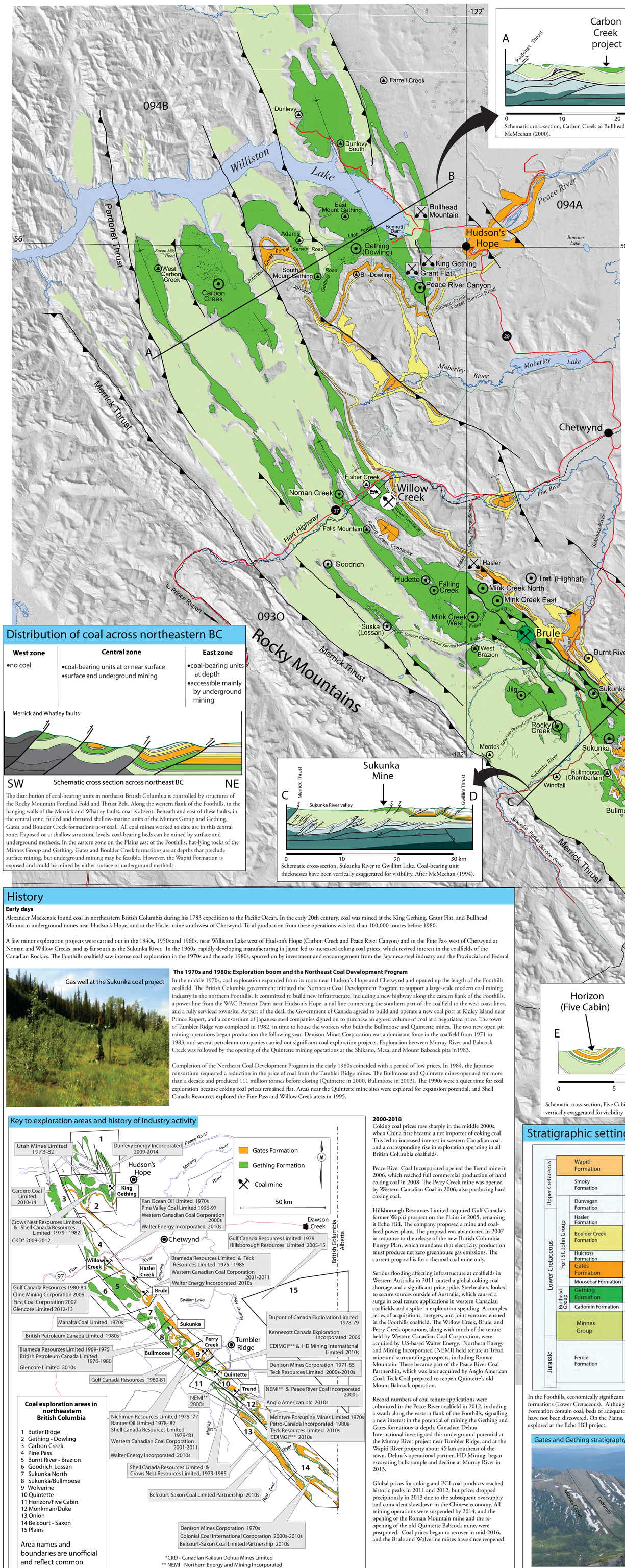
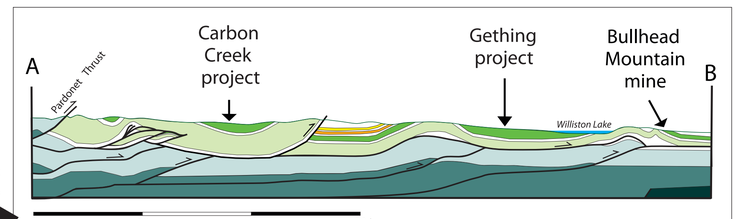
The Peace River coalfields

British Columbia Geological Survey Information Circular 2018 - 7

Ministry of Energy, Mines and Petroleum Resources





Schematic cross-section, Carbon Creek to Bullhead Mountain. Coal-bearing unit thicknesses have been vertically exaggerated for visibility. After McMechan (2000).

Wapiti Formation
Boulder Creek Formation
Gates Formation
Gething Formation
Minnes Group
Triassic and older formations (coloured on cross-sections only)
Coal exploration borehole
Gas exploration well
Rail load-out facility

Operating coal mine
Coal mine - operation suspended
Past producing coal mine
Coal developed prospect
Coal prospect

major road
rail line
resource road

Mine pit footprint
Mine infrastructure footprint

thrust fault, teeth on hanging wall
syncline
anticline

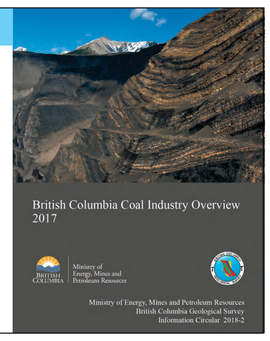
Scale
0 10 20 30
km

For further information

- Visit the British Columbia Geological Survey website to access:

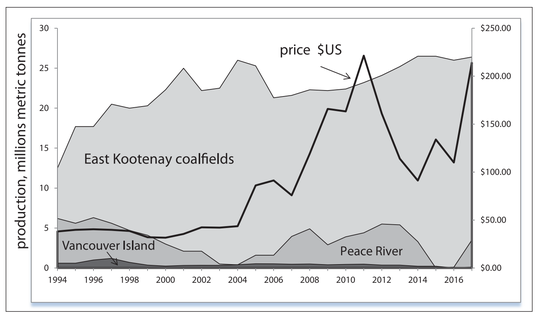
- COALFILE
- Coal Titles
- Coal Leases
- MINFILE
- Mineral Titles Online
- British Columbia Geological Survey Publication Catalogue
- MapPlace Digital geology

Visit The BC Oil & Gas Commission website for information on oil and gas exploration wells.



Context

Coal deposits in northeast British Columbia occur in the Foothills and Plains coalfields, together commonly referred to as the Peace River coalfields. The Foothills coalfield extends more than 400 km along the Rocky Mountains foothills, and has produced approximately 130 million tonnes of bituminous coal. The Plains coalfield has not been profitably mined to date.



The Foothills coalfield is the largest of British Columbia's coalfields but is second to the East Kootenay in production volume. Mines in the Foothills coalfield have higher operating costs due to greater distance to ports and major centres, and less mature infrastructure. Northeast coal operations are more vulnerable to price shocks than East Kootenay mines.

Current and recent production

Mine	Coal products	Production capacity	Years of operation	Total production to 2017	Reserves (Proven + Probable) Clean coal	Resources (Measured + Indicated) Raw coal
Willow Creek	**ULV PCI *HCC	~1.0 Mt/yr	2004 - 2007 2010 - 2013	3.9 Mt	18.6 Mt (2011)	48.9 Mt (2016)
Brule	ULV PCI	~1.4 Mt.yr	2004 - 2014 2016 - present	12.8 Mt	15.2 Mt (2016)	unavailable
Wolverine (Perry Creek)	HCC	3.5 Mt	2006 - 2014 2017 - present	7.7 Mt	8.3 Mt (2016)	unavailable
Trend	HCC	~2.0 Mt/yr	2006 - 2014	8.3Mt		

*Hard coking coal **Ultra low volatile pulverized coal injection product

Historical production

Past producing mines	Associated mines/pits	Total production	Years of operation	Mine type
King Gething	Grant Flat mine Portage Mountain Peace River Canyon Number 3	48000t	1944-1964	Underground
Hasler Creek		4585t	1941 - 1945	Underground and surface
Bullmoose	South Fork West Fork	34 Mt	1983 - 2003	Surface open pit
Sukunka	Chamberlain Skeeter Brameda BP #1	82058t	1972 - 1975	Underground
Quintette	Mesa Shikano Babcock	67 Mt	1983-2000	Surface open pit

Distribution of coal across northeastern BC

West zone	Central zone	East zone
•no coal	•coal-bearing units at or near surface •surface and underground mining	•coal-bearing units at depth •accessible mainly by underground mining

Schematic cross section across northeast BC

The distribution of coal-bearing units in northeast British Columbia is controlled by structures of the Rocky Mountain Foreland Fold and Thrust Belt. Along the western flank of the Foothills, in the hanging walls of the Merrick and Whatley faults, coal is absent. Beneath and east of these faults, in the central zone, folded and thrusted shallow-marine units of the Minnes Group and Gething, Gates, and Boulder Creek formations host coal. All coal mines worked to date are in this central zone. Exposed or at shallow structural levels, coal-bearing beds can be mined by surface and underground methods. In the eastern zone on the Plains east of the Foothills, flat-lying rocks of the Minnes Group and Gething, Gates and Boulder Creek formations are at depths that preclude surface mining, but underground mining may be feasible. However, the Wapiti Formation is exposed and could be mined by either surface or underground methods.

Schematic cross-section, Sukunka River to Gwillim Lake. Coal-bearing unit thicknesses have been vertically exaggerated for visibility. After McMechan (1994).

History

Early days

Alexander Mackenzie found coal in northeastern British Columbia during his 1783 expedition to the Pacific Ocean. In the early 20th century, coal was mined at the King Gething, Grant Flat, and Bullhead Mountain underground mines near Hudson's Hope, and at the Hasler mine southwest of Chetwynd. Total production from these operations was less than 100,000 tonnes before 1980.

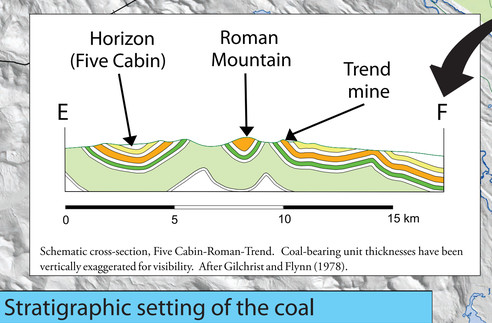
A few minor exploration projects were carried out in the 1940s, 1950s and 1960s, near Williston Lake west of Hudson's Hope (Carbon Creek and Peace River Canyon) and in the Pine Pass west of Chetwynd at Noman and Willow Creeks, and as far south as the Sukunka River. In the 1960s, rapidly developing manufacturing in Japan led to increased coking coal prices, which revived interest in the coalfields of the Canadian Rockies. The Foothills coalfield saw intense coal exploration in the 1970s and the early 1980s, spurred on by investment and encouragement from the Japanese steel industry and the Provincial and Federal

Gas well at the Sukunka coal project

The 1970s and 1980s: Exploration boom and the Northeast Coal Development Program

In the middle 1970s, coal exploration expanded from its roots near Hudson's Hope and Chetwynd and opened up the length of the Foothills coalfield. The British Columbia government initiated the Northeast Coal Development Program to support a large-scale modern coal mining industry in the northern Foothills. It committed to build new infrastructure, including a new highway along the eastern flank of the Foothills, a power line from the WAC Bennett Dam near Hudson's Hope, a rail line connecting the southern part of the coalfield to the west coast lines, and a fully serviced townsite. As part of the deal, the Government of Canada agreed to build and operate a new coal port at Ridley Island near Prince Rupert, and a consortium of Japanese steel companies signed on to purchase an agreed volume of coal at a negotiated price. The town of Tumbler Ridge was completed in 1982, in time to house the workers who built the Bullmoose and Quintette mines. The two new open pit mining operations began production the following year. Denison Mines Corporation was a dominant force in the coalfield from 1971 to 1983, and several petroleum companies carried out significant coal exploration projects. Exploration between Murray River and Babcock Creek was followed by the opening of the Quintette mining operations at the Shikano, Mesa, and Mount Babcock pits in1983.

Completion of the Northeast Coal Development Program in the early 1980s coincided with a period of low prices. In 1984, the Japanese consortium requested a reduction in the price of coal from the Tumbler Ridge mines. The Bullmoose and Quintette mines operated for more than a decade and produced 111 million tonnes before closing (Quintette in 2000, Bullmoose in 2003). The 1990s were a quiet time for coal exploration because coking coal prices remained flat. Areas near the Quintette mine sites were explored for expansion potential, and Shell Canada Resources explored the Pine Pass and Willow Creek areas in 1995.



Schematic cross-section, Five Cabin-Roman-Trend. Coal-bearing unit thicknesses have been vertically exaggerated for visibility. After Gilchrist and Flynn (1978).

Key to exploration areas and history of industry activity

Coal exploration areas in northeastern British Columbia

1 Butler Ridge
2 Gething - Dowling
3 Carbon Creek
4 Pine Pass
5 Burnt River - Brazion
6 Goodrich-Lossan
7 Sukunka North
8 Sukunka/Bullmoose
9 Wolverine
10 Quintette
11 Horizon/Five Cabin
12 Monkman/Duke
13 Onion
14 Belcourt - Saxon
15 Plains

Area names and boundaries are unofficial and reflect common usage in the coal exploration industry.

*CKD - Canadian Kailuan Dehua Mines Limited
** NEMI - Northern Energy and Mining Incorporated
*** CDIMGI - Canadian Dehua International Mines Group Incorporated

The above is not an exhaustive list of all exploration projects carried out in the Peace coalfields.

Data generated by coal exploration are stored in the COALFILE database and can be viewed online at: http://webmap.em.gov.bc.ca/mapplace/coal/search.asp

2000-2018

Coking coal prices rose sharply in the middle 2000s, when China first became a net importer of coking coal. This led to increased interest in western Canadian coal, and a corresponding rise in exploration spending in all British Columbia coalfields.

Peace River Coal Incorporated opened the Trend mine in 2006, which reached full commercial production of hard coking coal in 2008. The Perry Creek mine was opened by Western Canadian Coal in 2006, also producing hard coking coal.

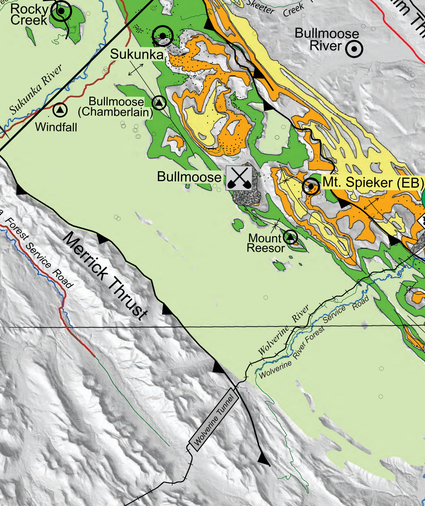
Hillsborough Resources Limited acquired Gulf Canada's former Wapiti prospect on the Plains in 2005, renaming it Echo Hill. The company proposed a mine and coal-fired power plant. The proposal was abandoned in 2007 in response to the release of the new British Columbia Energy Plan, which mandates that electricity production must produce net zero greenhouse gas emissions. The current proposal is for a thermal coal mine only.

Serious flooding affecting infrastructure at coalfields in Western Australia in 2011 caused a global coking coal shortage and a significant price spike. Steelmakers looked to secure sources outside of Australia, which caused a surge in coal tenure applications in western Canadian coalfields and a spike in exploration spending. A complex series of acquisitions, mergers, and joint ventures ensued in the Foothills coalfield. The Willow Creek, Brule, and Perry Creek operations, along with much of the tenure held by Western Canadian Coal Corporation, were acquired by US-based Walter Energy. Northern Energy and Mining Incorporated (NEMI) held tenure at Trend mine and surrounding prospects, including Roman Mountain. These became part of the Peace River Coal Partnership, which was later acquired by Anglo American Coal. Teck Coal prepared to reopen Quintette's old Mount Babcock operation.

Record numbers of coal tenure applications were submitted in the Peace River coalfield in 2012, including a swath along the eastern flank of the Foothills, signalling a new interest in the potential of mining the Gething and Gates formations at depth. Canadian Dehua International investigated this underground potential at the Murray River project near Tumbler Ridge, and at the Wapiti River property about 45 km southeast of the town. Dehua's operational partner, HD Mining, began excavating bulk sample and decline at Murray River in 2013.

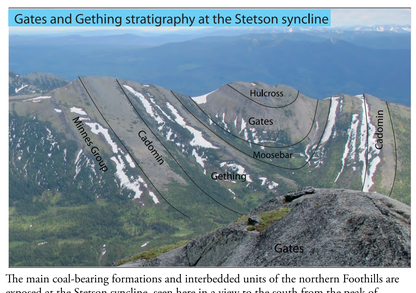
Global prices for coking and PCI coal products reached historic peaks in 2011 and 2012, but prices dropped precipitously in 2013 due to the subsequent oversupply and coincident slowdown in the Chinese economy. All mining operations were suspended by 2014, and the opening of the Roman Mountain mine and the re-opening of the old Quintette Babcock mine, were postponed. Coal prices began to recover in mid-2016, and the Brule and Wolverine mines have since reopened.

Stratigraphic setting of the coal



In the Foothills, economically significant coal deposits occur in the Gething and Gates formations (Lower Cretaceous). Although the Minnes Group and Boulder Creek Formation contain coal, beds of adequate thickness and continuity to be profitably mined have not been discovered. On the Plains, thermal coal in the Wapiti Formation has been explored at the Echo Hill project.

Gates and Gething stratigraphy at the Stetson syncline



The main coal-bearing formations and interbedded units of the northern Foothills are exposed at the Stetson syncline, seen here in a view to the south from the peak of Roman Mountain. The Cadomin Formation is distinctive and resistant to erosion, making it an important marker in the Canadian Rockies. The Moosebar Formation, a recessive unit of mainly marine shale, commonly forms valleys and supports vegetation. Resistant sandstones of the Gates Formation commonly form cliffs.

Coal quality

Coals from the Wapiti Formation are sub-bituminous in rank and none are coking coals. Advanced coal exploration in the Wapiti Formation has been confined to the Echo Hill prospect.

Coal from the Boulder Creek Formation has never been mined, but low-ash, medium-volatile, low sulphur coal has been identified from the formation at the Trefi project near Highhat Mountain.

Gates Formation coals are generally medium-volatile bituminous, although some of the deposits in the south contain high-volatile bituminous coal. Gates Formation coals are low in sulphur and phosphorus, and have consistently favourable ash chemistry. Hard coking coals from the Gates Formation coals are currently produced at the Wolverine (Perry Creek) mine. Most coal prospects south of the Wolverine River target Gates Formation coals.

Coking coal from the Gates Formation at the Trend mine

Low ash, low volatile Gething Formation coal at Sukunka

The Gething Formation is exposed along the length of the northern Foothills. The rank of coal in the Gething Formation is variable, ranging from high-volatile bituminous to semi-anthracite. Gething coals generally wash easily to low clean ash content; some are sufficiently low in ash that they do not require washing. Not all Gething coal seams yield coking coal, but the ultra-low volatile coal is marketed as pulverized coal injection (PCI) coal.

The Brule mine produces Gething Formation coal exclusively, as did the Willow Creek and the historic underground mines near Hudson's Hope. Gething coals are generally low in sulphur and phosphorus, but high sulphur seams do occur. Ash chemistry is variable in Gething coals; some seams have ash compositions that are very favourable for coking coal quality. (Riddell and Tian 2017).

The Minnes Group has not been a target of coal exploration because the proven and profitable Gates and Gething formations have received most of the exploration interest and investment. Coals hosted by the Minnes Group are generally of insufficient thickness and continuity for mining so they remain relatively unexplored. Stott and Gibson (1980) documented more than 100 seams of coal within the upper Minnes Group in the Carbon Creek area, with rank varying between high volatile and medium volatile bituminous.

References

British Columbia Ministry of Energy, Mines and Petroleum Resources 2006. Conventional natural gas play atlas, northeast British Columbia. Oil and Gas Division Petroleum Geology Publication 2006-1, 147p.

Gilchrist, R.D. and Flynn, B.P. 1978. Coal Resources, Peace River Coalfield, northeastern British Columbia. British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Preliminary Map 33, 1:50,000 scale.

McMechan, M. E. 2013. Geology, Kakwa area, British Columbia and Alberta. Geological Survey of Canada, Map 2065A, 1:125,000 scale.

McMechan, M.E. 2000. Structure section and geological map of the Foothills and Front Ranges, Carbon Creek area, northeast British Columbia. Geological Survey of Canada, Open File 3553, 1:125,000 scale.

McMechan, M.E. 1994. Geology and structure cross-section, Dawson Creek, British Columbia. Geological Survey of Canada, Map 1858A, 1:250,000 scale.

Riddell, Janet and Tian, Han. 2017. Ash chemistry database for British Columbia Rocky Mountain bituminous coals. British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Geofile 2017-10.

Smith, G.G. 1989. Coal Resources of Canada. Geological Survey of Canada Paper 89-4.

Stott, D.F. and Taylor, G.C. 1979. Geology of Monkman Pass map-area, northeastern British Columbia. Geological Survey of Canada Open File 630, 1:125,000 scale.

Stott, D.F. 1984. Cretaceous sequences of the Foothills of the Canadian Rocky Mountains. In: The Mesozoic of Middle North America, D.F. Stott and D.J. Glass (Eds.); Canadian Society of Petroleum Geologists Memoir, pp. 85-107.

Stott, D.F. and Gibson, D.W. 1980. Minnes Coal, northeastern British Columbia. In Current Research, Part C, Geological Survey of Canada, Paper 1980-1C, pp. 135-137.