

NATIVE SULPHUR OCCURRENCES IN DEVONIAN EVAPORITES, NORTHEASTERN BRITISH COLUMBIA

(O94)

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INTRODUCTION

Most of Canada's current supply of sulphur is produced as a byproduct of "sour" natural gas, by removal and processing of hydrogen sulphide. During the 1960s and 70s an imbalance of supply and demand resulted in the build-up of a stockpile of 21 million tonnes of unsold sour-gas sulphur in western Canada. The stockpile has been gradually worked down during the last decade and is expected to be exhausted by 1991. This will result in a sudden drop of 25 per cent in the Canadian share of the world sulphur market from the present level of 40 per cent.

Potential for native sulphur deposits in western Canada was recognized many years ago. Caron (1976) and Hollister (1977, 1984) pointed out exploration opportunities for Frasch sulphur deposits in Alberta and British Columbia. This report results from a compilation of occurrences of native sulphur in Middle Devonian strata in northeastern British Columbia as reported in oil and gas drill-hole logs. Over 600 drill-hole logs intersecting Devonian beds have been reviewed and 27 sulphur occurrences identified (Figure 3-10-1); the four considered to be the most significant are briefly described. Potential sulphur deposits in Middle Devonian rocks beneath the Great Plains are too deep to recover using available Frasch mining technology, however, technological advances are improving mining methods from year to year and the recovery techniques may reach these depths in the foreseeable future.

It became apparent during the course of this study that native sulphur is also present in evaporite facies of Upper Triassic age. Triassic occurrences are not covered by this report but are shallower and more accessible and therefore offer potential for less costly exploration and development. To document sulphur occurrences in their stratigraphic interval will require the review of approximately 600 additional drill hole logs.

GEOLOGICAL SETTING

The Middle Devonian evaporites in northeastern British Columbia are a significant source of sour gas and petroleum shows are known in the Keg River, Muskeg and Sulphur Point formations of the Elk Point Group. This carbonate reef complex represents the most promising environment for the development of sulphur deposits.

The lower Elk Point sedimentary deposition was initiated by slow submergence of the land mass and resultant marine transgression from the northwest. An evaporite basin formed

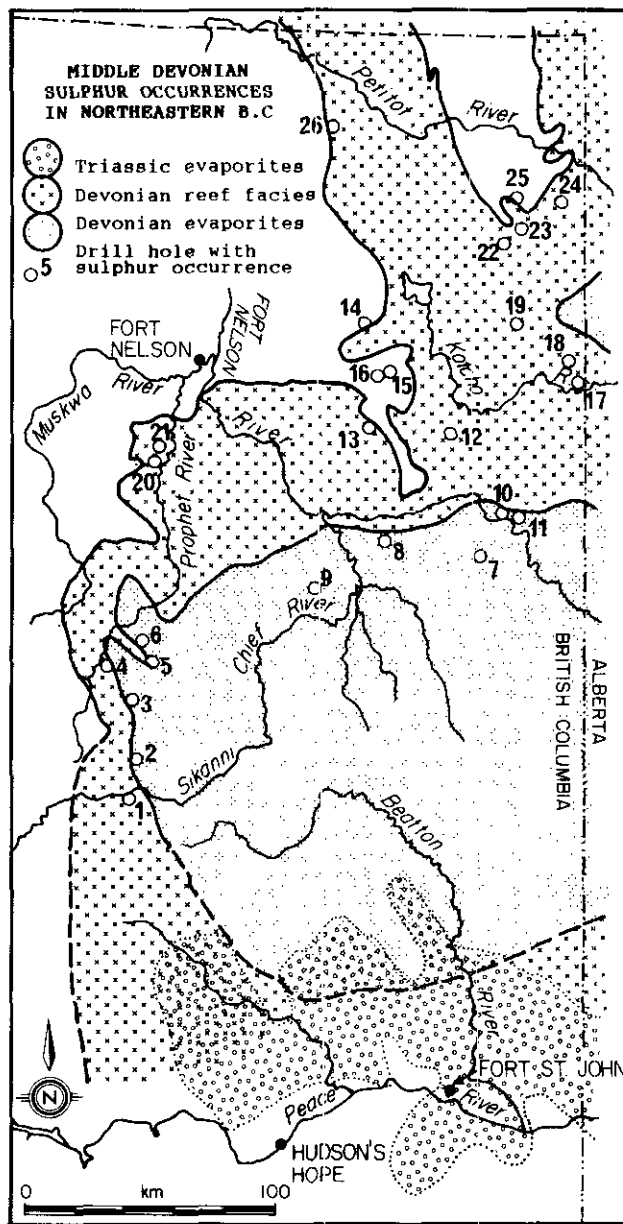


Figure 3-10-1. Middle Devonian sulphur occurrences and geological environments in northeastern British Columbia.

when barrier reef build-up restricted the circulation of marine water from the northwest. Reef growth was by a combination of organic build-up and the trapping of debris in and around the organic lattice. Local subsidence of the Keg River reef platform was commonly matched by reef build-up. Minor

TABLE 3-10-1
SULPHUR OCCURRENCES IN OIL AND GAS WELLS,
NORTHEASTERN BRITISH COLUMBIA

NTS	Well	Latitude	Longitude	Elevation (metres)	Remarks
94G/6	d-11-A	57°15'53"	123°00'15"	1004.6	Strong sulphurous odours and yellow sulphur in sandstones of the Triassic Halfway Fm. The sands have poor porosity and are well cemented with silica and carbonate. The top of the Halfway sands is @ 699.8 m.
94G/6	d-33-1	57°26'53"	123°01'40"	1214.9	Sulphur coatings on fractures lined with white dolomite in sandstone and siltstone of the Triassic Halfway Fm. @ 475.5 m.
94G/11	b-34-H	57°36'32"	123°02'25"	970.8	Free sulphur in dolomitic siltstone of the Triassic Toad/Grayling beds @ 588.2 - 591.3 m.
94G/11	a-25-D	57°44'05"	123°09'15"	984.5	Traces of sulphur in microfractures in Triassic siltstone and anhydrite of the Schooler Creek beds. Crystalline sulphur in Devonian Pine Point dolomite @ 3197.4 - 3211.6 m. and in underlying anhydrite. Traces sulphur in dolomite continue to 3334.5 m.
94G/15	a-83-J	57°46'07"	122°55'45"	786.7	6 m solid sulphur in Devonian Presqu'ile Fm. (see text).
94G/15	a-83-J	57°49'52"	122°57'30"	858.9	Major sulphur showing in Devonian Elk Point evaporites (see text).
94I/2	d-100-G	58°09'48"	120°44'30"	460.6	Traces of sulphur throughout the Devonian Keg River Fm. @ 2284.0 - 2289.4 m.
94I/3	d-61-K	58°13'10"	121°15'15"	473.4	Sulphur in Mississippian limestone. Slave Point carbonates and Elk Point anhydrite and dolomite (see text).
94I/4	d-27-C	58°01'18"	121°49'45"	648.9	Trace sulphur in Devonian Presqu'ile dolomite @ 2563.4 - 2571.0 m.
94I/7	a-34-H	58°21'34"	120°32'30"	430.4	Traces of sulphur in Devonian Lower Keg River dolomites from 2209.8 - 2246.4 m.
94I/8	a-35-E	58°21'38"	120°25'35"	432.8	Sulphur in Devonian dolomites of Upper Keg River Fm. (see text).
94I/10	a-34-E	58°36'38"	120°54'50"	410.1	Trace sulphur in Devonian Presqu'ile dolomite from 2130.6 - 2145.8 m.
94I/11	d-47-E	58°37'30"	121°27'18"	435.3	Trace sulphur in Devonian Sulphur Point limestone @ 1950.7 m.
94I/13	d-95-1	58°59'55"	121°33'15"	435.3	Trace sulphur in Devonian Elk Point dolomites @ 2407.9 - 2417.1 m.
94I/14	c-100-C	58°49'52"	121°22'15"	570.0	Sulphur staining in Devonian Pine Point limestone @ 627.9 - 647.7 m and in dolomite @ 656.8 - 673.6 m.
94I/14	c-91-D	58°49'55"	121°23'02"	570.1	Abundant H ₂ S odor and minor black sulphur solids in Devonian Presqu'ile dolomite @ 2178.1 - 2180.8 m.
94I/16	b-24-A	58°46'07"	120°02'58"	358.4	Black sulphur staining common in dolomite @ 1859.3 - 1889.8 m.
94I/16	b-46-A	58°47'10"	120°04'15"	359.0	Scattered traces sulphur in Devonian Elk Point dolomites between 1869.3 and 1941.6 m. traces of black sulphur in anhydrite of Chinchaga Fm. @ 1962.9 - 1969.0 m.
94I/16	b-86-L	58°59'07"	120°26'45"	534.4	Traces and occasional crystals of sulphur in Devonian Presqu'ile dolomite @ 1887.6 - 1898.9 m. 1923.3 - 1932.4 m and associated with pyrite @ 1941.6 - 1947.7 m.
94J/7	b-58-L	58°27'38"	122°58'15"	545.6	Sulphur staining in Devonian Muskeg evaporite @ 2383.5 - 2398.8 m.
94J/10	a-2-D	58°30'10"	122°53'32"	491.6	Traces of sulphur in dolomite interbeds in Watt Mountain Fm. @ 2340.9 - 2342.4 m. and 2350.0 - 2360.7 m.
94P/7	d-65-A	59°18'20"	120°33'15"	723.7	Possible reddish sulphur with ZnS in Devonian Slave Point dolomite @ 1950 - 1980 m.
94P/8	b-83-D	59°19'05"	120°24'30"	531.6	Slightly sulphurous Devonian Elk Point dolomite @ 2039.1 - 2069.9 m.
94P/8	a-74-G	59°23'35"	120°10'00"	456.5	Trace free sulphur in Devonian Keg River dolomite @ 1630.7 - 1633.7 m.
94P/8	b-7-L	59°25'05"	120°27'38"	513.6	Trace sulphur in fractures in Devonian Keg River dolomite @ 2048.3 - 2054.4 m.
94P/12	a-30-K	59°41'05"	121°52'00"	525.5	Sulphur fills hairline fractures in Devonian Slave Point dolomite @ 2079.3 - 2080.3 m.
94O/16	a-64-H	59°53'06"	122°02'30"	422.6	Light yellow sulphurous infill in Jean Marie limestone @ 1445.0 - 1446.4 m.

changes in sea level, high tides and storms, would occasionally cause washover of fresh marine water to reach the back-reef area. The restricted supply of fresh marine water and high evaporation rates resulted in evaporite deposition. The growth of sulphate-reducing bacteria flourished where anaerobic conditions prevailed (McCrossan and Glaister, 1964) and promoted the precipitation of sulphur. As deposition continued, more evaporites precipitated and a reflux process began. The concentrated brine then flowed towards the seaward side of the reef through the porous limestone. This resulted in some dolomitization, but more importantly, the barrier reef provided microniches in which sulphate-reducing bacteria could thrive. Thus the contact area between the reef and the evaporite basin is favoured for the entrapment of sulphur.

The Middle Devonian assemblage in the study area comprises the Elk Point Group and Slave Point Formation. The

Elk Point Group ranges in thickness from 600 metres in the Great Plains to 1000 metres in the northern Rocky Mountains. It comprises a cyclical sequence of evaporites, reefoid carbonates and thin beds of clastic rocks.

The Chinchaga Formation, at the base of the Elk Point Group, consists mainly of anhydrite interbedded with dolomite. The lower Keg River Formation comprises a thick reefal facies and thinner platform carbonates. The formation ranges from less than 15 metres thick in inter-reef areas, to some 200 metres thick at the rim of the barrier reef complex. The barrier complex comprises a massive carbonate bank, mainly of crystalline dolomite with occasional patches of limestone, and commonly contains thick sections with vuggy porosity.

Muskeg Formation evaporites overlie the relatively thin Keg River sequence behind the barrier, filling depressions between the Keg River reefs, and are in turn overlain by

limestones of the Sulphur Point Formation and a thin unit of interbedded shales, siltstones and occasional sandstones about 10 metres thick, the Watt Mountain Formation. The Watt Mountain Formation is not present in areas where reef growth continued from Elk Point into Slave Point time.

SULPHUR OCCURRENCES

This study was limited to reports from companies drilling exploratory oil and gas wells, and the research was done without benefit of field examination. It was not possible to verify inconsistent or questionable information. A few assumptions were consistently made when the source information was obscure. The description of sulphurous odors, often used in well reports, was assumed to be either hydrogen sulphide or sulphur dioxide gas as elemental sulphur is odorless. The term "black sulphur" in reports was taken to mean dark sulphur containing carbon impurities. A listing of 27 sulphur occurrences is provided in Table 3-10-1 and locations are plotted on Figure 3-10-1; the four wells considered most significant are briefly described below.

WELL a-25-D; 94G/15

This exploration well, located at latitude 57°46'07" north, 122°55'45" west, elevation 787 metres, reached the top of Presqu'île bedding, equivalent to the Keg River barrier, at a depth of 3094.0 metres. A drillstem test run for the interval 3189.7 to 3264.4 metres (10 465 to 10 710 feet) intersected 6.1 metres (20 feet) of solid sulphur. No other details are given.

WELL c-97-D; 94G/15

A major sulphur showing was intersected in this well within Elk Point evaporites and located at latitude 57°49'52" north, 122°57'30" west, elevation 858.9 metres. The drillstem test for the interval 3200 to 3262 metres (10 500 to 10 701 feet) recovered specks of free sulphur, 9.1 metres (30 feet) of muddy sulphur and 27.4 metres (90 feet) of native sulphur. Descriptions of 3-metre (10-foot) drilling samples, beginning at 3234 metres (10 610 feet) are as follows: dolomite and minor anhydrite with considerable native sulphur; dolomite with some scattered native sulphur; dolomite and trace sulphur; dolomite with minor amounts of sulphur; dolomite with traces of sulphur as above for the next 6.1 metres (20 feet); dolomite with rare trace sulphur for the following 9 metres (30 feet); dolomite with abundant sulphur in samples; dolomite with some sulphur; dolomite and trace brown chert with some sulphur contamination; dolomite with sulphur in samples; and dolomite samples contain elemental sulphur.

The Chinchaga beds, immediately beneath the Elk Point strata, and the pre-Devonian assemblage also contain sulphur in this hole. The interval 3302.2 to 3371.1 metres (10 834 to 11 060 feet) consists of dolomite and sandstone beds with "some elemental sulphur" to "trace sulphur staining".

WELL d-61-K; 94I/13

Sulphur occurrences were found in Mississippian limestone and Slave Point carbonates in this exploration hole located at

latitude 50°13'10" north, 121°15'15" west, elevation 473.4 metres. The Mississippian limestone contains free sulphur over the 3-metre interval from 798.6 to 801.6 metres (2620 to 2630 feet). The Slave Point Formation has trace sulphur in limestone over the interval 2094.0 to 2097.0 metres. A strong odor of sulphur dioxide is noted from the Elk Point interbedded anhydrite and dolomite at 2283.0 to 2286.0 metres.

WELL a-35-E; 94I/8

The upper member of the Upper Keg River Formation contains sulphur in this hole located at latitude 58°21'38" north, 120°25'35" west, elevation 432.8 metres. The interval from 2138.2 to 2141.5 metres contains approximately a metre of possible 30 per cent sulphur followed by a 9-metre interval of dolomite and anhydrite interbeds with a heavy sulphurous odor and possible native sulphur. The interval 2161.0 to 2173.2 metres (7090 to 7130 feet) is comprised of dolomite and possible thin sulphur-bearing beds. The native sulphur is yellow, coarsely crystalline to amorphous, and burns out of the samples as sulphur dioxide. It can be seen sparsely over the shaker table in daylight.

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