Petroleum geology framework, south-central Bowser basin, British Columbia

James W. Haggart*
Geological Survey of Canada, Vancouver, BC V6B 5J3
jhaggart@nrcan.gc.ca

and

J. Brian Mahoney
Department of Geology, University of Wisconsin - Eau Claire
Eau Claire, WS 54702-4004 USA

ABSTRACT
The Bowser basin occupies a large area of the Intermontane Belt of north-central British Columbia (*Fig. 1*). Significant coal resources exist in the basin's northern regions, but no serious assessment of resource potential has ever been undertaken for the southern parts of the basin - the hydrocarbon potential of this large region is thus completely unknown at present.

Stratigraphy

Recent geological mapping has documented a number of Mesozoic clastic and volcanic units widely-dispersed across the southern part of the basin (*Fig. 2*). Hazelton Group strata are generally distributed along the basin's margins and include andesitic to basaltic volcanic rocks and associated volcaniclastic strata, locally up to 1,000 meters thick. The Hazelton Group is considered economic basement for the region.

Overlying Middle-Upper Jurassic (+ Cretaceous?) Bowser Lake Group strata, locally more than 1000 meters thick, are typically molasse facies, representing sedimentation in deltaic to deep-basin turbidite environments. Bowser Lake Group strata are monotonously repetitive and lack good stratigraphic marker beds and biostratigraphic control. The upper part of the group consists of distal turbidites and hemipelagic shales deposited in outer-shelf to slope environments; at least four coarsening-upward sequences are found, each succeeded by thick shale successions.

A massive, fine-grained clastic facies forms a significant component of the Bowser Lake Group, probably aggregating to more than 350 meters in thickness. The facies consists of massive to parallel-laminated mudstone, silty mudstone, and siltstone. Fossils are moderately common in this facies and consist predominantly of buchiid bivalves, but include other bivalves and rare gastropods; plant debris is also common. Pyrite is present locally, either disseminated in the sediments or as spherical nodules; some fossils and burrows also exhibit pyritization. The facies is suggestive of a relatively shallow-water, possibly outer-shelf environment. Age control is problematic, but the facies may reflect basin shallowing during latest Jurassic to earliest Cretaceous time.

Conformably(?)-overlying Skeena Group rocks (ca. 2 km-thick) include non-marine to shallow-marine coarse- and fine-grained deltaic facies in its lower part, intercalated with black, organic-rich shale and coal, and minor basalt flows and volcanic breccias. Locally, Skeena Group sandstones appear to grade upward into a several hundred meter-thick succession of black, organic-rich shale, although these rocks may be older strata that are structurally imbricated with Skeena Group sandstones. Fine plant matter is locally abundant in these rocks, occurring as vegetative mats along bedding planes. A few fossils have been found, indicating a marine depositional environment.

Limited paleocurrent data suggest predominant E-W transport directions for both Bowser Lake Group and Skeena Group sediments.

Structural Geology

The structural grain of eastern Nass River map-area forms a large-scale arcuate pattern and present-day topographic trends parallel this pattern. Contractional structures predominate, and include thrust faults and upright to overturned recumbent folds with asymmetric, gentle- and steep-dipping limbs that are often traceable laterally for tens of kilometers. NNE-vergent structures dominate in the northeast, changing gradually to SSE-vergent structures in the southeast. The structural regime of most of the more northerly portions of the Bowser basin is dominantly compressional in nature and the bulk of the basin forms a fold-and-thrust belt; prior to tectonic shortening, the basin may have been nearly 50% wider than present dimensions (Evenchick, 1991).

The structural style of south-central Bowser basin is summarized schematically in *Fig. 3* and is characterized by broad, kilometer-wavelength folds, superimposed with numerous tighter folds of smaller wavelength (not shown in *Fig. 3*), all verging to the NNE. Folding is typically asymmetric, showing both gentle and steep to locally overturned limbs, often associated with thrust faults. The folding pattern results in numerous anticline/syncline pairs with obvious surface expression. Importantly, these structures locally imbricate sandstone bodies against organic-rich shale units.

Potential Source Rocks

There are two stratigraphic intervals that are potential source rocks within Jurassic-Cretaceous strata of the southern Bowser basin. The Bowser Lake Group contains shale and silty shale sequences that comprise intervals 10’s to 100’s of meters in thickness. These rocks accumulated primarily as distal turbidites and hemipelagic sediment; shale intervals in the upper portion of the group may represent outer shelf sediments. Fine-grained clastic rocks of the

Bowser Lake Group locally contain abundant carbonaceous material inferred to be Type II or III organic matter. However, locally well-developed slaty cleavage in fine-grained intervals suggests these rocks may be thermally overmature.

Fine-grained clastic rocks in the Skeena Group aggregate to over 600 meters and interfinger locally with coal-bearing sandstone. These rocks apparently accumulated in nearshore to shallow-marine environments adjacent to a major deltaic system. Depositional facies patterns and the occurrence of coal in coeval Upper Cretaceous rocks of the Groundhog and Telkwa coalfields indicate that Skeena Group lithologies contain significant quantities of terrestrially-derived Type III organic matter.

Potential Reservoir Rocks

Coarse-clastic intervals within the Bowser Lake Group consist primarily of first-cycle volcanogenic detritus characterized by abundant volcanic lithic fragments, angular to subangular plagioclase grains, and a clay-rich matrix. Porosity and permeability in these sediments is therefore extremely low, and they do not constitute potential reservoirs. In contrast, the basal part of the Skeena Group contains thick intervals of medium- to coarse-grained sandstone deposited in deltaic, marginal-marine, and nearshore environments. These rocks include medium- to thick-bedded, moderately well-sorted chert lithic arenite, containing abundant calcite cement; preliminary analysis suggests at least two cementation episodes. The distribution of calcite cement indicates a relatively high initial porosity, suggesting these strata represent a potential hydrocarbon reservoir.

Thermal Maturation

The total organic content and level of thermal maturation within fine-grained clastic strata of the Bowser basin varies considerably across the basin. Intrusion of the mid-Cretaceous to Tertiary Coast Plutonic Complex has led to overmaturation of potential source rocks along the western margin of the southern Bowser basin, but this thermal overprint decreases significantly to the east and southeast. Only small Tertiary(?) igneous plutons have been identified in western and central portions of Nass River map-area, close to the Coast Plutonic Complex. A dyke provided a radiometric age of 83.1 ± 0.2 Ma, indicating that some magmatic activity took place in the region during Late Cretaceous. Remnants of areally-restricted Pleistocene volcanic flows are noted locally, in geographic association with Eocene plutons. Skeena Group vitrinite reflectance values of 1.6 to 3.8 indicate strata are locally within the oil and gas window. Additional assessment of thermal maturation based on pollen analysis suggests that rocks along the eastern margin of the basin may be within or slightly above the oil window.

Conceptual Play

Conceptual hydrocarbon plays hypothesized for south-central Bowser basin are summarized in *Fig. 4*. Deltaic and marginal-marine sand bodies within the Skeena Group are lenticular in nature, and can be expected to pinch out laterally in finer-grained facies, thus providing possible stratigraphic traps. Fold structures in eastern Nass River map-area typically exhibit minimal plunge and have significant lateral extent, and are locally traceable in surface expression across distances of 25 or more kilometers. Sandstone bodies are often incorporated in the folding, and are locally thrust over fine-grained facies, providing potential structural traps.

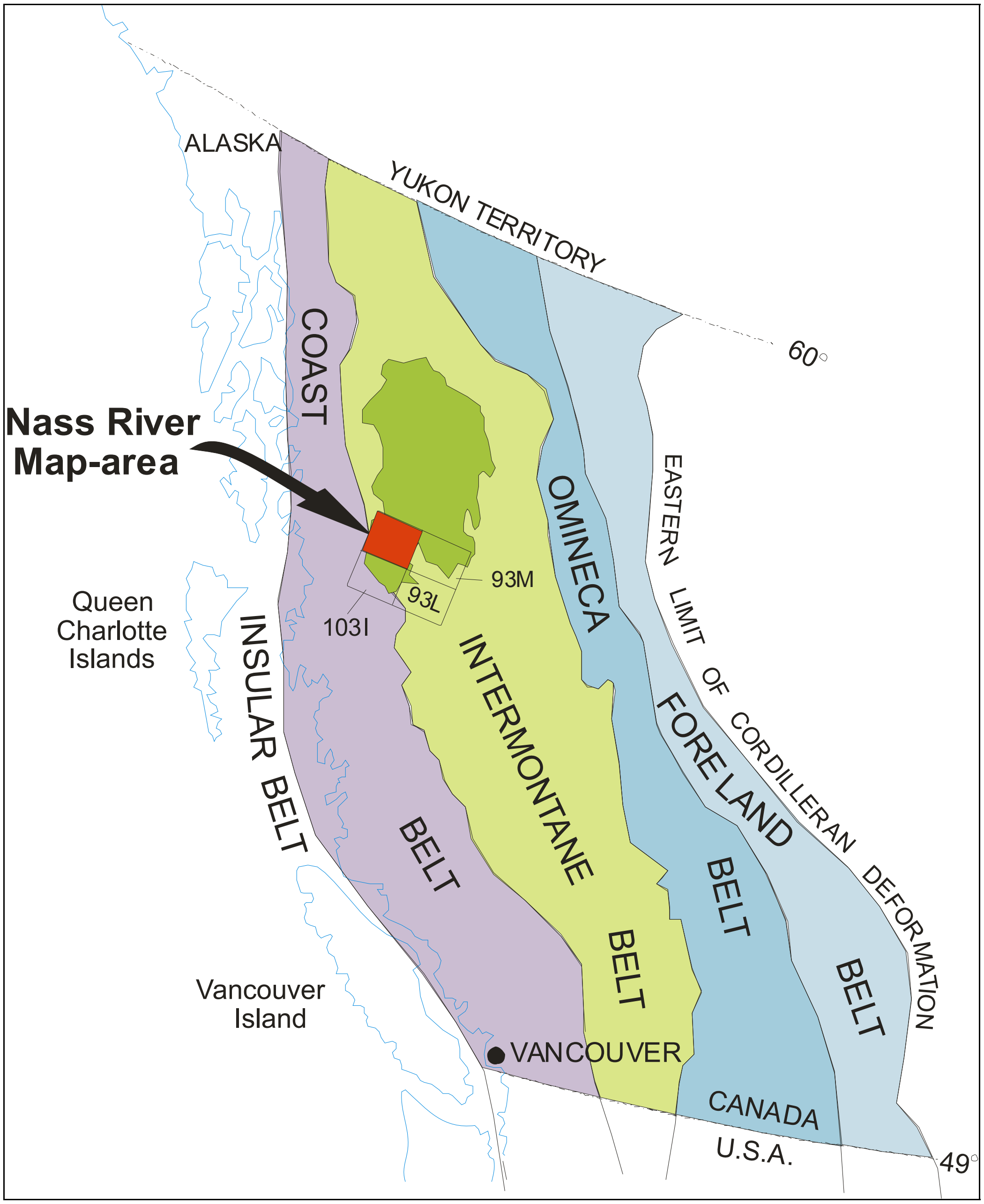

Fig. 1. Location map, showing Bowser basin in dark green.

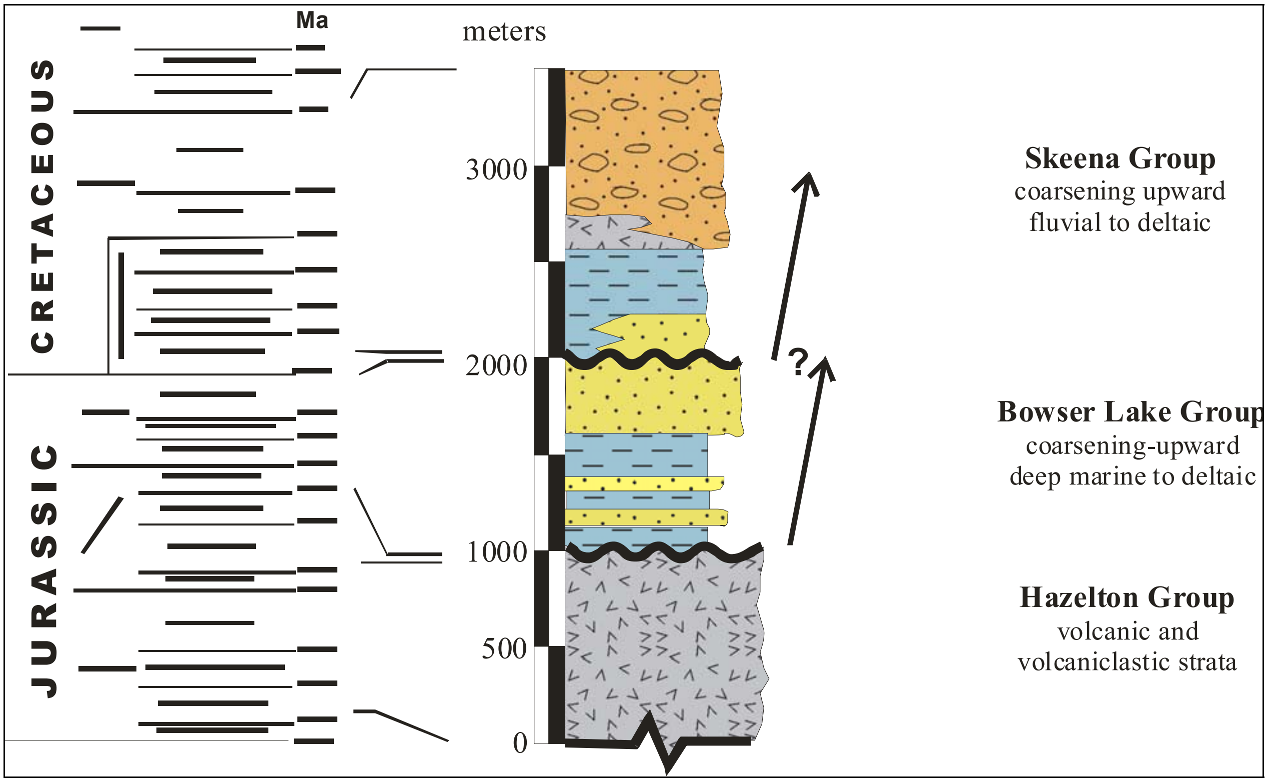

Fig. 2. Schematic stratigraphic column of Jurassic-Cretaceous strata of south-central Bowser basin.

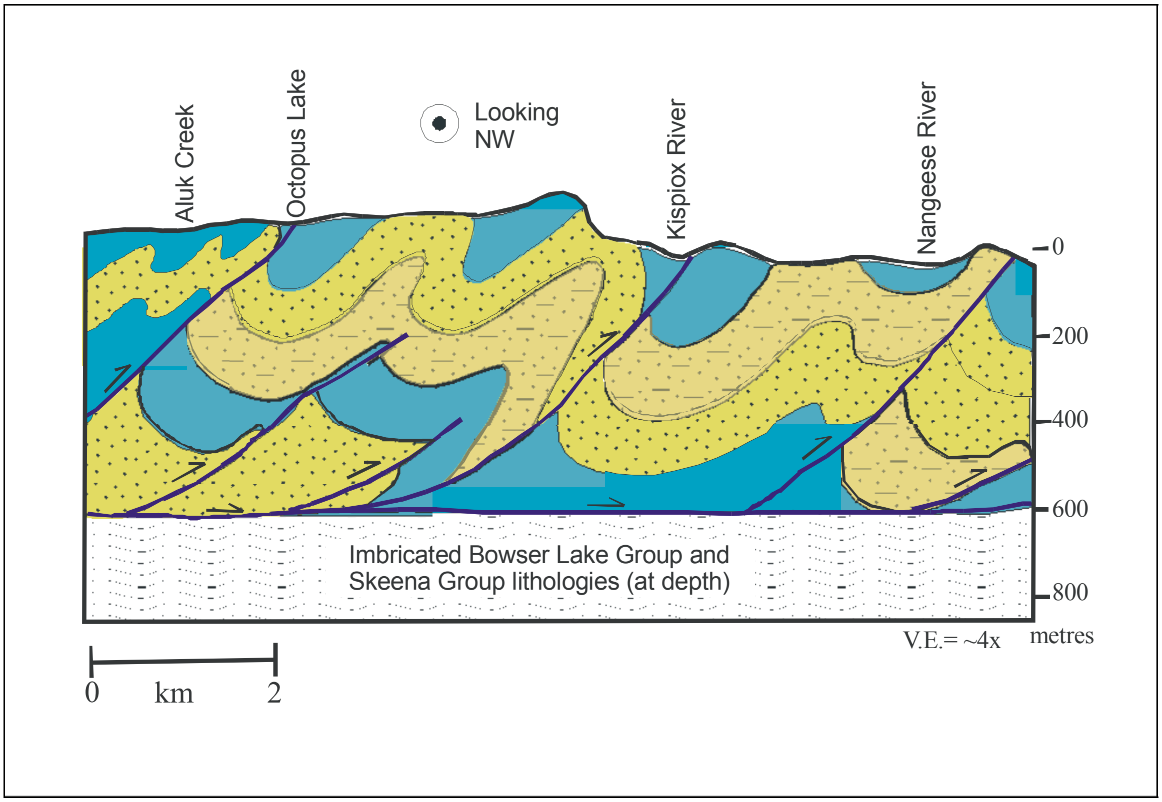

Fig. 3. Schematic structural cross-section across Kispiox River valley, north-central 93P/09.

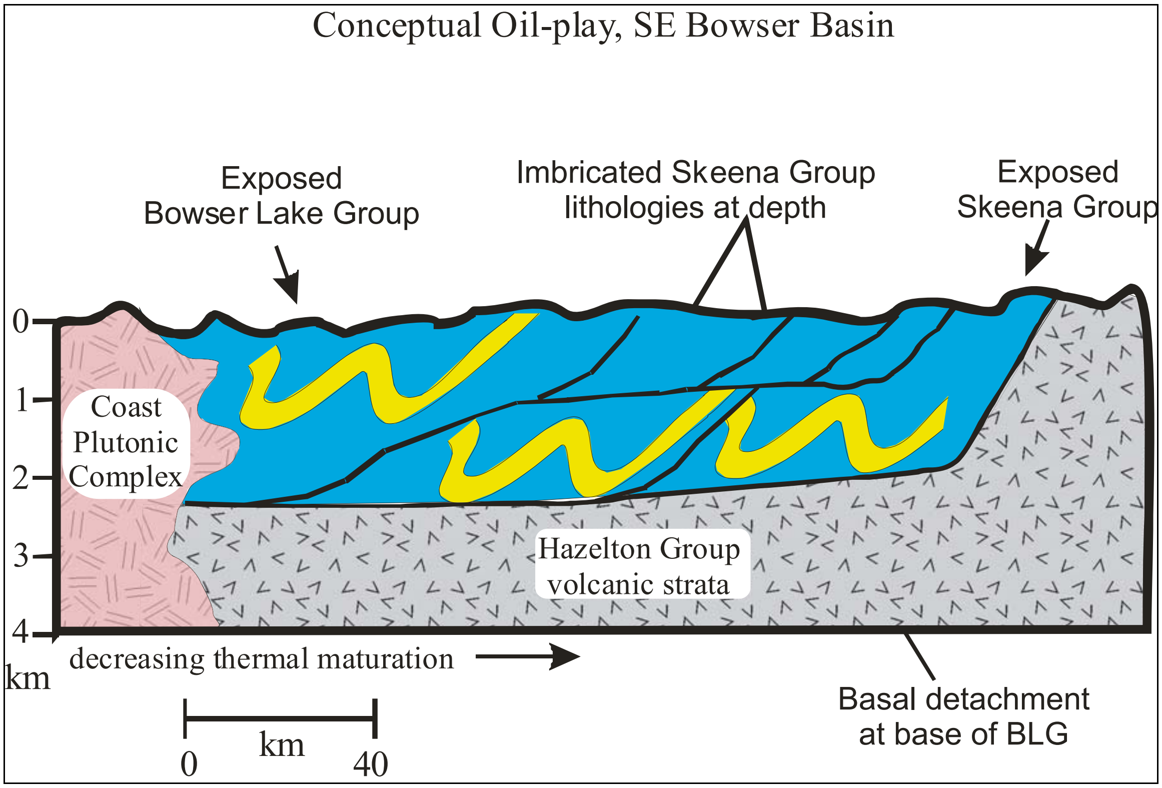

Fig. 4. Conceptual oil-play, southeastern Bowser basin. Possible reservoir strata in deltaic facies of Skeena Group are structurally imbricated with organic-rich facies of Skeena Group, and beneath sandstone bodies of both Bowser Lake Group and Skeena Group.