Logfacies Distribution of the Wilcox Coal-Bearing Interval in North-Central Louisiana: A Quick-Look Technique for Coalbed Methane Resource Evaluation

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EXTENDED ABSTRACT

When the surface exposures of the Tertiary-aged Wilcox Group coals in northern Louisiana were initially described they were noted to be of lignite rank. However, the recent success of coalbed methane (CBM) production from relatively low-rank coals in the Powder River Basin, Wyoming has sparked interest in other U.S. basins containing coals of similar rank (F. C. Breland, Jr., 2006, personal communication). Research, headed by the U.S. Geological Survey, has shown that the coals in northern Louisiana and the greater Gulf Coast increase in rank with depth to sub-bituminous and possibly bituminous (Warwick *et al*., 2004). Ongoing research at the Louisiana Geological Survey and the University of Louisiana at Lafayette is being conducted with the goal of developing a 3-D database of northern Louisiana Wilcox coal distribution and properties on a basin-wide scale.

As part of this larger goal, the present study further develops the technique employed by Coates *et al*. (1980) and Rogers (1983) to more quickly identify coal prone areas within the fluvial-deltaic Wilcox Group (Holly Springs Delta System) from easily-obtainable, digitized SP and resistivity logs. This adapted technique relies on the premise that limestone does not typically occur in fluvial-deltaic depositional environments and that the high-resistivity beds of the regressive Lower Wilcox are coals. These assumptions are verified by four wells containing porosity logs (density, neutron, or sonic), which allow high-resistivity beds to be identified as coal or limestone in the study area. The technique uses well-log response, statistical cutoffs, and sandstone body geometry to interpret depositional environment and coal-prone areas.

In the study area (Fig. 1), one hundred well logs penetrate the Wilcox Group sufficiently to be utilized in the study. For sandstone body geometry an average of the 5th and 95th percentile of the SP curve over the Wilcox interval is used as a sandstone/shale cutoff line. From this, gross interval thickness, net sandstone thickness, and net-to-gross ratio isochore maps are generated. Interpretations of these maps are combined with comparisons of log character to published typical log character for fluvial-deltaic depositional environments to arrive at logfacies maps.

Results agree with previous work near the present study area showing a regressive, progradational delta complex in the Lower Wilcox. The Upper Wilcox is characterized by a transgressive, lagoon barrier-bar complex.

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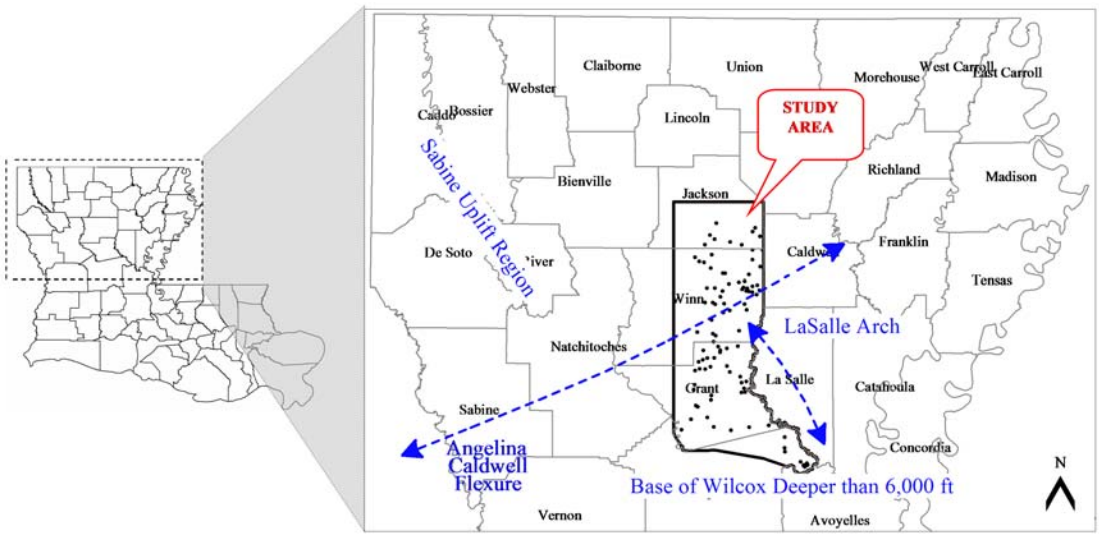

Figure 1. Map showing study area and nearby structural elements.

For net coal calculation a cutoff is employed on the deep resistivity curve with the assumption that resistivity values for sandstone are less than shale; both are much less than coal (resistivity of sandstone < shale << coal). Within the Wilcox though, the presence of sandstone serves to decrease the overall baseline of resistivity values such that statistical baseline cutoff calculations would not account for thicker, "clean" shale, inducing error. However, the upper portion of the underlying Midway Group is comprised of "clean," marine shale with stable baseline resistivity values. Thus, the resistivity cutoff line is established as the 50th percentile of the resistivity values of the upper portion of the Midway Group marine shale. By using marine shale of the Midway Group to determine the coal cutoff value, inclusion of shale into net coal calculations within the Wilcox is kept to a minimum.

In the current study, the Lower Wilcox is subdivided into 4 correlative units for detailed study (Fig. 2). Maximum coal accumulation and delta progradation/ aggradation coincide such that average net coal thickness increases through units 1, 2, and 3 from 8 to 31 ft. Unit 4 is a transitional interval between the constructional and destructional phases of the deltaic system and average net coal thickness decreases to 8 ft. Coal-thickness determinations in the transgressive Upper Wilcox using the present technique are not reliable due to the presence of low porosity-high resistivity limestone, which are categorized as coal when resistivity is the sole discriminator. Overall, coal accumulation in the transgressive Upper Wilcox is minor relative to the progradational deltaic complex of the Lower Wilcox.

Figure 3 shows the interpreted logfacies and coal prone areas of the Lower Wilcox for each interval. As mentioned above, logfacies interpretations are based on sandstone body geometry (gross interval thickness, net sandstone thickness, and net-to-gross ratio) and well-log response. Coal areas are based on the 15 ft net coal thickness contour with the exception of Interval 3, which is based on the 50 ft net coal thickness contour. Maximum net coal thickness for a single well in Interval 3 is 132 ft.

What becomes apparent from these snapshots is the movement of delta front- deposition from the east (Fig. 3A), to the south (Fig. 3B), and south of the study area (Fig. 3C) where no delta front deposits are found. Then, as seen in Interval 4 (Fig. 3D), transgression became dominant with clean, reworked barrier-bar sandstone located landward of shelf deposits.

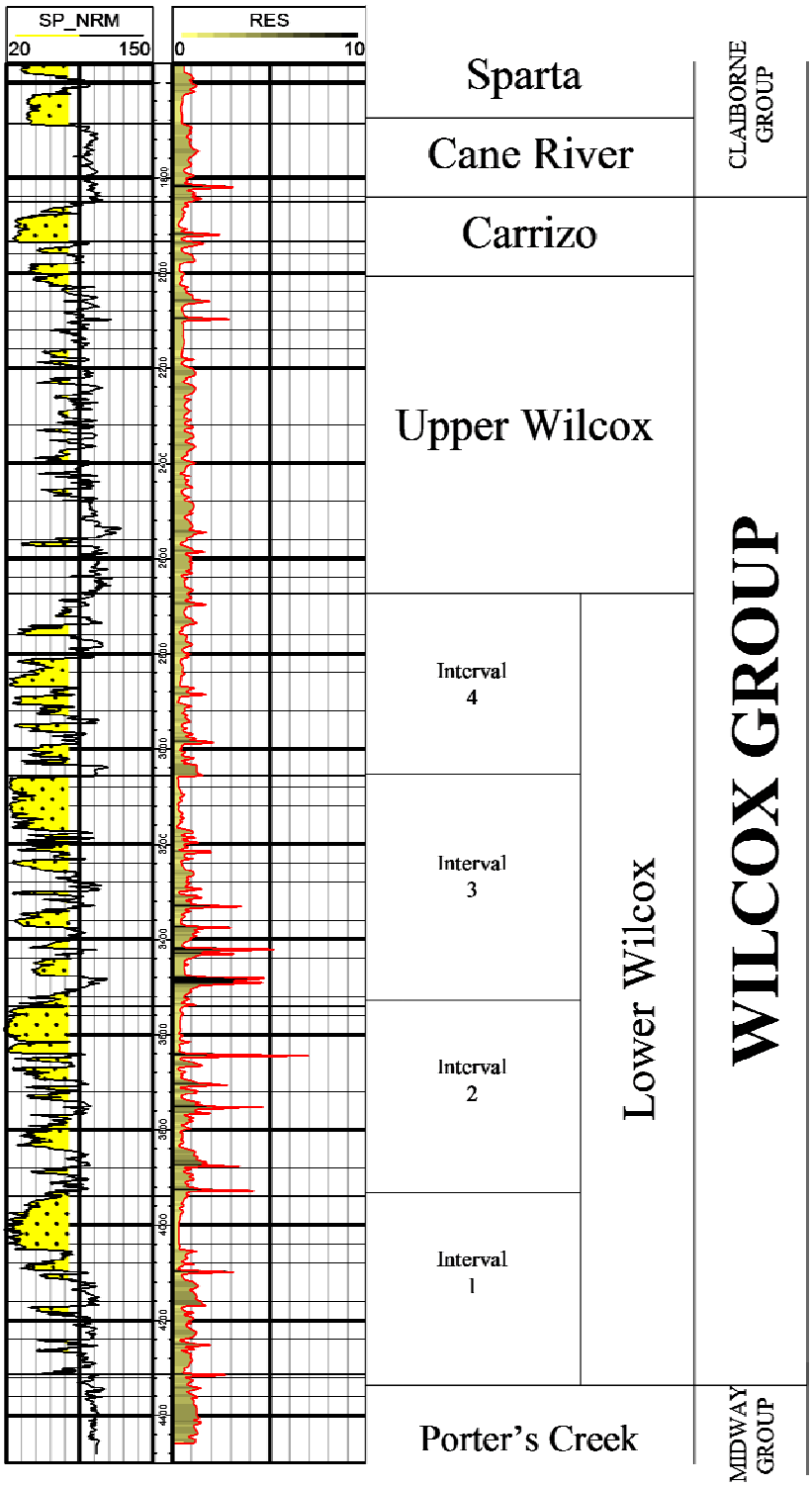

Figure 2. Type log (Bodcaw Co., Bodcaw Fee No. 2, Section 10 T8N-R1E, Grant Parish) and stratigraphic nomenclature used in this study.

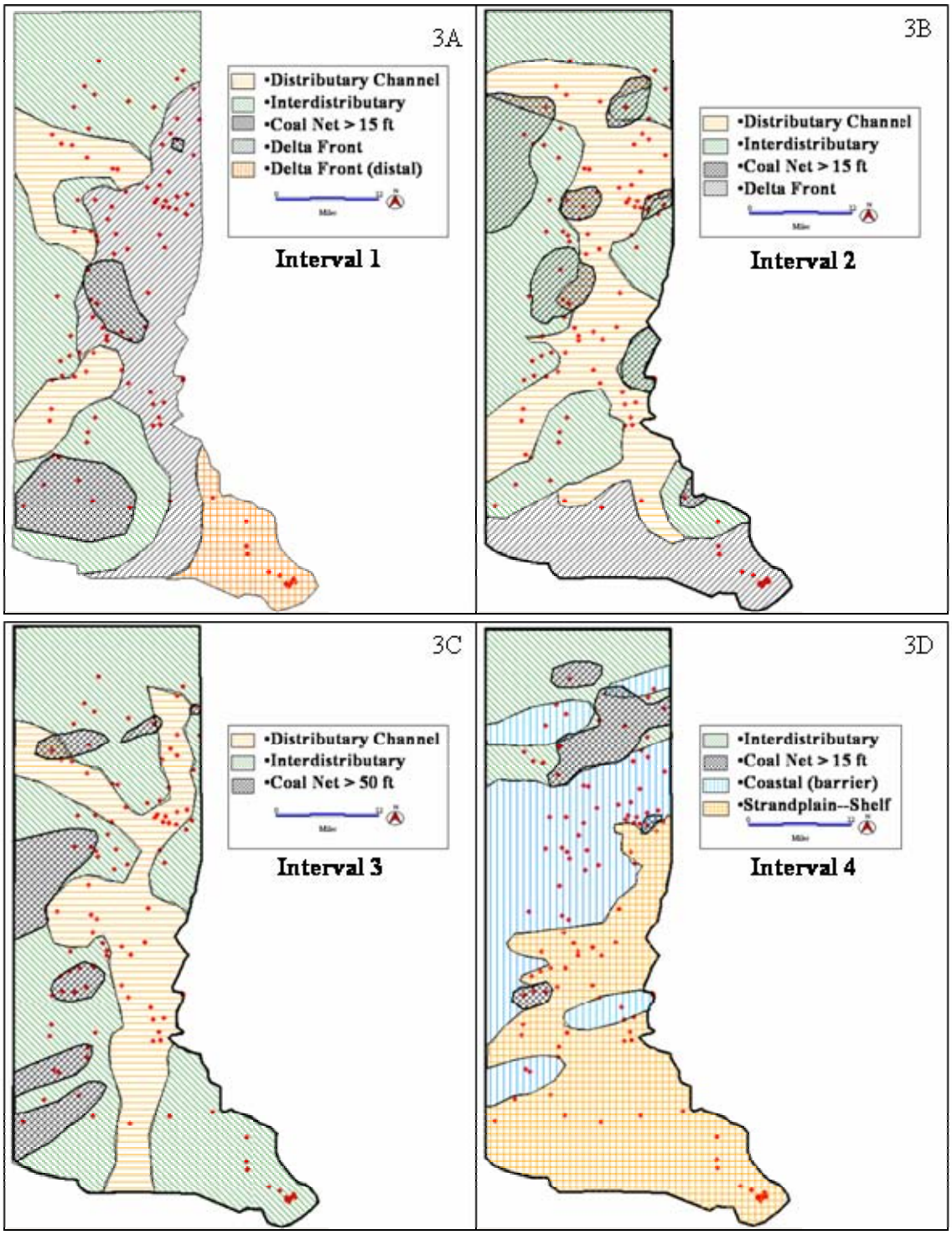

Figure 3. Logfacies distribution for the Lower Wilcox: (A) Interval 1, (B) Interval 2, (C) Interval 3, and (D) Interval 4.

The simple technique presented here allows interpretation to progress quickly over a large area so that, in conjunction with other, ongoing research, fairway delineation based on coal occurrence can proceed more quickly for the basin as a whole.

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