Progress toward identifying the Jurassic early orogenic foreland responses to Pacific plate margin tectonics

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Summary

The Cordillera-foreland paired system and the Late Jurassic orogenic flexural foredeep of western WCSB adjacent to the earliest Rocky Mountains thrust load (e.g. Raines et al., 2013) have long been recognized, the latter by its thick clastic wedge, the earliest of several that extend into the Tertiary. Volcanic ashes and syndepositional detrital zircon grains throughout the Jurassic succession in western WCSB attest to its proximity to the convergent North American Plate margin and their age peaks coincide with Cordilleran magmatic episodes compatible with Omineca, and possibly more westerly Canadian Cordilleran sources (Pană et al. 2018a,b).

The SW Canadian terrane accretion model involves a west-to-east and temporal succession of three potential load masses along the western North America Plate margin during Jurassic collision and contraction, each of which might be expected to have left a record of flexural impressions in the evolving back-arc to orogenic foreland systems to their east: 1. Early Jurassic colliding Quesnellia arc, 2. early Middle Jurassic uplift of Omineca thickened collision zone, and 3. early Late Jurassic early Rocky Mountains thrust uplifts.

Western facies and marginal features of the Early and Middle Jurassic basin are missing now, having been incorporated in subsequent tectonics and eroded, and recognition of distal forebulge and backbulge features in the preserved eastern thin and tabular platformal distal foreland sequence that must have preceded the early Rocky Mountains forebulge is challenging. Normal marine faunas throughout the entire WCSB Jurassic indicate that none of the western load masses entirely blocked connections with Pacific Ocean waters, nor did any provide prolific sediment input as far east as the preserved record until late in the Jurassic. Offshore arcs are not necessarily continuous or without deep-water passages, and forebulges are commonly not elevated above sea level. However, several observations allow comparison with better establish interpretations in western U.S., where some detail has been interpreted (e.g. Jordan, 1985; Bjerrum and Dorsey, 1995; Fuentes et al., 2009). Some differences in timing of events are perhaps largely a result of diachroneity, perhaps zippering, of western terrane accretion, and in Canada may be an artifact of different degrees to which the most westerly available basin successions are preserved.

At least two episodes of western plate margin loading may be represented in the Early and Middle Jurassic of SW WCSB and both have been taken to suggest loading southwest of the basin:

1. Sub-Jurassic downcutting into Early Triassic strata in SE B.C. contrasts apparent continuity with the Triassic in NE B.C. where it may be continuous with the latest Triassic, suggesting pre-Jurassic tectonic loading SW of the basin (Stockmal et al., 1992). Phosphorite concentration is best developed in the initial Jurassic flooding strata in SE B.C.

2. The forebulge unconformity proposed below Bajocian initial foreland strata in western Montana (Ward and Sears, 2007) is substantially older than that recognized in Canada which is latest Middle Jurassic ("sub-Oxfordian"), and the Middle Jurassic Utah-Idaho Trough (e.g. Bjerrum and Dorsey, 1995) is older than the Canadian early foredeep. The more complete and thicker Middle Jurassic strata below the sub-Oxfordian unconformity in SW Alberta and SE British Columbia than farther north along the margin has been suggested to indicate greater loading to the southwest as well. Subsidence toward the west decreased in western U.S. by late Middle Jurassic time due to load relaxation, as Rocky Mountain thrusting began and the early trough began to subside in Canada, continuing to fill and overfill until the Early Cretaceous.

Contractional and transpressional events have been recognized through the Jurassic as far north as east central Yukon, but the northern Yukon and Mackenzie Delta area was characterized by extensional tectonics that prevailed across Arctic Canada until the later Early Cretaceous. Although a single dominant sediment input area has been interpreted in the Mackenzie Delta-Richardson Mountains area continuously throughout the Jurassic and Lower Cretaceous (Poulton 1996; Dixon, 2004), continuity with the southern foreland system is lost due to the absence of Jurassic strata over a large area north of the Liard Line to central Yukon, at least in part below the sub-Cretaceous unconformity. Brooks-Mackenzie Basin (Balkwill et al., 1983) may not have connected with the more southerly foreland system at all, so that the northern access to the ocean that allowed marine faunas into the WCSB foredeep trough, is unknown.

Major Basin Events and Phases, southwestern WCSB (Fig. 1):

1. The initial marine Jurassic transgression was diachronous through the Early Jurassic, younger eastward onto the craton and possibly in the southwest. These strata perhaps extended west into the back-arc basin east of Quesnellia (Slide Mountain terrain; Monger and Price, 2002). McCartney (2012) suggested that the basin in NW Alberta and NE BA.C. was in a backbulge position following interpretation of a sill to its west by Riediger and Coniglio (1992).
2. Widespread Poker Chip shale deposition beginning in latest Pliensbachian coincides with a global transgression, with geochemical signatures of the global Early Toarcian Oceanic Anoxic Event (T-OAE; Them et al., 2017).
3. Phosphate- and carbonate-rich phase: Authigenic dispersed and nodular phosphate into the Early Bajocian since at least the Permian also occur as far north as western Sverdrup Basin. Carbonate units and cements occur into the Bathonian. These must have been deposited in basin settings related to Omineca loading prior to the regional sub-Oxfordian forebulge unconformity that truncates them.
4. The unconformity was triggered by initial Rocky Mountains thrust-loading, the oldest thrusts having been dated by illite in fault gouge (Pană and van der Pluijm, 2015; Pană et al., 2018b).
5. Glauconitic phase: altered tuffaceous unit (Pană et al., 2018b) deposited above the sub-Oxfordian forebulge unconformity, within the transition interval from a broader depositional basin to narrow orogenic foredeep.
6. Coarsening- and shallowing-upward foredeep fill siliciclastics; initial shale underfill (Upper Fernie Shale) coincident with global Kimmeridgian transgression; then overfilled and bevelled later in the Early Cretaceous.
7. Some latest Jurassic and Neocomian units preserved below the sub-Mannville/sub-Cadomin unconformity contain caliche, kaolinite, or tripolitic chert grains, all products of long-term subaerial weathering.

Adknowledgements, References, Compilations with Additional Sources

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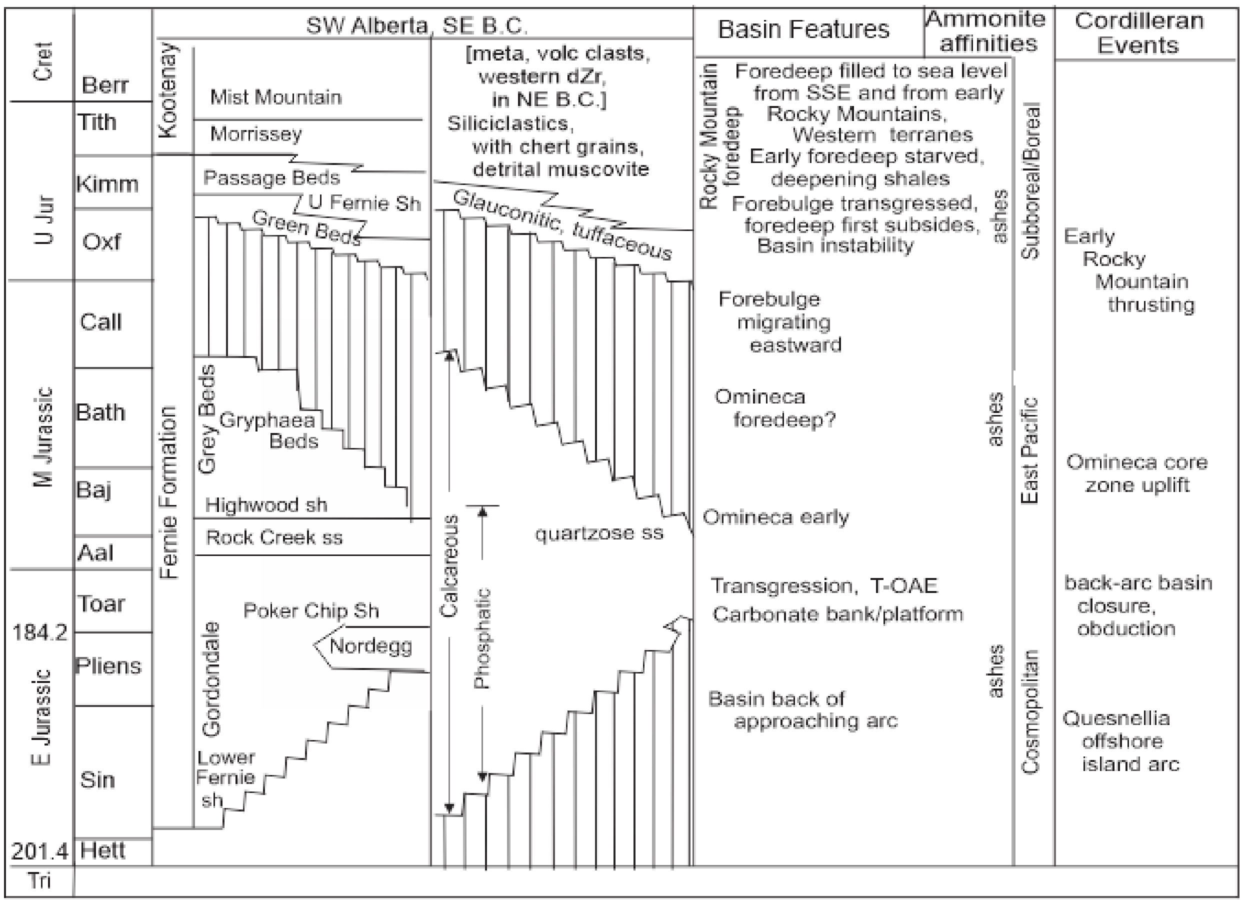

Figure 1. Correlations between Jurassic events in the Western Canada Sedimentary Basin and the adjacent Cordilleran orogen. The WCSB Jurassic basin sequence is modified from Poulton (1989; Poulton et al., 1993; Pană et al., 2018a,b). The directions of facies changes and downcutting are inconsistent. The ages for only two of the stages are well controlled by radiometric dating (Hesselbo et al., 2020): detailed correlations of radiometric ages from the orogen with biostratigraphically dated events in the basin must be taken with caution (e.g. Pană et al., 2018b).