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Upper Jurassic and Lower Cretaceous Strata of the Western Canada Sedimentary Basin

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Middle to Late Jurassic time marked initial formation of the western Canada foreland basin in response to tectonic docking of allochthonous terranes and orogenesis on the western flank of the North American craton. Accretion of the Intermontane superterrane created an orogenic highland that shed coarse clastic detritus into the foredeep to create the oldest of several basin-scale clastic wedges (Cant and Stockmal, 1989). Upper Jurassic-Lower Cretaceous (UJ-LK) strata are capped everywhere by the pre-Mannville unconformity, formed as foreland basin sedimentation paused during Hauterivian and Barremian time. It truncates the UJ-LK section eastward, although isolated remnants of fluvial sandstones of the uppermost UJ-LK section cap mesas preserved beneath the pre-Mannville unconformity.

Stratigraphic Summary

We recognize UJ-LK strata in four areas: the Rocky Mountains, Foothills and adjacent subsurface of northeastern BC and adjacent Alberta; the Rocky Mountains, Foothills and adjacent subsurface of southwestern Alberta and adjacent British Columbia; the Plains of southeastern Alberta, southern Saskatchewan and southwestern Manitoba; and the Beaufort-Mackenzie Basin in northern Yukon and Northwest Territories (Figure 1).

Subdivision of Alberta – BC foredeep stratigraphy into southern and northern areas reflects limited preservation of UJ-LK strata in the subsurface. In west-central Alberta between Townships 30 and 42, the eastern subcrop edge of UJ-JK strata lies within the Foothills, where structural deformation obscures interpretation of the interval. UJ-LK strata in the southeastern Alberta / southern Saskatchewan / southwestern Manitoba Plains are physically separated from the foredeep package by pre-Mannville erosion.

Upper Jurassic-Lower Cretaceous strata are absent north of the subcrop edge in northeastern BC. Lower Cretaceous (Aptian) strata lie on Triassic, Mississippian and Devonian formations in the Northwest Territories south of the Beaufort-Mackenzie Basin. UJ-LK strata are preserved in northern Canada only along the northern margin of the Atlas study area in the Eagle Plain and Beaufort-Mackenzie areas (within the red polygon in Figure 1). Here the structural and depositional controls are markedly different from southern Canada, and sediments deposited during latest Jurassic and earliest Cretaceous time do not form a discrete mappable package but are contained within relatively continuous Jurassic-Lower Cretaceous successions.

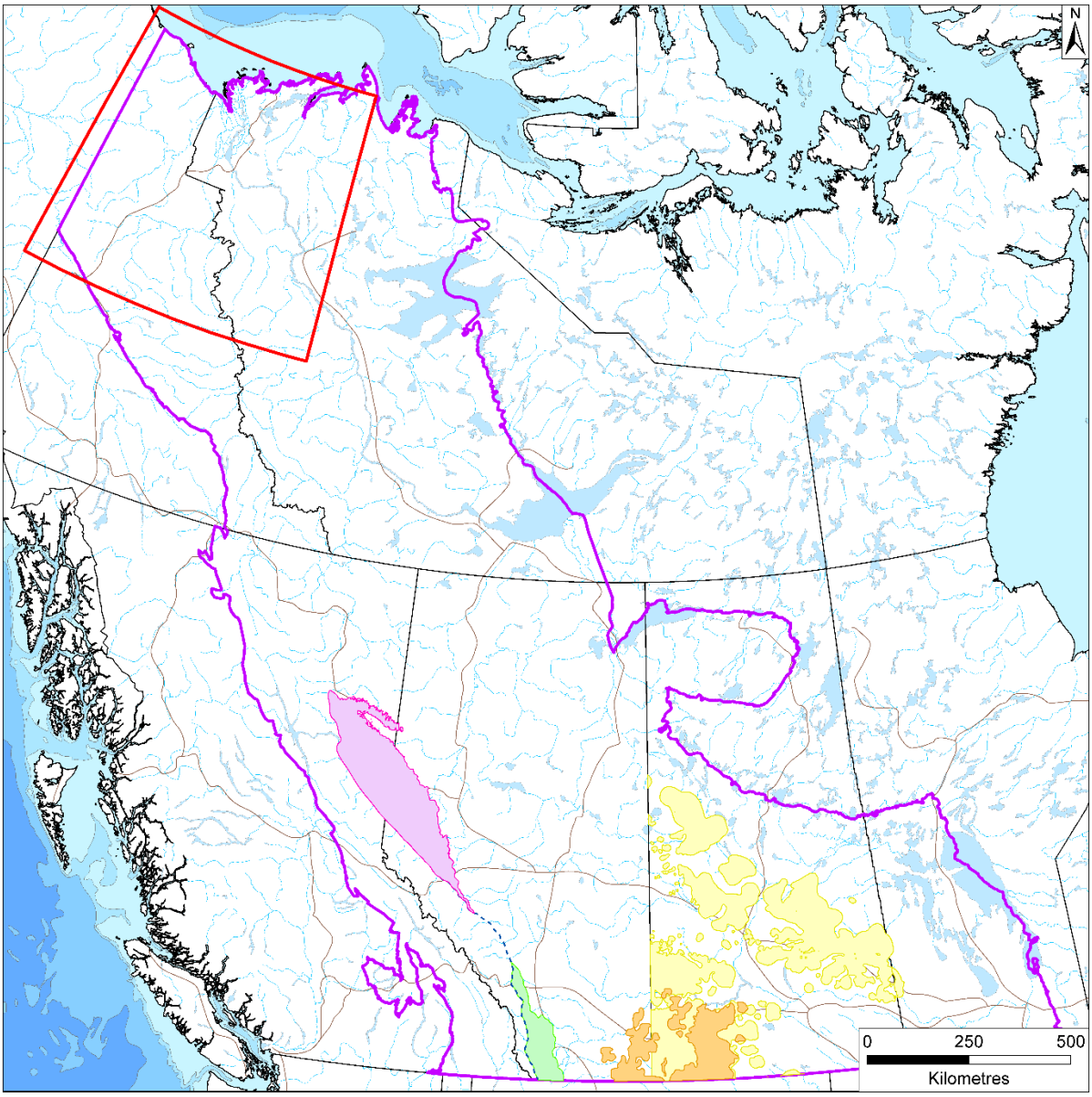


Figure 1. Atlas 2027 base map highlighting preserved Upper Jurassic – Lower Cretaceous strata, in northeastern BC and adjacent Alberta, southwestern Alberta and adjacent British Columbia, and southeastern Alberta / southern Saskatchewan / southwestern Manitoba Plains. Rectangle in Northern Canada highlights Beaufort-Mackenzie depositional regime.

Minnes Group (NEBC / West-central AB)

Stott (1998) assigned uppermost Jurassic and lowest Cretaceous strata in northeastern British Columbia and west-central Alberta to the Minnes Group (Figure 2). Minnes strata thicken rapidly

southwestward from an eastern and northern subcrop edge to a maximum of more than 2000 metres thick, reflecting both depositional thickening westward into the foredeep and easterly truncation beneath the pre-Mannville unconformity.

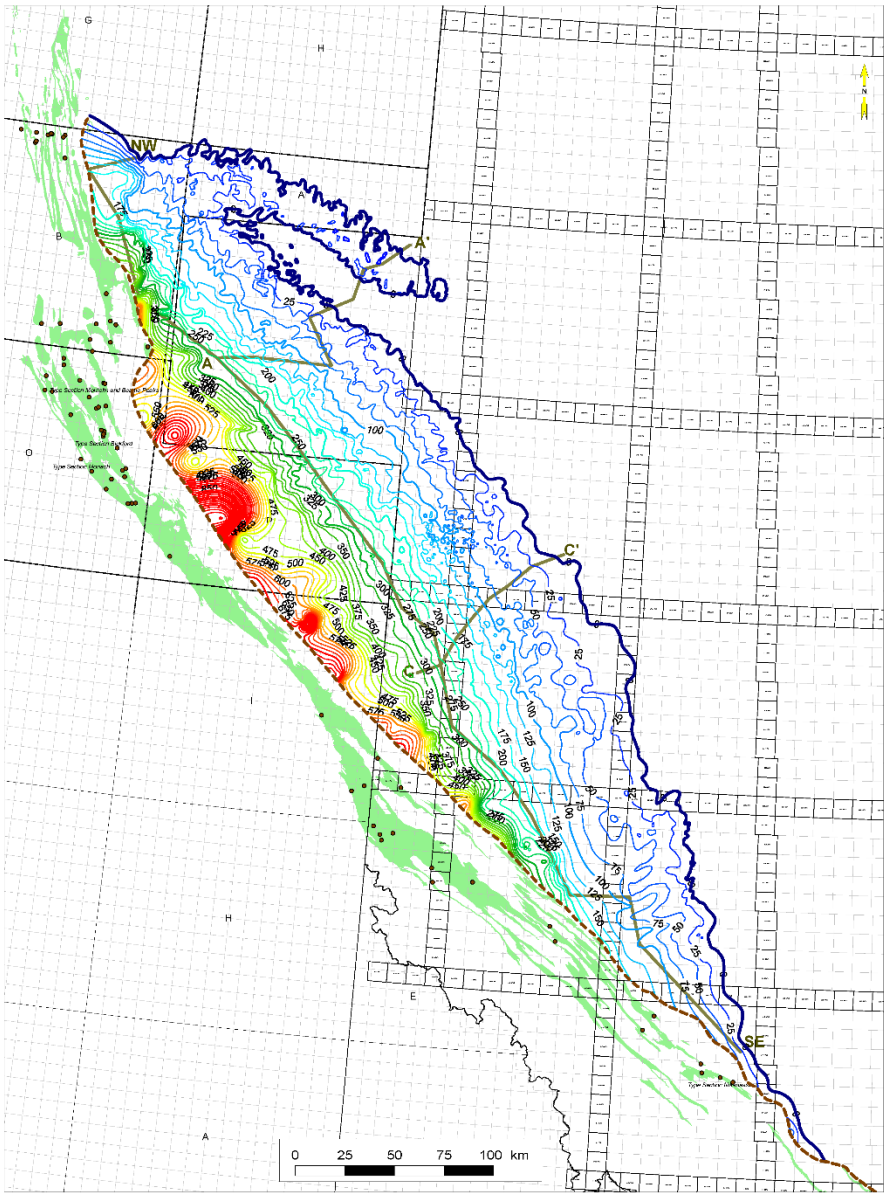


Figure 2. Gross isopach map, Minnes Group and correlative Nikanassin Formation in northeastern British Columbia and adjacent western Alberta. The western limit of subsurface well control and hence contouring was determined by review of logs from individual oil and gas wells to preclude those with evidence of significant structural deformation in the UJ-LK section.

The Minnes Group comprises four formations. In ascending order, these are the Monteith, Beattie Peaks, Monach and Bickford, each of which is defined by a type section cropping out in northeastern BC. However, abrupt thickness changes and lack of distinctive marker beds make correlations challenging, leading to two distinctly different regional subsurface correlation schemes. Common oilfield terminology is different again, carrying the Nikanassin Formation northward throughout the subsurface from a type area in the west-central Alberta Foothills. The Buick Creek sandstone of the Buick Creek – Fireweed area near the northern subcrop edge is a local name for part of the Monteith Formation, although it commonly has been miscorrelated with the younger Cadomin and Gething formations.

Kootenay Group (SEBC / SWAB)

Gibson (1985) mapped the Kootenay Group in outcrop in the southwestern Alberta Foothills, westward into the Fernie Basin of southeastern BC and as far north as the North Saskatchewan River, where it transitions to the Nikanassin. It lies between the Fernie Formation below and the Lower Cretaceous Blairmore Group above, reaching thicknesses of 1100 metres in western outcrop sections and thinning eastward to a zero edge near the eastern boundary of the Foothills (Figure 3). Like the Minnes, eastward thinning is a product of both depositional thinning and truncation beneath the pre-Mannville unconformity.

Gibson (1985) designated a Kootenay Group reference section at Mount Allan about 50 km west of Calgary, where it is thick and well exposed. It demonstrates a progradational succession from deltaic sandstones at the base (Morrissey Formation), through coal-dominated lower alluvial plain facies of the Mist Mountain Formation to proximal, higher-energy braidplain sandstones and conglomerates of the Elk Formation.

Subsurface correlations and mapping of the Kootenay are hindered by relatively poor well control in the southwestern Alberta outer Foothills and adjacent Plains.

Success Formation (SWSK / SEAB)

Christopher (1974) defined the Success Formation in southwestern Saskatchewan as an unconformity-bounded unit lying between the Jurassic Vanguard Group below and the Cretaceous Mannville Group above, and subdivided it into older S1 and younger S2 units. Hayes (1983) revised Success equivalents in southeastern Alberta, re-assigning the lower S1 to the Upper Jurassic Swift Formation and the upper S2 to the Mannville Group, separated by a significant unconformity. Leckie et. al. (2004) showed that the Success S2 unconformably overlies the Swift / S1 and is itself incised beneath the pre-Mannville unconformity, meaning the Success S2 is older than the Mannville and consequently part of the UJ-LK package.

Success S2 deposits are dominated by fine- to coarse-grained sandstones featuring high-angle planar and trough cross-beds with mud clasts commonly overlying the basal contact. The upper part of the S2 is heavily weathered; extensive solution of chert grains creates a clay-rich pedogenic aspect in some places, which Christopher (2004) referenced as kaolinitic and sideritic quartzose sandstones. Elsewhere weathering produced excellent reservoir exhibiting secondary solution porosity. Deposition took place over a broad braided fluvial outwash plain with subsequent weathering and soil formation before pre-Mannville incision. Figure 4 illustrates

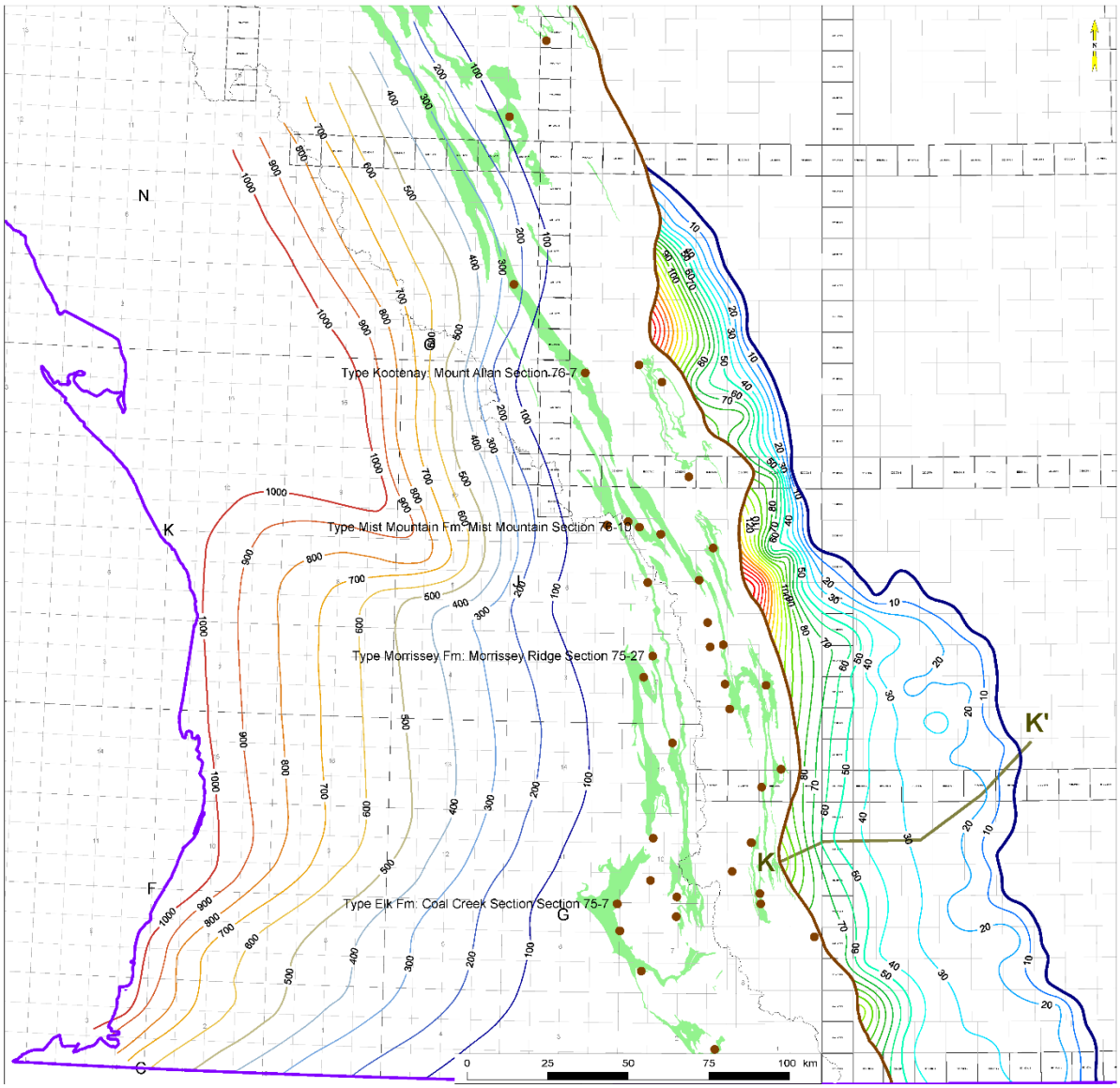


Figure 3. Gross isopach map, Kootenay Group in southwestern Alberta and adjacent southeastern British Columbia. Dots locate outcrop sections summarized by Gibson (1985); outcrop type sections for the Morrissey, Mist Mountain and Elk formations are highlighted. The western limit of subsurface well control and hence contouring was determined by review of logs from individual oil and gas wells to preclude those with evidence of significant structural deformation in the Kootenay section. Contours west of the structural margin represent palinspastically-restored values from outcrop sections by Gibson (1985).

stratigraphic relationships of the Success S2 in southern Alberta, highlighting its occurrence on mesas and interfluves preserved between pre-Mannville valleys. These Success S2 occurrences are highlighted orange in Fig. 1.

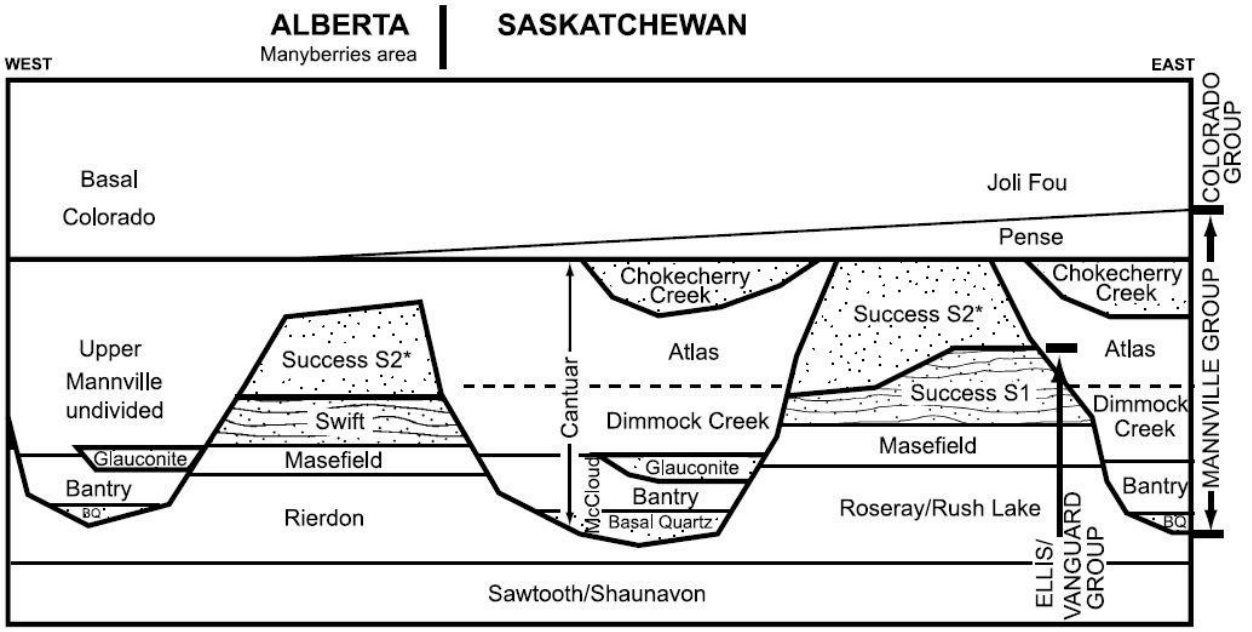


Figure 4. Schematic cross-section showing Jurassic – Lower Cretaceous stratigraphic relationships in southeastern Alberta and southwestern Saskatchewan. Note preservation of the Success S2 unit on mesa tops, unconformably overlying Upper Jurassic Swift Formation and incised by pre-Mannville valley erosion (from Leckie et. al., 2004).

Other pre-Mannville strata mapped across the WCSB Plains include:

- Success S2 north and east of the type area in Saskatchewan and Manitoba, lying on Paleozoic strata and characterized by karst deposits (highlighted yellow on Fig. 1);
- Deville Formation (“Detrital” member) of southern and central Alberta, consisting of karst and residual deposits like the northern S2;
- Regional ‘A’ sandstone of Zaitlin et. al. (2002), mapped across southern Alberta; and
- J3 sandstone of Hopkins (1981) in the Medicine River area of west-central Alberta.

While some of these strata may be equivalent to the Success S2 defined in southeastern Alberta and southwestern Saskatchewan, they have not been mapped formally as part of the UJ-LK

succession because their ages cannot be constrained to the time interval, and because they were not deposited in the same braided fluvial environments.

Acknowledgements

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