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Pennsylvanian-Early Permian Paleogeography, Tectonics and Carbonate Associations, East-central British Columbia

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Introduction

New paleogeographic interpretations for the Pennsylvanian and Early Permian succession of east-central British Columbia (Fig. 1) reveal the disruption of a Pennsylvanian carbonate ramp by a high that was tectonically active during the latest Pennsylvanian. During the Early Permian, this high separated an interior seaway with a warm-water carbonate association from an open ramp with a cool-water association. Conodont biostratigraphy is essential to correlate these and other Pennsylvanian and Permian sequences in the region (Fig. 2). These correlations demonstrate a succession punctuated by several sequences that formed in response to both eustatic sea-level changes and tectonics. The tectonic control is indicated by conglomeratic units, reworked conodonts, and the correlation between the temporal characteristics of the study area unconformities with those described in Nevada (Trexler *et al.,* 2004; Snyder *et al*., 2002) where post-Antler tectonic events have been mapped.

The outcrops studied are located in the Sukunka-Kakwa area in east-central British Columbia within NTS map sheets 93P, J and O (Fig. 1). Data obtained from the field were combined with previous work (Bamber and Macqueen, 1979; McGugan and Rapson, 1976) in addition to well data from west-central Alberta and east-central British Columbia (Fossenier, 2002; Dunn, 2003; Porter, 2007; Wamsteeker, 2007).

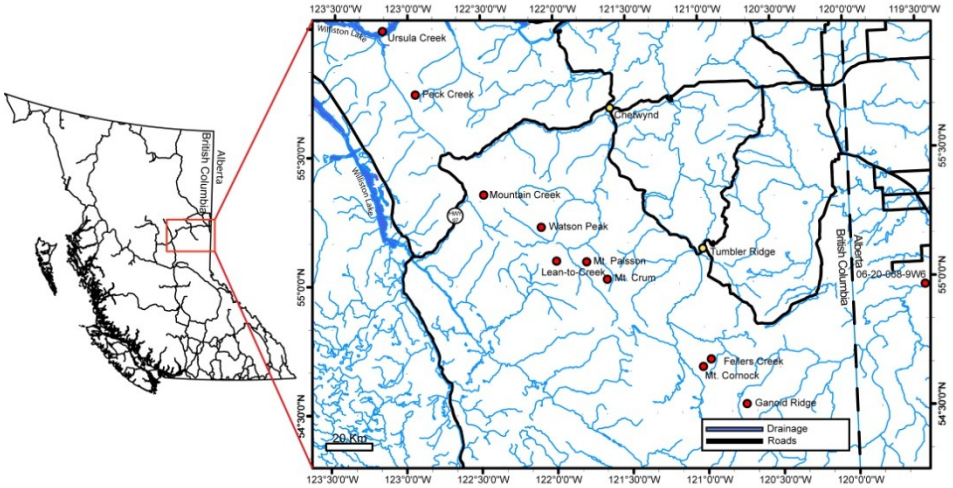

Figure 1: Study area with studied outcrops labeled. Modified from Zubin-Stathopoulos *et al.,* 2011.

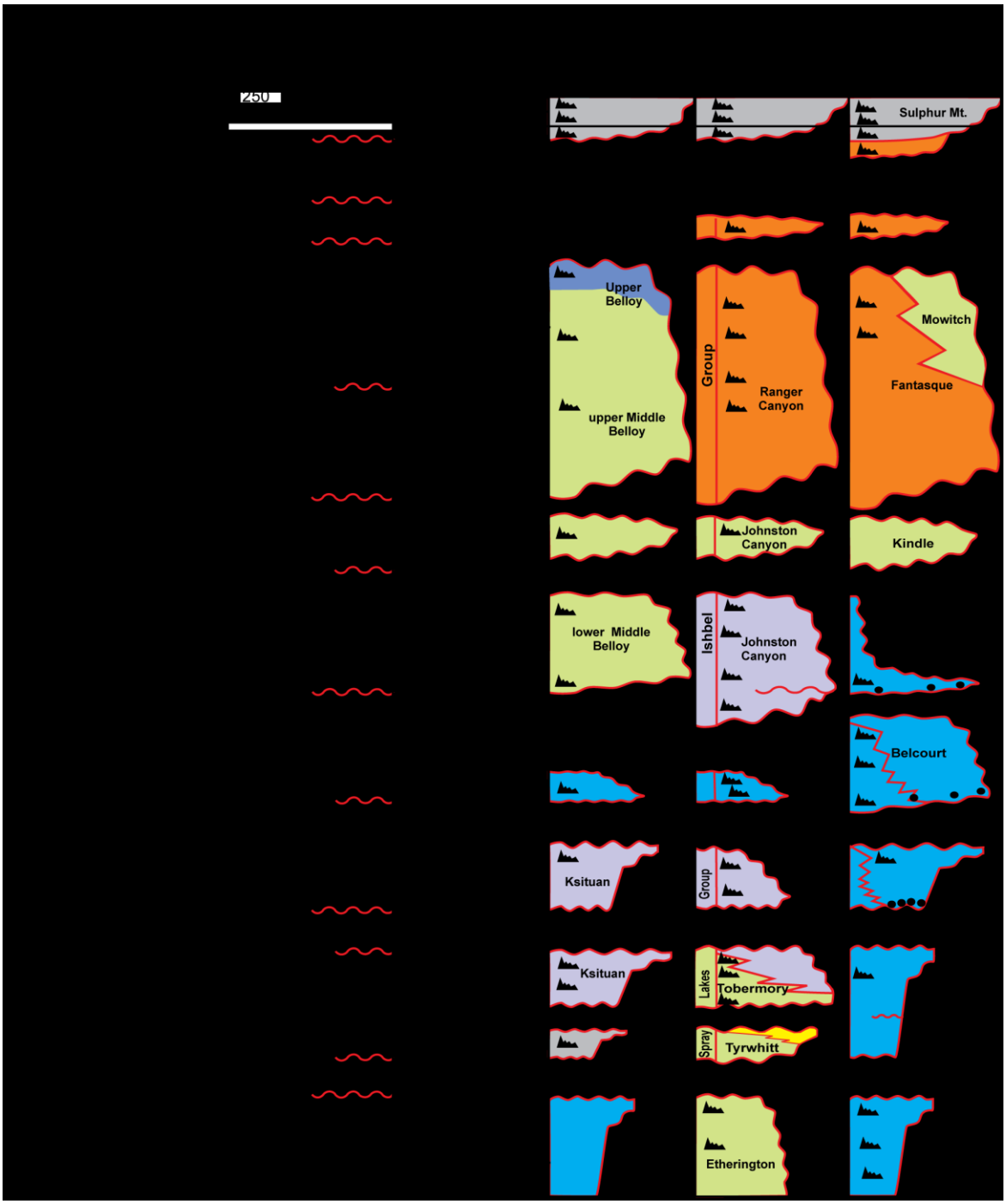

Figure 2: Stratigraphy and tectonostratigraphic sequences of east-central British Columbia, Peace River Basin and the 'Banff Region' of the southwestern Alberta Rockies. Colours represent primary lithology. Blue=limestone, purple=dolostone, orange=chert, yellow=quartz arenite, green=bioturbated/bioclastic sandstone and grey=silty shale. Tectonostratigraphic sequences modified from Snyder *et al*., 2002 and Trexler *et al*., 2004. C=Carboniferous, P=Permian. Stratigraphy modified from Zubin-Stathopoulos *et al.,* 2011.

Moscovian Sequence

The lowest portion of the Belcourt Formation at Fellers Creek is represented by a mixed conglomerate-carbonate unit that includes Moscovian conodonts (*Diplognathodus edentulus*, *Idiognathodus sp*. and *Adetognathus lautus*) and reworked conodont-bearing Mississippian carbonate clasts. Moscovian rocks are present at Mountain Creek and Lean-to-Creek where they are correlated with the Hanington Formation

consisting of mudstone and wackestone with no conglomeratic units. These outcrops are located in a more western thrust sheet than Fellers Creek. This sequence is completely missing, either due to non-deposition or erosion, at several outcrops including Mt. Palsson, Mt. Crum, Watson Peak, Mt. Cornock and Peck Creek. Thicker carbonate units occur to the east in the subsurface and record a large Moscovian sub-basin as indicated by several species of *Neognathodus* (Henderson *et al*., 2002).

Asselian Sequence

Asselian aged rocks of the Belcourt and Hanington formations overlie the "C6" unconformity (Fig. 2). Age diagnostic conodont fauna include *Adetognathus n.sp. B*, *Sweetognathus expansus*, *Streptognathodus verus*, *Streptognathodus fusus* and *Gondolelloides canadensis*. Belcourt Formation deposits at Fellers Creek consist of several shoaling-upward cycles containing oolitic and algal grainstone, *Palaeoaplysina* boundstone, echinoderm-brachiopod packstone and wrinkly laminated dolostone. The Hanington Formation was originally described as only Pennsylvanian in age (Bamber and Macqueen, 1979), but it is herein identified as ranging into the Early Permian. The Asselian Hanington Formation consists of mudstone and brachiopod-bryozoan wackestone, packstone and rare grainstone. This sequence is completely missing from several outcrops including Mt. Palsson, Mt. Crum, Watson Peak, Mt. Cornock and Peck Creek.

Sakmarian Sequence

Sakmarian aged fossils include the conodont *Sweetognathus merrilli* and the colonial rugose coral *Protowentzelella kunthi (*pers. comm. E.W.Bamber). The Sakmarian portion of the Belcourt Formation consists of *Palaeoaplysina* boundstone, coral boundstone, brachiopod-bryozoan-echinoderm grainstone and brachiopod-algal packstone. The Sakmarian portion of the Hanington Formation consists of brachiopod-bryozoan wackestone, packstone and rare grainstone. *Neognathodus bothrops* (Moscovian) occurs in one level at Fellers Creek within the Sakmarian interval from a lag containing carbonate and chert clasts. These carbonate clasts are derived from erosion of an uplifted area where Moscovian rocks once existed proximal to the Fellers Creek section (Fig. 3). The Sakmarian sequence is completely missing from several outcrops including Mt. Palsson, Mt. Crum, Watson Peak, Mt. Cornock and Peck Creek.

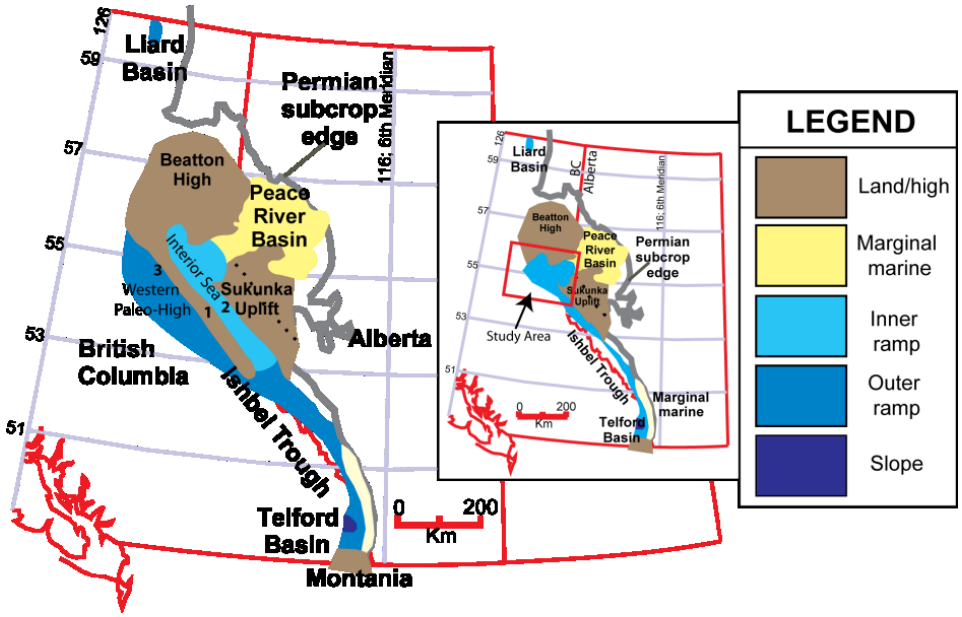

Figure 3: Simplified late Sakmarian paleogeography of northwestern North America showing tectonic elements integrated from Henderson et al., 2002 and the configuration of a new "western paleo-high" extending south from the Beatton High. Paleolatitudes during the Early Permian were about 30 degrees south of current latitudes. 1=Mt. Cornock, 2=Fellers Creek, 3=Mountain Creek. Modified from Zubin-Stathopoulos *et al.,* 2011.

Discussion

A paleogeographic high along the current outcrop belt was variably expressed and episodically uplifted between the Moscovian and the Sakmarian (Fig. 3). This high controlled the position of Moscovian subbasins within an overall broad open embayment and later separated Early Permian warm-water carbonate deposits such as *Palaeoaplysina* boundstone in the Belcourt Formation from cool-water carbonate deposits such as brachiopod-bryozoan packstone (Hanington Formation) found today in a more western thrust sheet. The presence of a reworked Moscovian species *Neognathodus bothrops* within the Sakmarian interval at Fellers Creek indicates Moscovian rocks were uplifted and eroded into the basin during the Sakmarian in the vicinity of the western paleo-high (Fig. 3). During at least the Asselian and Sakmarian this high acted as a barrier from cool upwelling waters thereby creating a protected sea where a warm-water carbonate biota could flourish, comparable to the modern Sea of Cortez inboard from the Baja Peninsula.

Conclusions

The close juxtaposition of shallow cool-water and shallow warm-water carbonate associations would often be attributed to climate change between successions of different age. Conodont biostratigraphy indicates that the *Palaeoaplysina* and fusulinacean bearing packstone and grainstone at Fellers Creek are the sameage as brachiopod-bryozoan packstones at Lean-to-Creek and Mountain Creek. In this case, the close juxtaposition of these two very different carbonate associations can be attributed to the influence of the Western Paleo-High protecting a relatively low latitude interior sea from cool upwelling waters to the west.

Acknowledgements

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