Seismic modeling of Upper Cretaceous coal-bearing strata of the Willow Creek Area, east of Drumheller: implications for CBM exploration

C. Willem Langenberg* (willem.langenberg@gov.ab.ca), Frances J. Hein,
Alberta Geological Survey/Alberta Energy and Utilities Board
4th Floor, 4999-98th Avenue, Edmonton, Alberta, T6B 2X3,

Sarah Richardson and Rudi Meyer
Department of Geology and Geophysics
University of Calgary, Calgary, Alberta, T2N 1N4

ABSTRACT

Most of the coal resources in the Drumheller area (Drumheller Coal zone) are contained in estuarine, tidal and fluvial deposits of the Upper Cretaceous Horseshoe Canyon/Bearpaw transition zone. This sequence was deposited in an easterly prograding deltaic complex fed by rivers flowing from the West and draining into the Bearpaw Sea. Most of this delta complex is interpreted to have deposited in an embayment, where tidal currents dominated over wave and river processes. The paleo-swamps developed on the floodplains overlying, and in-land from the distributary and tidal channels. The upper part of the transition zone appears to have a higher proportion of fluvial channels and associated overbank deposits.

Ten measured stratigraphic columns were recorded along a 4 km stretch of the Willow Creek area. A structural cross section with 6 times vertical exaggeration was constructed from these columns with help from panoramic photographs taken from opposing valley walls. Six coal seams can be distinguished in this interval, whereby four (#0, #1, #4 and #5 seams) are continuous along the whole cross section and two (#2 and #3) are intermittently exposed. The distributary channel deposit below the #0 seam locally shows lateral accretion bedding (IHS) with dips in various directions, hence representing several amalgamated channel bars.

The seismic response along this cross-section line was modeled by ray-tracing. Our modeling indicates that the coal seams and the inclined beds can be seismically imaged in areas of CBM exploration. Imaging of coal seams is possible given sufficiently high quality seismic data with dominant frequencies of approximately 100 Hz, whereas the more closely-spaced inclined beds require higher frequencies, approximately 150 Hz, to be effectively imaged.

Construction of synthetic seismograms from nearby wells shows that seismic definition of coal beds is dependent not only on coal bed thickness, but also on the nature of the surrounding matrix and the spacing of multiple coal seams. The majority of coals in these wells become seismically distinct (separate events for

the top and base of a coal bed) at frequencies greater than 150 Hz, though single coal seams surrounded by homogeneous high-contrast sediments become distinct at much lower frequencies, approximately 100 Hz. These observations and predictions will be of great importance in areas of CBM production, where the best production will be expected from thick, continuous coal beds.