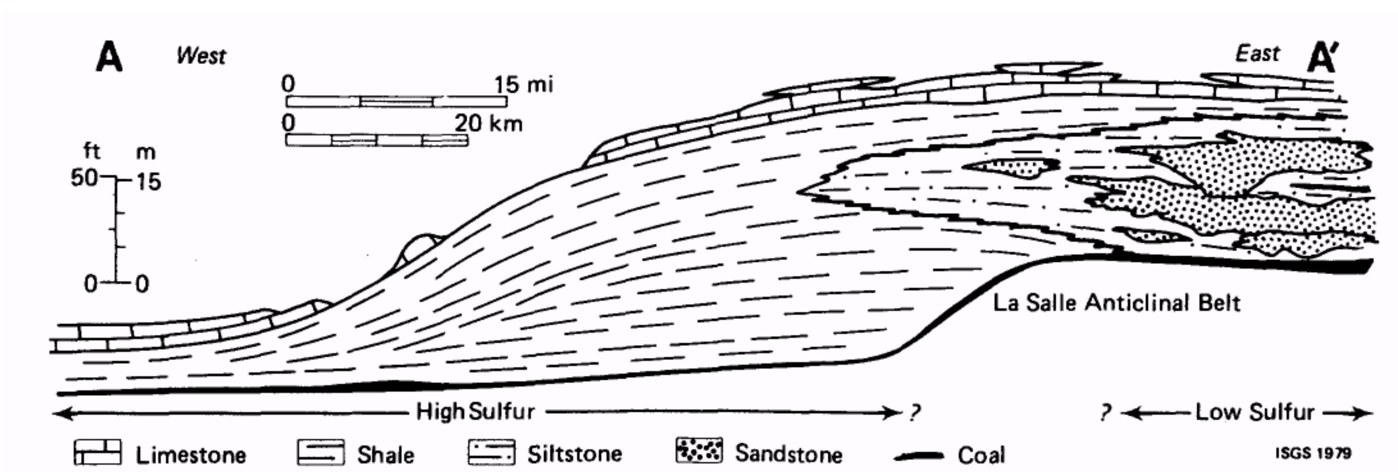

FIGURE 13. Schematic cross section of sediments overlying Danville (No. 7) Coal Member shortly after deposition of West Franklin Limestone Member. Location shown on figure 12.

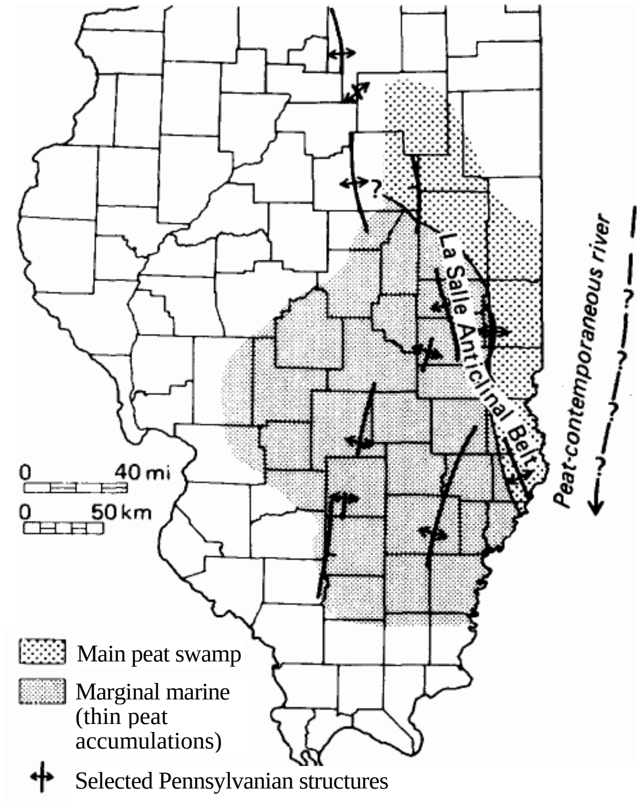

FIGURE 14. Paleogeography at time of Danville Coal swamp.

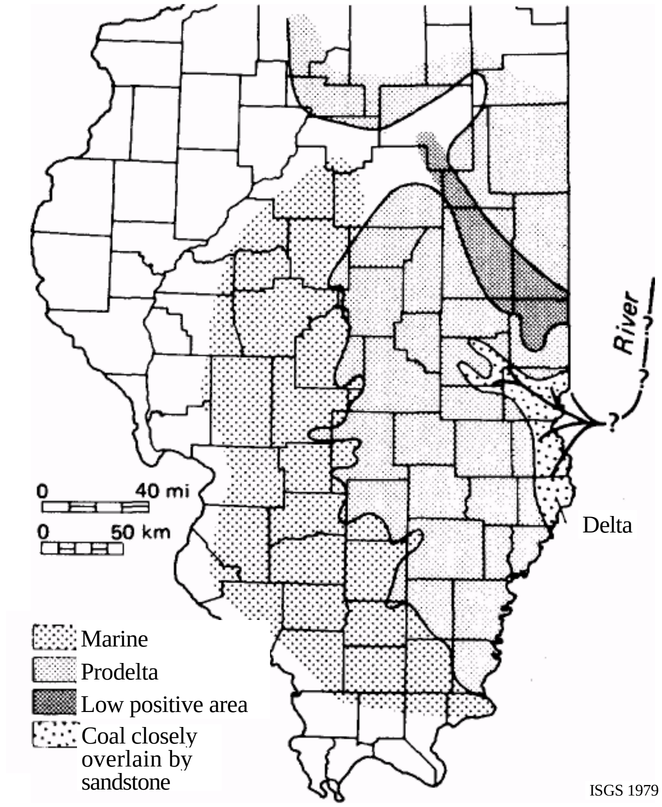

FIGURE 15. Paleogeography following time of Danville Coal swamp.

Thinning of the unit in eastern Illinois probably reflects uplift along the La Salle Anticlinal Belt, which was active throughout much of Pennsylvanian time (Clegg, 1965). Although few chemical analyses are available, the depositional model we have constructed indicates that low-sulfur coal is probably restricted to Clark, Crawford, and Lawrence counties in east-central Illinois and to western Indiana.

Figure 13 is a schematic east-west cross section of the interval between the Danville Coal and the first overlying limestone (West Franklin Limestone Member, eastern Illinois; Piasa Limestone Member, western Illinois). The indicated topography of the coal has been inferred from the thickness of the overlying wedge of sediments and from the position of the La Salle Anticlinal Belt. The slope of the coal along the west flank of the La Salle Anticline is greatly exaggerated. In eastern Illinois, the coal is closely overlain by sandstone and siltstone. The thickness and stratigraphic position of sandstone varies greatly, indicating an environment of many small, shifting, distributary channels. However, the coal is not known to be eroded by any of these channels. The siltstone and sandstone are stratigraphically higher above the coal and grade into shale westward. The wedge of elastics thins to the west. A thin coal is present in eastern Illinois in a position midway between the Danville Coal and the West Franklin Limestone.

This succession of sediments indicates that a clastic wedge prograded westward over the Danville peat swamp. Distributary sands and channel-mouth bars were confined to the area east of the La Salle Anticlinal Belt, while pro-delta sediments accumulated to the west. Peat accumulated on the eastern portion of the delta platform for a short time. Marine transgression caused the shoreline to migrate eastward and eventually covered the wedge (Piasa Limestone, West Franklin Limestone).

This sequence of delta progradation and marine transgression and its possible relationship to sulfur content of the coal is shown in figures 14 and 15. The paleogeography of the Danville peat swamp is shown in figure 14. Regional structure seems to have influenced the accumulation of peat. East of the La Salle Anticlinal Belt and in parts of northern Illinois, the Danville Coal is 0.6 to 1.8 m (2-6 ft) thick. West of the La Salle Anticlinal Belt, the coal is generally less than 1 m (3 ft) thick, often less than 0.6 m (2 ft) thick. This indicates less favorable or shorter lived favorable conditions for peat accumulation than in the areas to the east of the anticline. The area west of the anticlinal belt was probably topographically lower and was inundated earlier by marine transgression.

We hypothesize that a river flowed through the peat swamp in western Indiana. No actual channel is known, but much of the area is now outside the outcrop of the

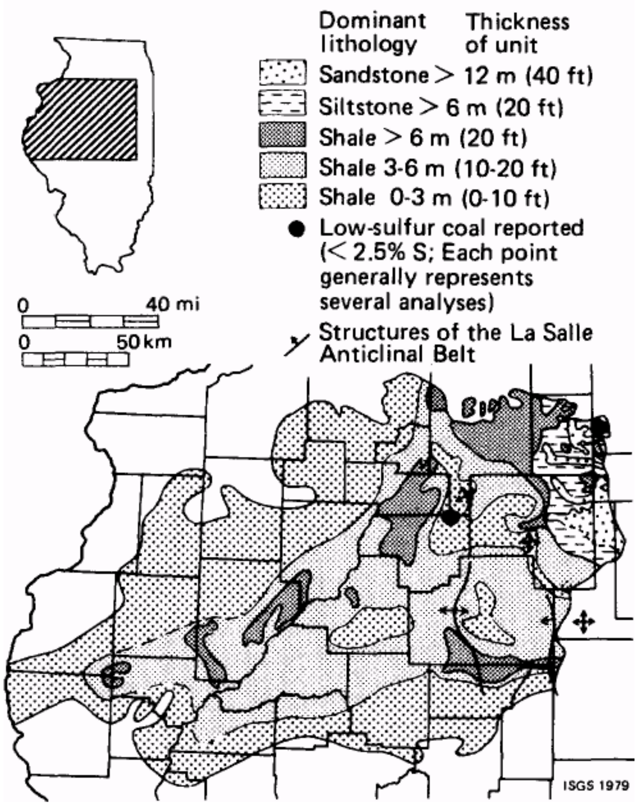

FIGURE 16. Generalized lithofacies and thickness map of Francis Creek Shale Member overlying Colchester (No. 2) Coal Member (thickness from Smith, 1970).

Danville Coal. Crevassing of the river's levees, possibly in response to marine transgression, may have caused diversion of the river channel to the west into the Illinois area. A cluster of large splays was deposited over the coal in western Indiana and parts of eastern Illinois. As the base level rose, this system of splay deposits developed into a major deltaic lobe (fig. 15). The limit of low-sulfur coal has not yet been clearly defined. Probably only the coal covered by early splay deposits was shielded from the transgressing marine waters. This area may correspond to areas east of the La Salle Anticlinal Belt, where sandstone closely overlies the coal (fig. 15). The silts and shales to the west of this area were probably deposited in a marine pro-delta environment and were too late to shield the peat against the subsequent marine environment.

COLCHESTER (NO. 2) COAL MEMBER

Depositional conditions associated with low-sulfur Colchester (No. 2) Coal appear similar to those associated with the Danville Coal. In northern Illinois, the coal is overlain by a clastic wedge called the Francis Creek Shale Member (Savage, 1927; Smith, 1970). This wedge is more than 24 m (80 ft) thick in northeastern Illinois and thins gradually westward and southward (fig. 16). In northeastern Illinois, the unit consists largely of siltstone and sandstone. As the unit becomes thinner to the southwest, it grades into gray shale. Where the Francis Creek Shale is absent, the coal is overlain by a marine black shale.

Low-sulfur coal was reported (Gluskoter and Simon, 1968) from several mines in the area where the coal is overlain by thick sandstone and siltstone. However, high-sulfur coal was also reported in several mines in this area. Elsewhere, only one mine was reported to have low-sulfur coal where overlain by the gray shale.

It is generally believed that the Francis Creek Shale prograded from the northeast over the peat swamp (Wright, 1965; Shabica, 1970). Peat to the northeast of the present-day outcrop of the coal was covered with sediment while still under brackish-water conditions. Peat to the southwest was largely invaded by marine waters before being covered by the Francis Creek Shale. The area of low-sulfur coal in northeastern Illinois represents a transitional area where marine and nonmarine conditions were interfingering. Fossils found in this area support the interpretation of a transitional zone. Well-preserved plant and animal fossils are found in ironstone concretions throughout the area. In some areas, the assemblages are distinctly nonmarine, while nearby areas have distinct marine faunas (Johnson and Richardson, 1970; Baird, 1978).

CONCLUSIONS

At least two forms of splay deposits are associated with low-sulfur coal in Illinois. Areas of low-sulfur Herrin (No. 6), Harrisburg (No. 5), and Murphysboro coals are overlain by small crevasse-splay deposits scattered along ancient rivers that flowed through the peat swamp. These deposits occur in isolated, well-defined areas and are best found by exploring along the trend of peat-contemporaneous rivers. Areas of low-sulfur Danville (No. 7) and Colchester (No. 2) coals underlie splay deposits, which are part of large deltaic lobes. These low-sulfur areas may have irregular and poorly defined boundaries. They are best found by exploring areas overlain by coarser elastics toward the landward margin of the delta lobe.

Structure and topography appear to have some control over the thickness of the coal, as well as location of rivers flowing through the peat swamp, and distribution of splay deposits. An understanding of the paleogeography at the time of and immediately following peat deposition is an aid to exploring for low-sulfur coal. For example, the Walshville channel formed its drainageway along a broad, swampy shelf area situated between two low positive areas. Regionally, the coal is thick on this shelf area, and locally, it is thickest adjacent to the channel. A shallow lake or flood basin formed in a low area of the shelf. This low area may have resulted from structural movement that blocked drainage in this area. Coal is thin or absent within the central area of the lake but is thick along some of the lake margin. The boundaries of the deposit that covered the coal in this area conform to the inferred paleotopography.

The La Salle Anticlinal Belt may have had some influence on the thickness and quality of the Danville Coal. The coal is thickest and has a lower content of sulfur in an area east of the anticlinal belt. This area may have been topographically higher than areas to the west. Peat accumulation continued here after lower areas had been inundated by marine waters. The peat in much of this area was covered by nonmarine elastics before it could be contaminated by sulfur from transgressing marine waters.

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