Lower Triassic Stratigraphy and Petroleum Potential, Sverdrup Basin, Arctic Canada*

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Abstract

Lower Triassic strata are very widespread in the subsurface of the Sverdrup Basin and are assigned to two formations: the sandstone-dominant Bjorne Formation, and the shale and siltstone-dominant Blind Fiord Formation. The source terrains, consisting mainly of Devonian siliciclastics, lay mainly to the south and east of the basin. A small source terrain (Crockerland) lay to the northwest and the Sverdrup Basin was connected to the Chukchi/North Slope area of Arctic Alaska by a relatively narrow strait. Sediment supply to the basin was very high and the succession exceeds 2000m in thickness in the depocenters.

The strata comprise a single 2nd order depositional sequence which is bound by the latest Permian 1st order sequence boundary at the base and a 2nd order boundary at the top. Both boundaries consist of major unconformities (unconformable shoreline ravinements) which penetrate into the basin and adjoin with prominent maximum regressive surfaces which can be correlated over the entire basin. The 2nd order sequence can be subdivided into three 3rd order sequences and the approximate ages of these are Griesbachian-Dienerian, Smithian and Spathian. Numerous fourth order sequences occur within each 3rd order sequence.

Each 3rd order sequence consists of braided to meandering stream strata on the southern and eastern basin flanks and these change facies to sand-dominated delta front deposits. Farther basinward, mid-outer shelf deposits consist of interbedded fine- to very fine-grained sandstone, siltstone and shale of storm origin. Slope deposits consist mainly of shale and siltstone and thick submarine fan deposits occur in the basin center. Because of high subsidence rates, the Lower Triassic facies belts remained relatively stationary without much basinward progradation in spite of the high sediment supply.
Porous sandstones are common in the braided stream and delta front facies and may also occur in the submarine fan facies. Potential traps include Tertiary anticlines, salt structures and stratigraphic traps associated with sequence boundaries. The main potential source rocks are bituminous shales of the directly overlying Middle Triassic succession and possibly organic rich shales in the Spathian sequence. An extensive oil sand deposit, representing an exhumed oil field on the basin flank, occurs on Melville Island. Gas and oil shows occur in the uppermost sandstones of the succession in wells on Melville and Ellesmere islands.
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Geological Survey of Canada
Early Mesozoic Reconstruction
Mesozoic
Sverdrup Basin
(15 km)

Main Reservoirs
Main Source Rocks
Lower Triassic
Early Triassic Facies

Prudhoe Bay
Triassic Paleogeography

ALASKA (rotated)

Prudhoe Bay

FLUVIAL - NEARSHORE SHELF
OFFSHORE SHELF - BASIN
LAND

0 km 300
### Latest Permian-Latest Triassic

**1st Order Sequence, Sverdrup Basin**

<table>
<thead>
<tr>
<th>TRIASSIC</th>
<th>2nd Order</th>
<th>1st Order Sequence</th>
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</thead>
<tbody>
<tr>
<td>Permian</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Induan</td>
<td>2</td>
<td>Bjorne Fm, Blind Fiord Fm</td>
</tr>
<tr>
<td>Olenekian</td>
<td>3</td>
<td>Roche Point Fm, Murray Harbour Fm</td>
</tr>
<tr>
<td>Anisian</td>
<td>4</td>
<td>Pat Bay Fm, Barrow Fm</td>
</tr>
<tr>
<td>Ladinian</td>
<td></td>
<td>Fosheim Mbr, Heiberg Fm</td>
</tr>
<tr>
<td>Carnian</td>
<td></td>
<td></td>
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<tr>
<td>Norian</td>
<td></td>
<td></td>
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<tr>
<td>Rhaetian</td>
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</tbody>
</table>

*Note: MFS indicates the Maximum Flooding Surface.*
<table>
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<th>TRIASSIC</th>
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<td>Rhaetian</td>
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<tr>
<td>Jurassic</td>
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</tr>
</tbody>
</table>
Lower Triassic Control Points and Isopach
Early Triassic Facies
Isopach Bjorne Formation
Main Sediment Input Centres
Stratigraphic Cross Sections

BJORNE FORMATION
CONTOUR INTERVAL 500m

TH Tanquary High

TH

Stratigraphic Cross Sections
Stratigraphic Cross Section
Fosheim Input Centre
Lower Triassic 3rd Order Sequences
Braided Stream Facies
Delta Front/Shallow Marine Facies
Top Early Triassic Sequence
Outer Shelf Facies
Slope Facies
Sequences in Outer Shelf to Slope Facies
Griesbachian-Dienerian Sequence in Turbidite facies
Stratigraphic Cross Section
Flank of Tanquary High
Spathian Sequence - Dark Grey to Black Shales
Stratigraphic Cross Section
Northern Margin of Basin

TH Tanquary High
Lower Triassic Stratigraphic Cross Section
Northern Axel Heiberg Island

S Griesbach Creek
Bukken River
North Bukken
Aurland Fiord

Spathian Sequence
Smithian Sequence
Griesbachian-Dienerian Sequence

vf-mg Sandstone
Siltstone and Shale
Limestone

40 metres
Shallow Shelf Facies Capping G-D Sequence
Mid-Shelf Facies Capping Smithian Sequence
Stratigraphic Cross Section
Sabine Input Centre
Early Triassic Sequence, Western Sverdrup Basin
Shallow Marine Facies
Hazen F-54
Early Triassic Paleogeography
Oil and Gas

The fluvial and shallow shelf sandstones of the Bjorne Formation have up to 20% porosity and oil and gas shows occur at the top of the formation in wells in the western Sverdrup Basin and in one well on Fosheim Peninsula.

Oils Sands occur at Marie Bay on western Melville Island.
Excellent Source Rocks (Middle Triassic) Directly Overlie the Lower Triassic Strata
Thermal Maturation
Top Lower Triassic
Potential Traps

Structural-stratigraphic related to unconformity truncation on basin margin

Structural-stratigraphic related to basinward facies change.

Tertiary (salt-cored) anticline

Flank of salt dome
Early Triassic Paleogeography
Pre-drift Restoration

Crockerland

Prudhoe Bay field

Marie Bay Oil Sands

ALASKA (rotated)
Jurassic Strata Unconformably Overlying Lower Triassic Bjorne Formation, Marie Bay
Bitumen in Bjorne Sandstone, Marie Bay
Truncation and Overstep of Bjorne Fm By Norian Strata
Early Triassic Sequence, Western Sverdrup Basin
Mapped Seismic Closures
Conclusions

• The Lower Triassic Succession encompasses a 2\textsuperscript{nd} order sequence and can be subdivided into three 3\textsuperscript{rd} order sequences.

• Very thick fluvial to shallow shelf sandstones were deposited in areas of high input.

• Submarine fans occur in the basin.
Conclusions

• Crockerland was a minor source area and northwesterly derived sandstones are not prospective.

• Lower Triassic fluvial and shallow shelf sandstones are excellent potential reservoirs.
Conclusions

• Oil-prone source rocks of Middle Triassic age directly overly the Lower Triassic succession.

• Potential traps include anticlinal structures and combination structural stratigraphic traps.
Conclusions

Lower Triassic strata are very prospective over large areas of the southern margin of the Sverdrup Basin.
Acknowledgements

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