Pennsylvanian to Permian Belloy Formation and Lower Triassic Montney Formation of the Western Canada Sedimentary Basin: Sequence Biostratigraphy, Paleogeography and Tectonics

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INTRODUCTION

Sediments that comprise Pennsylvanian to Lower Triassic strata in western Canada were deposited on the western margin of Pangea at approximately 20° to 30°N paleolatitude. Throughout the Pennsylvanian and Permian the prevailing climate was relatively arid and the deposits are characterized by condensation as a result of non-deposition, erosion, or very slow deposition rates. In contrast, the Triassic is characterized by relatively high deposition and accommodation rates.

PENNSYLVANIAN

Thin shale and dolomitic siltstone units (Taylor Flat; locally "Belloy") have yielded Serpukhovian (Upper Mississippian) conodonts in the Eagle-Stoddart area. In this area, several channel-like, dolomitic, occasionally bioclastic, sandstone units that have yielded mid-Bashkirian (Lower Pennsylvanian) conodonts cut these units. These channels may have developed in response to uplift along the southern margin of the Beaton High; the uppermost Permian to Lower Triassic Montney Formation directly overlies these thin Serpukhovian and Bashkirian units. Recently, other Pennsylvanian and Permian units have been recognized by conodont biostratigraphy in the Eagle-Stoddart area, but these are very localized in distribution suggesting strong controls by faulting on distribution and preservation of these units. A broad Serpukhovian embayment is also interrupted by uplift of the Pouce Coupe High where Bashkirian limestone units (Lower Ksituan) are apparently missing. Evaporite units may have been deposited locally during this time. The Pouce Coupe High was transgressed during the latest Bashkirian to Early Moscovian by a shallow-water dolostone succession (Middle Ksituan). This unit represents a potential reservoir unit in the Sukunka River area and is the reservoir at the Progress gas field. These Middle Pennsylvanian dolostone and dolomitic sandstone units have yielded the following conodont assemblages: an Upper Bashkirian to Lower Moscovian assemblage including *Rhachistognathus minutus minutus*, *Rhachistognathus minutus declinatus*, and *Idiognathoides marginodosus*; a Lower Moscovian (Kashirian) assemblage including *Neognathodus kashiriensis*, *N. bothrops* and *N. medadultimus*; and a Lower Kasimovian assemblage yielding rare *Streptognathodus oppletus* and *S. elegantulus*. These three assemblages are not found in succession in any one section and there is strong evidence that each may be separated by a sequence boundary. In Kananaskis Country, strata correlated with the first of these assemblages unconformably overlie Bashkirian coastal aeolian dunes (Storelk Formation). It appears that these Pennsylvanian strata were deposited on a structural high, and that only the maximum flooding intervals of some third-order sequences are preserved, since numerous international Pennsylvanian zones are apparently absent. Kasimovian to Gzhelian dolomitic limestone and Asselian to Sakmarian limestone sequences (Upper Ksituan/Lower Carbonate Member of Belloy) are very restricted in distribution and locally form an almost estuary-like embayment. In many areas, Lower Permian strata unconformably overlie rocks correlative with the above assemblages, but locally, Lower Triassic strata overlie the Kashirian assemblage. Apparent truncation of biozones and variation in age of preserved units above and below the sub-Permian sequence bounding unconformity, suggest that tectonic uplift and downwarping were largely responsible for development of this unconformity.

PERMIAN

The lowest Permian in the region is a very thin unit that is only locally distributed and comprises up to four parasequences of chert and dolostone. These parasequences have yielded *Diplognathodus* sp., *Adetognathus* sp., and *Sweetognathus merrilli* that correlate with the Upper Asselian to Lower Sakmarian. Local variation in the number of parasequences and the isolated distribution of the succession may reflect onlap onto downwarped portions of the unconformity. In the Peace River Basin a latest Carboniferous uplift event apparently joined the Pouce Coupe High (Henderson *et al*., 1994). with the Sukunka Uplift. This broad uplift remains prominent during an Artinskian transgression when predominantly sandstone of the Middle Sandstone Member was deposited in the Peace River Basin; this sandstone unit has good reservoir characteristics and represents tidal channel deposits as well as arid continental lithofacies. Elsewhere a condensed Artinskian succession (Henderson and McGugan, 1986) of shaly siltstone and silty dolostone unconformably overlies the lowest Permian sequence. Artinskian strata comprise up to four conodont zones including the *Sweetognathus* aff*. merrilli*, *Sweetognathus whitei-Mesogondolella bisselli*, *Neostreptognathodus pequopensis*, and *N*. *pnevi* zones. Onlap onto a sub-Artinskian unconformity is suggested by the local distribution of *S.* aff*. merrilli;* in many sections the base of the Artinskian sequence is represented by the *S. whitei-M. bisselli* Zone. The Artinskian sequence rarely exceeds 35 metres in thickness indicating that the succession was deposited during a period of tectonic quiescence with slow, but relatively continuous deposition. The top of the succession is locally characterized by micro-karsting indicating subaerial exposure. A very condensed Kungurian to Upper Guadalupian succession is represented in most sections by a 10-metre thick secondary-chert unit (locally up to 60m). Calcareous sandstone nodules within this unit have successively yielded *Mesogondolella idahoensis* , *Mesogondolella* cf*. rosenkrantzi,* and *Merrillina praedivergens*. The lateral persistence of this thin unit indicates very slow deposition rates, comparable to the underlying Artinskian succession. The sparse distribution of conodonts makes it difficult to assess continuity of deposition, but there is evidence in the Peace River Basin that there may be at least two sequences in this succession. A major transgression may have flooded part of the Sukunka Uplift leaving a prominent island during the Roadian and Wordian. Lithofacies for this interval include shallow marine limestone, chert, and minor sandstone that are referred to the Upper Belloy carbonate member, Ranger Canyon, Fantasque, and Mowitch formations.

LOWER TRIASSIC

In contrast to the underlying Pennsylvanian and Permian successions, the Triassic of western Canada is thick (almost 1.35 km; up to 350 metres of Lower Triassic), with less frequent and shorter duration breaks in deposition, that suggest significantly increased accommodation rates. The age of the basal transgressive unit varies across the region; in some sections it is uppermost Changhsingian (uppermost Permian), in others it is Lower or Upper Griesbachian, and in a few sections Lower Dienerian (Henderson, 1997). This diachroneity can be attributed to the duration of the transgression, as well as paleotopography on the unconformity surface. Significant paleotopography and increased accommodation rates indicate that a major tectonic event controlled deposition of lowest Triassic strata. A second tectonic event is suggested by structural inversion and buckling of the Dienerian-Smithian sequence boundary. This tectonic event generated turbidite reservoirs in the Valhalla-La Glace region and coquina reservoirs in the Tangent area. The Lower Triassic succession is characterized by fine-grained siliciclastics and lingulid-bivalve coquinal dolostones. Uppermost Changhsingian and Lower Griesbachian strata include black, pyritic shale that lack bioturbation, suggesting deposition during an anoxic interval. The continued lack of bioturbation in Upper Griesbachian shoreface sandstone in the Ring-Border area contributes to the reservoir quality. Upper Permian and Lower Triassic conodonts include *Clarkina subcarinata*, *C. meishanensis* and/or *C. sheni*, *C. taylorae*, *C. carinata*, *C. planata*, *Neospathodus kummeli*, *N. cristagalli*, *N. dieneri*, *N. pakistanensis*, and *N. waageni*.

References

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