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Seismic modeling of Upper Cretaceous coal-bearing strata east of Drumheller, Alberta, Canada: implications for CBM exploration

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. 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 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. 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. Actual seismic images obtained from high-resolution acquisition methods will show the lateral continuity of thick coal seams. Shear wave data, obtainable from seismic methods and Vertical Seismic Profiling (VSP) in existing well bores, have the potential of detecting anisotropy and fracturing of the coal beds. Finding areas of enhanced permeability in this way will assist in the development of Alberta's CBM resources.