USGS
science for a changing world

Assessment of Undiscovered Conventional Oil and Gas Resources of the Western Canada Sedimentary Basin, Canada, 2012

The U.S. Geological Survey mean estimates of undiscovered conventional oil and gas resources from provinces in the Western Canada Sedimentary Basin of central Canada are 1,321 million barrels of oil, 25,386 billion cubic feet of gas, and 604 million barrels of natural gas liquids.

Introduction

The U.S. Geological Survey (USGS) recently completed a geoscience-based assessment of undiscovered oil and gas resources of provinces within the Western Canada Sedimentary Basin (WCSB) (table 1). The WCSB primarily comprises the (1) Alberta Basin Province of Alberta, eastern British Columbia, and the southwestern Northwest Territories; (2) the Williston Basin Province of Saskatchewan, southeastern Alberta, and southern Manitoba; and (3) the Rocky Mountain Deformed Belt Province of western Alberta and eastern British Columbia (fig. 1). This report is part of the USGS World Petroleum Resources Project assessment of priority geologic provinces of the world. The assessment was based on geoscience elements that define a total petroleum system (TPS) and associated assessment unit(s) (AU). These elements include petroleum

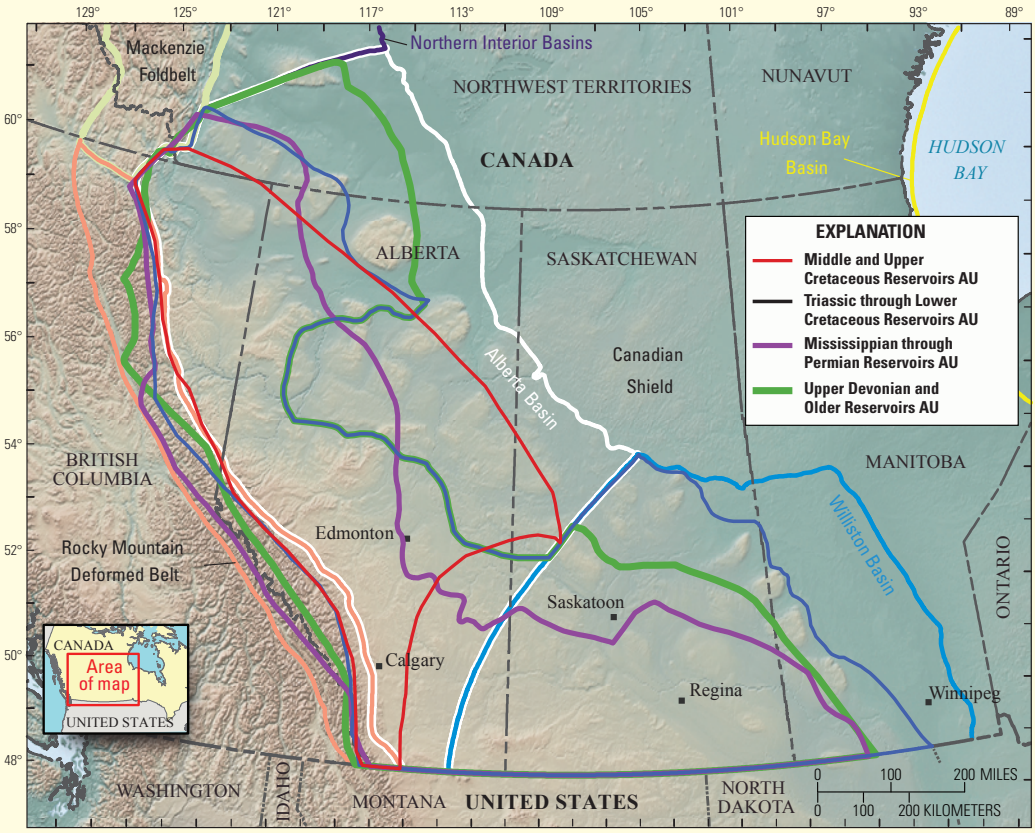

Figure 1. Extent of the Western Canada Sedimentary Basin is approximated by the outer boundaries of the labeled Alberta Basin Province, Williston Basin Province, and Rocky Mountain Deformed Belt Province. Contained are conventional assessment units (AUs) for the (1) Middle and Upper Cretaceous Reservoirs AU of the Middle through Upper Cretaceous Composite Total Petroleum System (TPS); (2) Triassic through Lower Cretaceous Reservoirs AU, and (3) Mississippian through Permian Reservoirs AU, both of the Exshaw-Fernie-Mannville Composite TPS; and (4) Upper Devonian and Older Reservoirs AU of the Elk Point-Woodbend Composite TPS.

source rocks (geochemical properties and petroleum generation, migration, and accumulation), reservoir description (reservoir presence, type, and quality), and petroleum traps (trap and seal types, and timing of trap and seal formation relative to petroleum migration). Using this framework, the Elk Point-Woodbend Composite TPS, Exshaw-Fernie-Mannville Composite TPS, and Middle through Upper Cretaceous Composite TPS were defined, and four conventional AUs within the TPSs were quantitatively assessed for undiscovered resources in the WCSB (table 1).

Figure 1 shows assessment unit (AU) boundaries for the (1) Middle and Upper Cretaceous Reservoirs AU; (2) Triassic through Lower Cretaceous Reservoirs AU; (3) Mississippian through Permian Reservoirs AU; and (4) Upper Devonian and Older Reservoirs AU. Boundaries of the AUs (fig. 1) encompass the extent of potential conventional petroleum resources within the labeled petroleum provinces. Conventional AUs are defined within three total petroleum systems (fig. 2, table 1) based mainly on results of 1D and 4D petroleum system modeling documented in Roberts and others (2005) and Higley and others (2009). Actual TPS divisions are considerably more complex in the WCSB (Allan and Creaney, 1991), particularly since the petroleum source rock kitchen for the Alberta Basin is proximal to and under the Canadian Rocky Mountains, and the Williston Basin petroleum is sourced from the south.

Resource Summary

The USGS assessed undiscovered conventional oil and gas resources for provinces in the WCSB (table 1). Undiscovered, technically recoverable conventional resources mean totals are 1,321 million barrels of oil (MMBO), 25,386 billion cubic feet of gas (BCFG), and 604 million barrels of natural gas liquids (MMBNGL). Mean undiscovered resources for the (1) Middle and Upper Cretaceous Reservoirs AU are 110 MMBO, 2,530 BCFG, and 69 MMBNGL; (2) Triassic through Lower Cretaceous Reservoirs AU are 571 MMBO, 15,728 BCFG, and 400 MMBNGL; (3) Mississippian through Permian Reservoirs AU include 185 MMBO, 3,210 BCFG, and 42 MMBNGL; and (4) Upper Devonian and Older Reservoirs AU totals are 455 MMBO, 3,918 BCFG, and 93 MMBNGL.

Sources of Data

The primary source of well history and production data used in this assessment was the IHS Energy Enerdeq™ Desktop Canada database (2011). Other data sources are documented in Higley and others (2005, 2009). The Energy Resources Conservation Board (Energy Resources Conservation Board, 2011) contains pertinent geoscience and energy-reserves information accessed for this study.

Assessment Team

Western Canada Sedimentary Basin Assessment Team: Debra K. Higley (Task Leader; *higley@usgs.gov*) and Review Committee: Ronald R. Charpentier, Troy A. Cook, Timothy R. Klett, Richard M. Pollastro, Christopher J. Schenk (Project Leader), Marilyn E. Tennyson, and Craig J. Wandrey. Further information on this and other World Petroleum Resources Project basins can be accessed at *http://energy.usgs.gov/OilGas/AssessmentsData/WorldPetroleumAssessment.aspx.*

Table 1. Western Canada Sedimentary Basin conventional resource assessment results.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas. MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas fields, all liquids are included under the NGL (natural gas liquids) category. Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95-percent chance of at least the amount tabulated. Other fractiles are defined similarly. Largest expected oil field size is in MMBO; largest expected gas field is in BCFG. Fractiles are additive under the assumption of perfect positive correlation. Gray shading indicates not applicable. TPS, total petroleum system; AU, assessment unit.]

Total petroleum systems (TPS) and assessment units (AU)	Field type	Expected largest field size	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Middle through Upper Cretaceous Composite TPS														
Middle and Upper Cretaceous Reservoirs AU	Oil	1.2	74	107	154	110	112	168	247	172	0	0	1	0
	Gas	13.0					1,595	2,302	3,327	2,358	47	67	98	69
Exshaw-Fernie-Mannville Composite TPS														
Triassic through Lower Cretaceous Reservoirs AU	Oil	0.6	386	557	805	571	810	1,175	1,698	1,204	1	2	3	2
	Gas	14.4					9,799	14,173	20,459	14,524	268	388	560	398
Mississippian through Permian Reservoirs AU	Oil	0.9	125	180	261	185	324	472	687	484	1	1	1	1
	Gas	38.7					1,826	2,660	3,846	2,726	27	40	58	41
Elk Point-Woodbend Composite TPS														
Upper Devonian and Older Reservoirs AU	Oil	3.3	306	444	641	455	390	573	835	587	0	1	1	1
	Gas	25.1					2,241	3,253	4,698	3,331	62	90	129	92
Total conventional resources			891	1,288	1,861	1,321	17,097	24,776	35,797	25,386	406	589	851	604

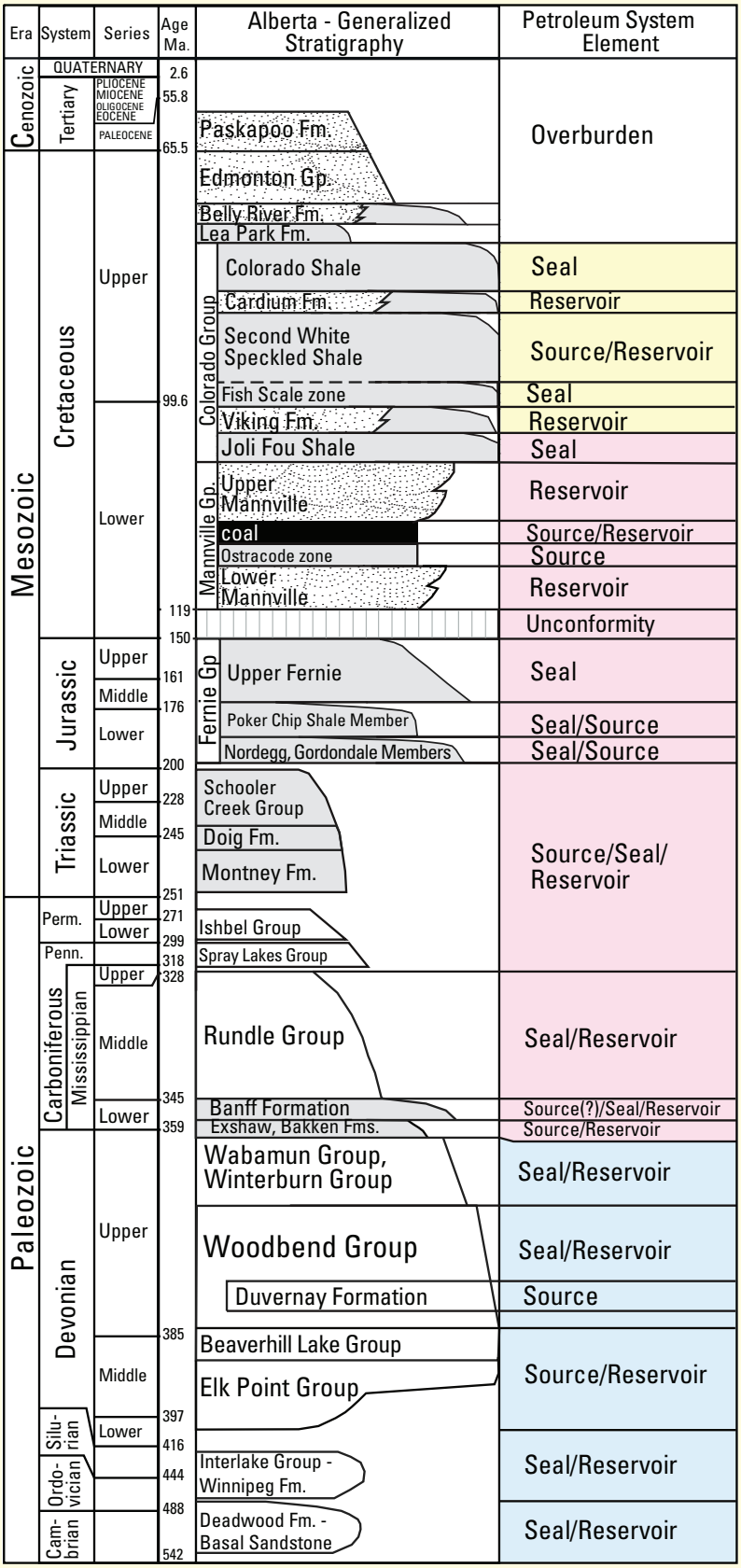

Figure 2. Generalized stratigraphic section of mainly the Alberta portion of the Western Canada Sedimentary Basin showing age ranges of the Middle through Upper Cretaceous Composite TPS (yellow), Exshaw-Fernie-Mannville Composite TPS (pink), and Elk Point-Woodbend Composite TPS (blue). Lithologies include primarily shale or marl (gray), sandstone (stipple), carbonates (white), and coal (black). Mossop and Shetsen (1994) was the primary source for lithofacies types. Modified from Higley and others (2009). (Fm(s), Formation(s); Gp., Group; Mem., Member; Perm., Permian; Penn., Pennsylvanian.)

References Cited

Allan, J., and Creaney, S., 1991, Oil families of the Western Canada Basin: Bulletin of Canadian Petroleum Geology, v. 39, no. 2, p. 107–122.

Energy Resources Conservation Board, 2011, Alberta's energy reserves 2010 and supply/demand outlook 2011–2020: Calgary, Alberta, Energy Resources Conservation Board ST98-2011, 263 p.

Higley, D.K., Henry, M.E., and Roberts, L.N.R., 2005, Petroleum system modeling of the Western Canada Sedimentary Basin—Isopach grid files: U.S. Geological Survey Open-File Report 2005–1421, 14 p. (Also available at *http://pubs.usgs.gov/of/2005/1421*.)

Higley, D.K., Lewan, M.D., Roberts, L.N.R., and Henry, M.E., 2009, Timing and petroleum sources for the Lower Cretaceous Mannville Group oil sands of northern Alberta based on 4-D modeling: American Association of Petroleum Geologists Bulletin, v. 93 no. 2, p. 203–230.

IHS Energy, 2011, IHS Energy Enerdeq™ Desktop Canada database: Unpublished database available from IHS Energy, 15 Inverness Way East, Englewood, Colo., 80112.

Mossop, G., and Shetsen, I., comps., 1994, Geological atlas of the Western Canada Sedimentary Basin: Calgary, Alberta, Canadian Society of Petroleum Geologists and Alberta Research Council, accessed June 1, 2012, at *http://www.ags.gov.ab.ca/publications/wcsb_atlas/atlas.html*.

Roberts, L.N.R., Higley, D.K., and Henry, M.E., 2005, Input data used to generate one-dimensional burial history models, central Alberta, Canada: U.S. Geological Survey Open-File Report 2005–1412, 14 p. (Also available at *http://pubs.usgs.gov/of/2005/1412/*.)

Cascade Mountain, located in the Bow River Valley and bordering Banff in the Canadian Rockies of Alberta. Photo by Debra Higley.