Coal in the Ferron Sandstone: A Model for Deltaic Coal-Bearing Strata

by

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The Emery coal field (Fig. 1.), with total coal resources of about 1.3 billion metric tons (Lupton, 1916; Doelling, 1972), is one of the smaller coal fields in the Rocky Mountain region. Nonetheless, it combines a variety of characteristics that make it ideal for studying the geometries of coal beds and determining their paleoenvironmental settings:

1. Natural exposures of the Ferron are superb.
2. The structural strike is approximately perpendicular to the general shoreline trends, making it possible to trace all of the major coal beds in a depositional dip direction from their landward to their seaward extremes. This is also true for the shoreline sandstone units.
3. All of the major coal beds contain one or more altered volcanic ash layers that can be correlated over considerable distances. These serve as isochronous surfaces.
4. Most areas have been drilled for purposes of coal exploration, some of them extensively.

Ferron coals range up to about 10 meters in thickness. Five seams (see cross sectin in Ferron Synopsis), designated A, C, G, I, and J, are economically important. The A and C seams have been mined at many locations. The G and J coals are relatively thin: the G coal has never been mined; the J coal has been mined on a small scale in several old mines in the northern part of the field. The I coal attains the greatest thickness of any Ferron coal and was actively mined at a large-scale, commercial at Consolidation Coal Company's Emery Mine, until several years ago, when the mine was idled. Ferron coals are

presently the object of an active coalbed methane development program in the vicinity of Price, about 50 miles to the NNE.

The thick coals of the Ferron are the result of coalification of great thicknesses of peat. Accumulation of thick intervals of peat requires special environmental conditions.

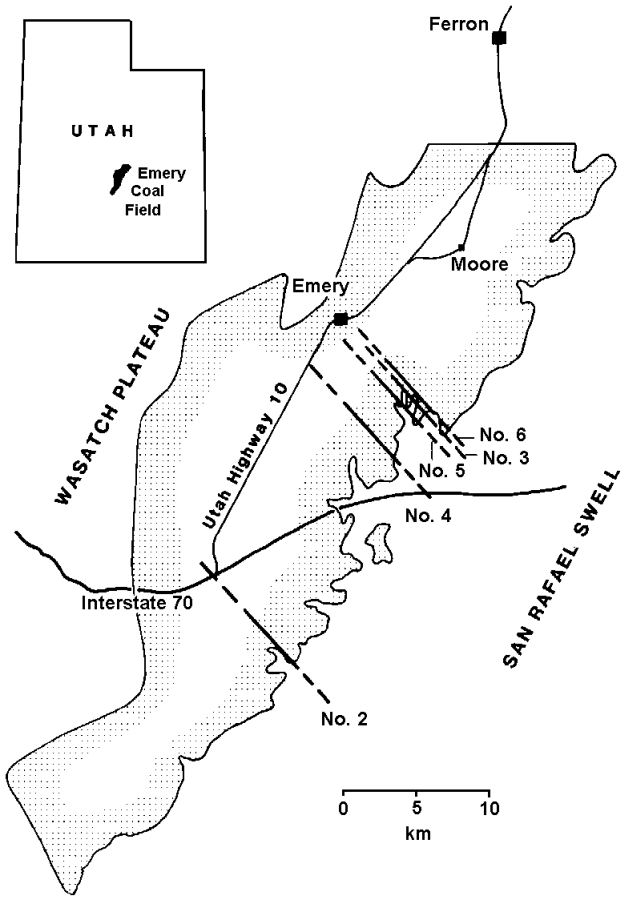

Figure 1 -- Map of the Emery coal field, central Utah. The landward pinch-outs of the shoreline sandstone units discussed in the text are indicated. They can be related to the individual pinch-outs shown in Figures 4 through 8. No landward pinch-outs are shown for delta-front units Kf-7 and Kf-8 because they cannot be accurately defined on the basis of available information. Neither is associated with significant thicknesses of coal.

1. Climatic conditions must be such that rapid plant growth is promoted, which usually means humid conditions in tropical to temperate settings.
2. Little or not influx of clastics can occur. Swamps that grow to elevations higher than the adjacent rivers and floodplains (i.e. “raised mires” of some authors) are very effective at inhibiting influx of clastics.
3. The ground water level must rise, ideally at a rate that nearly equals the rate at which peat can be produced. Peat that remains above the groundwater table is subject to oxidation. This is the primary reason why so many highly productive modern swamps are underlain by little or no peat.

Figure 2 -- Outcrop of the A coal bed in Willow Springs Wash in the southern part of the Emery coal field. The coal is about 3 meters thick here and is erosionally overlain by a fluvial channel sandstone. The light layer in the top of the coal bed is a volcanic ash layer. It can be traced through the southern and central parts of the Emery coal field.

In the Cretaceous of the Western Interior, these condition were most commonly met in delta-plain and coastal-plain settings. Figure 3 shows the relationship that might be expected to occur between shoreline sandstone bodies and age-equivalent coals. Just as the shoreline sandstone bodies are most continuous along depositional strike, coal beds might be expected to be most continuous along strike also. This is, in fact, the case in deposits that accumulated along wave-dominated coasts. The situation in the Ferron, however, is more complicated.

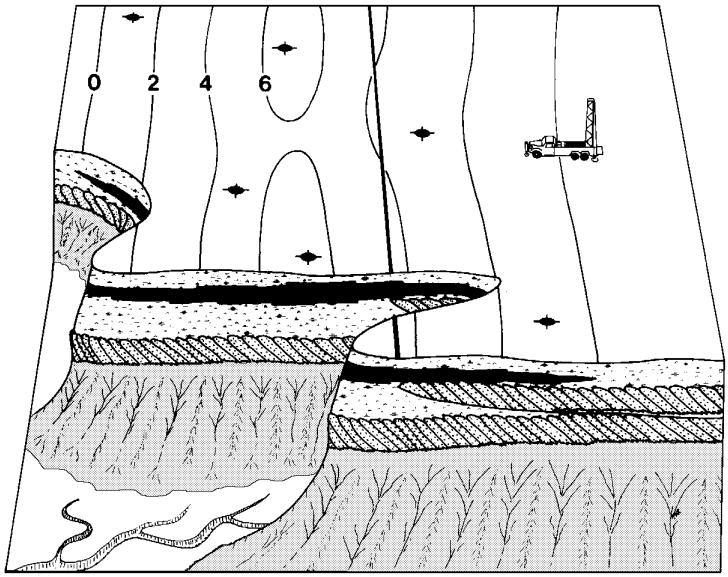

Figure 3 -- Diagram showing the general relationship that might be expected between coal beds and related shoreline sandstone units. The area of thickest coal overlies the pinch-out and extends landward from it, being elongate parallel to the coast.

A clear genetic relationship exists between the geometries of major coal beds of the Emery coal field and the geometries of their associated shoreline sandstone bodies. Figures 4 through 8 show this relationship for the five most important coal beds. Bodies of thick coal are associated with the landward pinch-outs of the shoreline sandstone bodies, extending landward about 10 kilometers from each of the pinch-outs. The A coal presents a more complicated picture. In addition to a thick body of coal landward of the pinch-out of the Kf-2 sandstone, it includes thick bodies of coal overlying the sandstone. This is the result of stacking of parasequences: these pods of coal lie immediately landward of an area of vertical stacking of parasequence-level shoreline sandstone bodies within Kf-2.

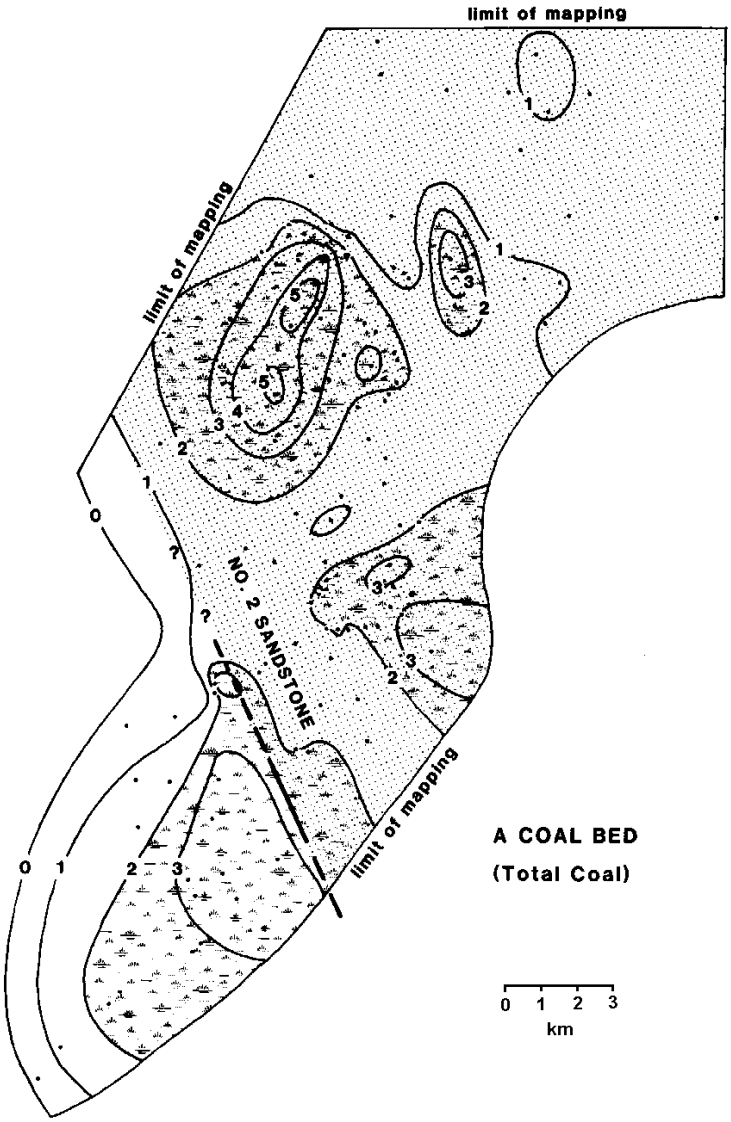

Figure 4 -- Map of the A coal bed. The landward pinch-out of the associated Kf-2 sandstone is indicated. In this and the following figures, the stipple pattern indicates the presence of the shoreline sandstone unit beneath the coal. North is up on the page. Dots indicate control points. The easternmost points are outcrops, the remainder drillholes. Note the thick area of coal overlying and landward of the pinch-out. The A coal bed is different that the younger coals of the Ferron in that it includes several thick pods of coal overlying the associated shoreline sandstone in positions seaward of the pinch-out.

The thick coal accumulations in the Ferron are generally characterized by pod-like configurations. The I and J coal beds include pods that are elongate

perpendicular to the paleocoast. Areas of thick coal in the A and G beds do not display strong elongation. The C coal includes two areas of thick coal that together extend parallel to the coast. The southeastern and better controlled thick area, however, might be considered as having an elongation perpendicular to the paleocoast. The simple model of Figure 3 is contrasted with the actual, pod-like shapes of thick coal bodies of the Ferron in Figure 9.

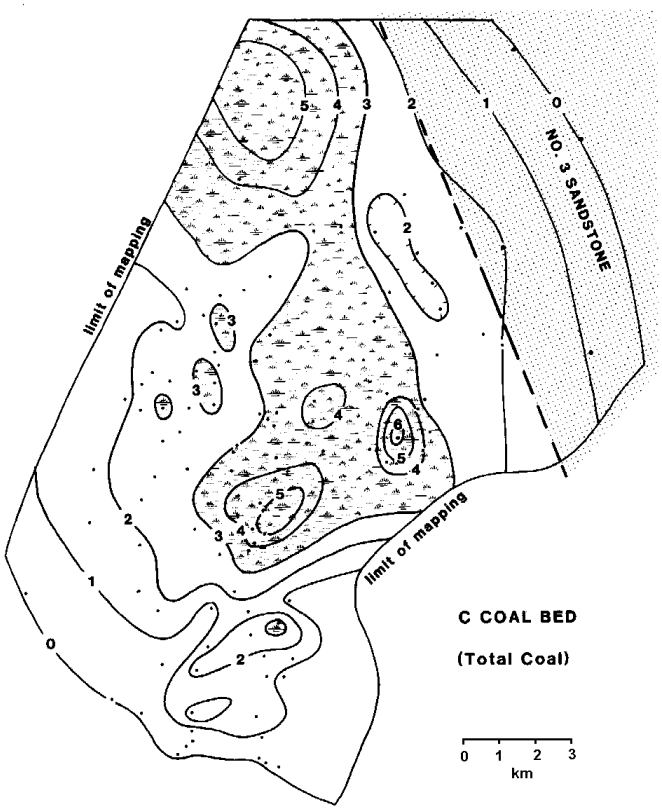

Figure 5 -- Map of the C coal bed. (Work conducted since this figure was prepared has demonstrated that the landward pinch-out of Kf-3 actually splits the coal seam. Accumulation of peat probably began during the final stages of progradation of Kf-2, largely occurred during the transgression that preceded Kf-3 progradation, and continued through Kf-3 progradation.)

The reason for the pod-like shapes of the Ferron coals is the presence meanderbelts that accumulated sediment contemporaneously with peat accumulation. Areas of thin coal generally correspond to areas of thick meanderbelt deposits and visa versa. This relationship is particularly clear for the I coal bed, where a thick meanderbelt deposit is flanked immediately to the west by thick I coal just southeast of the town of Emery. The configuration of the C coal bed can be explained similarly: note the inverse relationships between the thickness of the C coal bed and the thickness of the interval between the C coal and the underlying A coal bed in Figure 10. Figure 11 shows the depositional history of the C coal bed and associated units.

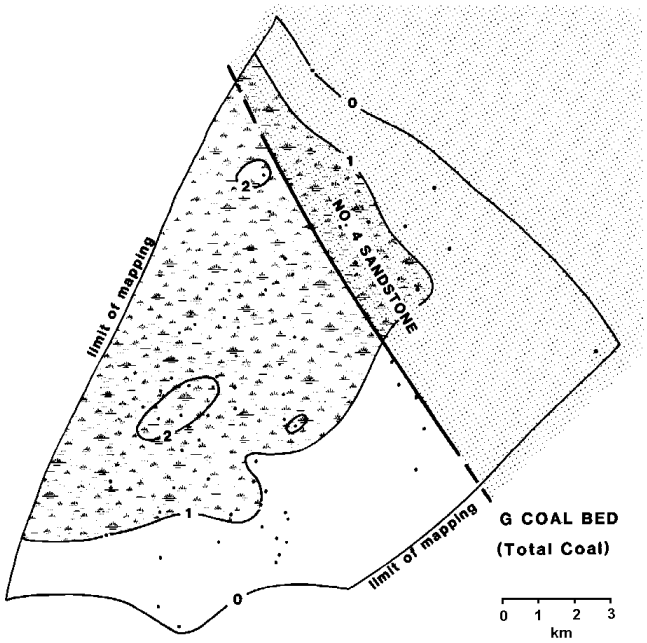

Figure 6 -- Map of the G coal bed. This coal bed is relatively thin, exceeding 2 meters in thickness only locally.

The model described here was constructed to assist in coal exploration. Today, this increasing means exploration for coal beds that can be tapped for their content of methane.

References Cited

Lupton, C. T., 1916, Geology and coal resources of Castle Valley in Carbon, Emery, and Sevier Counties, Utah: U.S. Geol. Survey Bull., 628, 88 p.

Doelling, H. H., 1972 Central Utah coal fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery: Utah Geological and Mineral Survey Monograph Series, no. 3, 570 p.

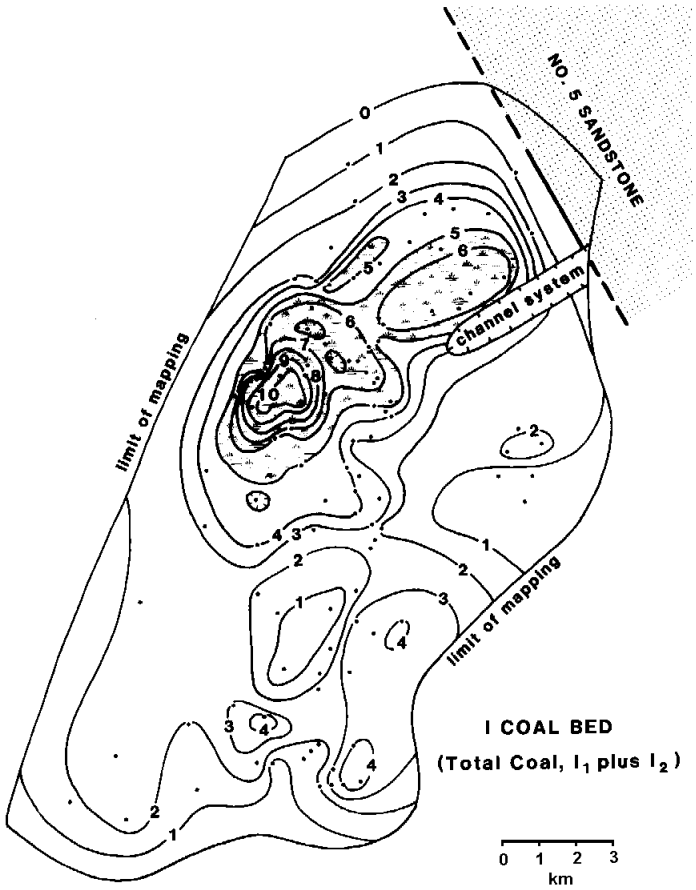

Figure 7 -- Map of the I coal bed. The I coal attains thicknesses of 10 meters and has been commercially mined south of Emery. A prominent fluvial channel system lies along the eastern flank of the thick coal accumulation and is well exposed on outcrops in Muddy Creek Canyon.

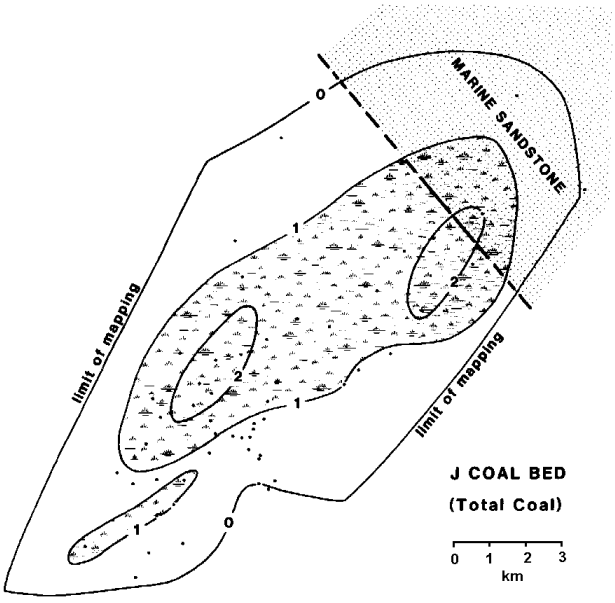

Figure 8 -- Map of the J coal bed. The J coal merges southward with the top of the I coal near its southwestern limit. Elsewhere, it is separated from the I coal by bay and lagoonal beds that lie behind the landward pinch-out of the Kf-6 shoreline sandstone unit.

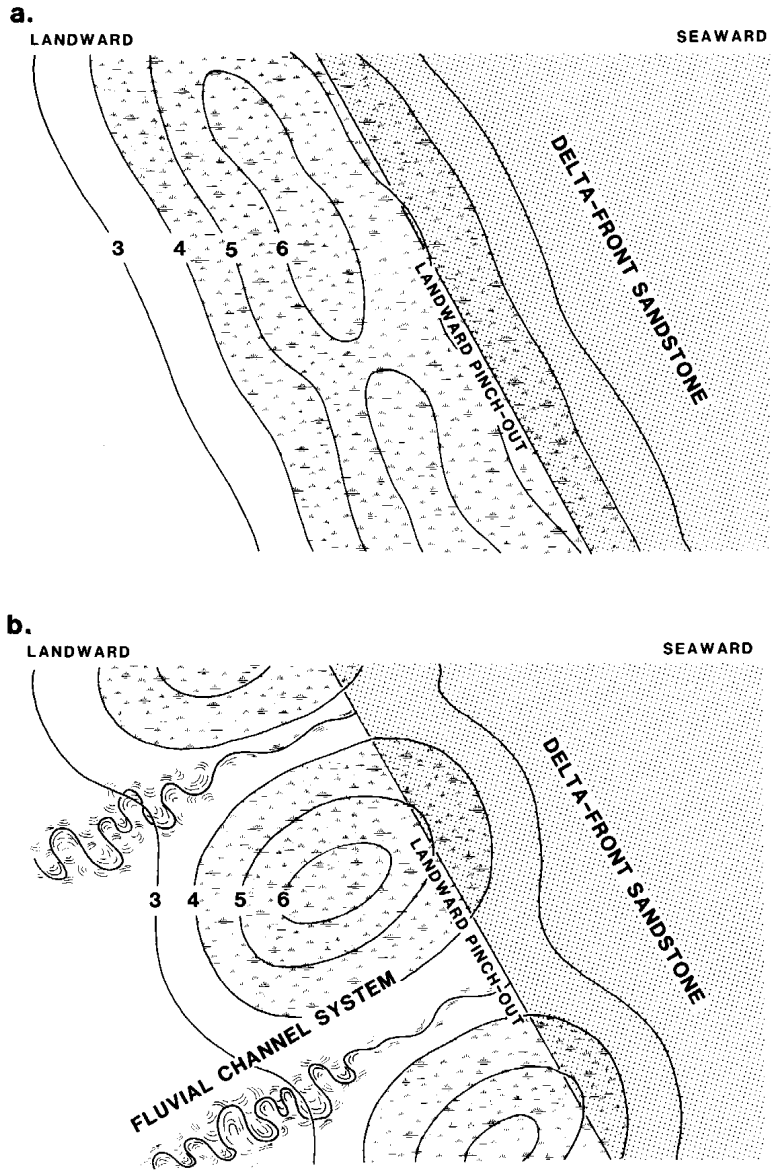

Figure 9 -- Diagrams contracting the configurations of the idealized coal bed shown in Figure 2 and the actual, pod-like shapes observed for the Ferron coal beds. The pod-like shapes, which are commonly elongate perpendicular to the shoreline trend, owe their origins to the fact that the coal accumulated contemporaneously with fluvial channel belts.

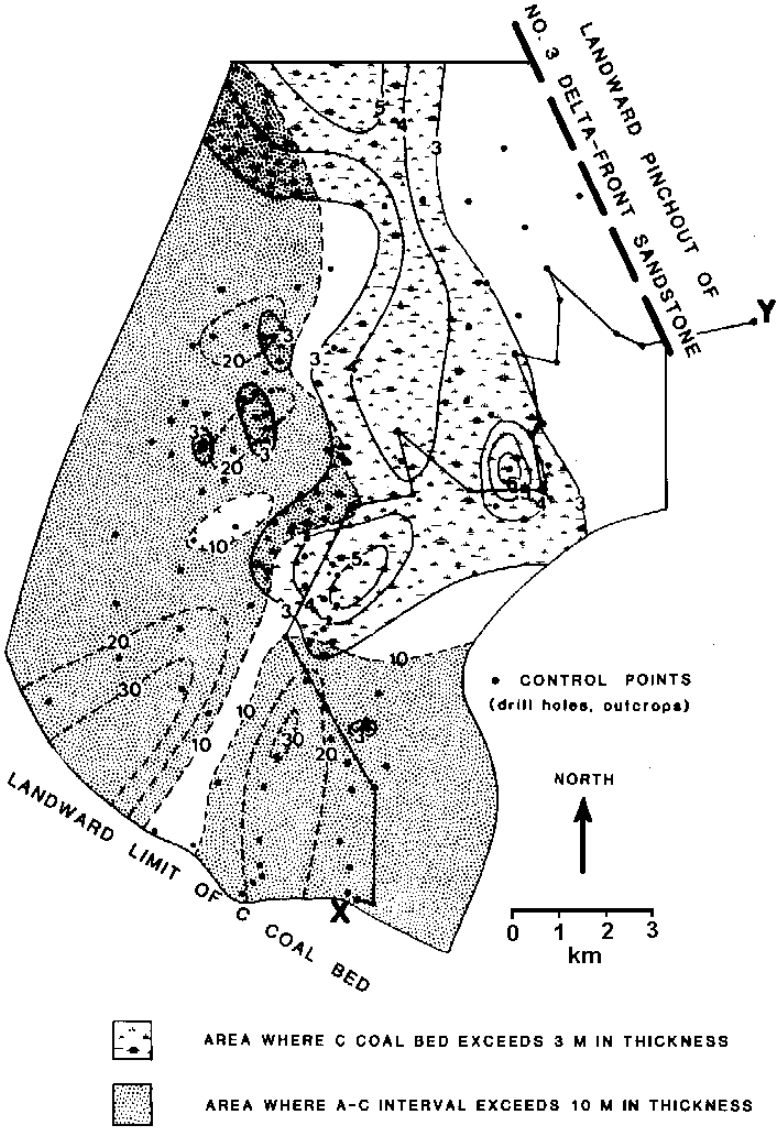

Figure 10 -- Map relating thicknesses of the C coal bed (area where thickness exceeds 3 meters shown by swamp pattern) and thickness of the interval between the A and C coals (area where thickness exceeds 10 meters shown by stipple pattern). The thicknesses shown an inverse relationship, the fluvial sediments and peat being lateral facies equivalents. The approximate position of the cross section shown in Figure 11 is indicated.

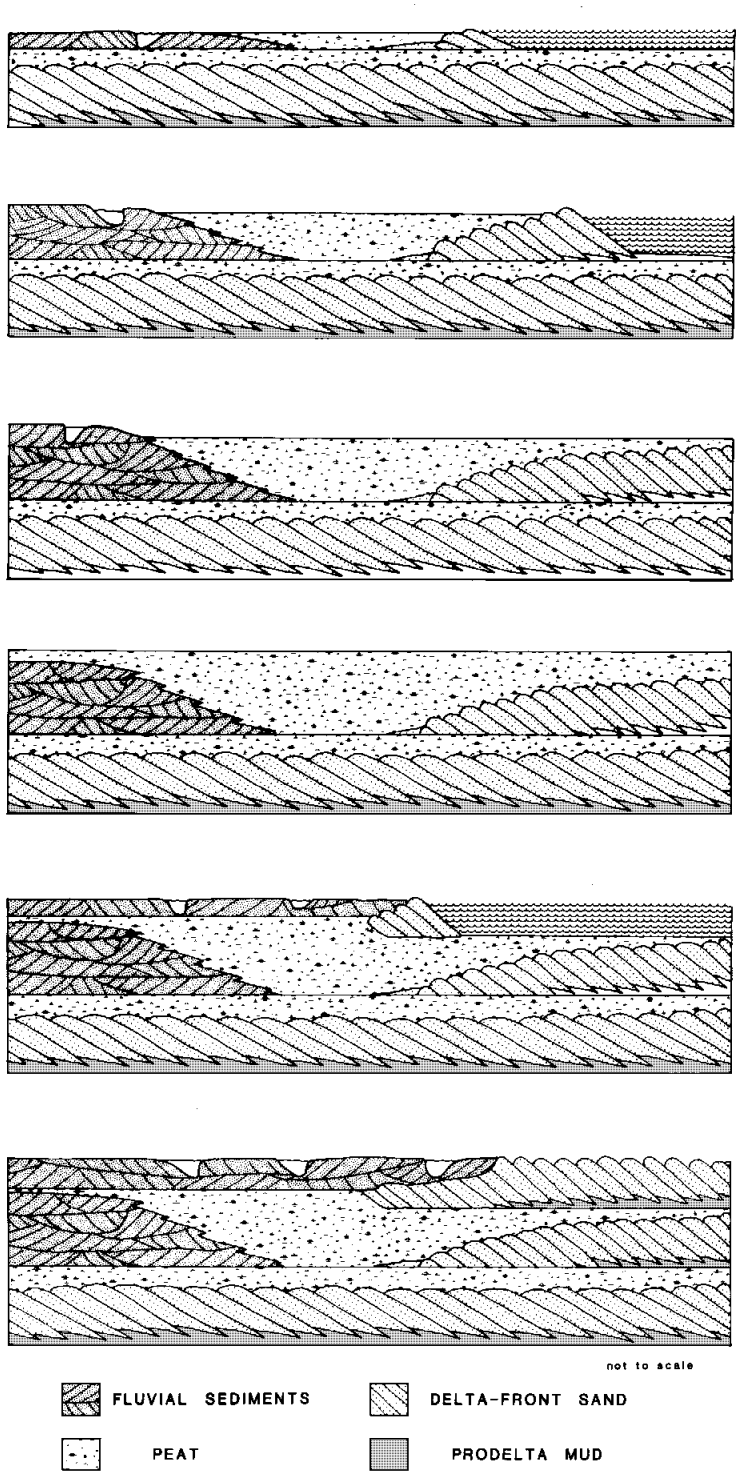

Figure 11 -- Diagrammatic cross section showing the depositional history of the C coal bed and associated units.