

Anatomy of an unconformity and its earliest overlying fill – the basinwide sub-Cretaceous unconformity of Western Canada*

Dale A. Leckie¹

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¹Nexen Inc., Calgary, Alberta, Canada (Dale_Leckie@Nexeninc.com)

The morphology and drainage network of the sub-Cretaceous unconformity in Western Canada is reconstructed utilizing over 240,000 hydrocarbon exploration wells. GIS software was used to determine the fluvial drainage on the resulting topography. The unconformity, covering over 1,000,000 km², (386,000 miles²) occurred after deposition of Oxfordian-Kimmeridgian sediment of the first foreland basin clastic wedge. The unconformity is associated with an episode of tectonic and magmatic quiescence in the Canadian Cordillera from 140 to 125 Ma. Tectonic compression associated with the Colombian Orogeny may have decreased or changed direction.

The resulting drainage systems on the unconformity were extremely complex with multiple drainage divides. In S Saskatchewan, the rivers flowed south into the USA. In NE Alberta and NW Sask, rivers flowed north and east into a large embayment lapping onto the Canadian Shield. In W-central Alberta, rivers drained Paleozoic carbonate uplands, flowing south and west towards the old foredeep and the Fox Creek Escarpment. In NW Alberta, rivers flowed northwest and west also towards the Fox Creek Escarpment. Paleocurrents from the Rocky Mountains indicate that westernmost rivers flowed north-northwest in SW Alberta and northeast in easternmost British Columbia.

The earliest fill (Aptian) above the unconformity is highly variably with large areas of non-deposition and pedogenesis. In the W and SW, basal sediment of the Cadomin and Dalhousie fms were deposited as low-accommodation braided rivers flowing NNW, parallel to the basin axis. In central Saskatchewan, gold-bearing tidally-influenced rivers drained the Canadian Shield flowing to the SSW. In NE Alberta, the McMurray Fm, host of the second largest hydrocarbon accumulation on earth, was deposited in a tidally-influenced, meandering fluvial and tidal bar system within an embayment open to the northeast, with sediment derived from the Canadian Shield. Much of S Saskatchewan was a dissected upland surface, exposed for 10-15 million years, forming thick paleosols.