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GEOLOGY OF SULPHUR DEPOSITS

NORTHERN ALBERTA

SUMMARY

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Introduction

Native sulphur has been recorded in rocks of Middle and Upper Devonian age in northeastern Alberta at several localities and in similar evaporitic rocks in the Pine Point area, Northwest Territories (Figure 1). Recently there has been considerable activity in the Fort Vermilion area for sulphur deposits which occur mostly in surficial deposits of Quaternary age. This report summarizes the known information and potential of these native sulphur occurrences.

At the present time all Canadian western sulphur is coming from 20 sulphur recovery plants - all but one in Alberta - associated with natural gas production. Estimated production this year is around 2.3 million tons, and both Canadian and U. S. producers continue to ration supplies to consumers. Individual orders for sulphur may range up to $70.00 per ton at the present time.

Peace Point Area

(Wood Buffalo National Park)

Dark brown encrusted nodules of native sulphur occur in the Peace Point member of the Waterways Formation in the Peace Point area of northern Alberta. The nodules are as much as 4 inches in diameter, and may occur at as many as 14 localities at the surface along the banks of the Peace River.

According to Norris (1963, p. 65) the sulphur probably formed from the decomposition of metallic sulphides (a statement worth further consideration); but it may also have formed from the reduction of gypsum contaminating the shale.

One specific locality is described as follows by Norris (1963, p. 128) "Within the shale (of a sink-hole composed of rocks belonging to the Peace Point Member) are irregular masses, some as large as a man's fist having a core of native sulphur surrounded by a rind 1/16 to 1/4 inch thick and weathering a dark orange-brown. The sulphur is probably derived from sulphides common in this unit, or possibly from the decomposition of gypsum."

Also of significance is that the Peace Point Member only occurs in caverns, widened joint fissures, and sink-holes within the Slave Point Formation suggesting that a erosional hiatus exists between the Slave Point Formation and the Peace Point Member. This in turn may

mean that the sulphur deposits were formed during this suggested period of erosion, and also that the sulphur deposits are closely associated with sink-holes.

Conclusions: Economic sulphur deposits may be present in the belt of evaporitic and carbonate rocks of the Waterways Formation in Northern Alberta and are very likely associated with sink-holes in this formation. This formation and related units may extend for at least 240 miles in a northwest direction and the potential outcrop or near-surface subcrop band may be as much as 200 miles wide in Alberta.

Fort Vermilion Area

Over 40 sulphur prospecting permits (Figure 2) have been issued in Northern Alberta in the past year, most of them in the past few months. Little is known about the deposits but a general summary of existing information is given below:

1. Original finding on Permit No. 8 - presumably a flat-lying bed of native sulphur occuring at and just below the surface. The deposit has been tested with 200 auger drill holes 9 feet deep which indicates an area of the sulphur bed of at least 1400' by 1400'. No tonnages, grade, or geologic description available but some samples assay better than 70% sulphur. Indicated tonnage estimated from the above information results in a deposit of over one million tons.

2. Some samples are reported to be an earthy material, mainly brown in color with some native sulphur visible; other samples have considerable native sulphur. This information and the near-surface occurrence of the deposits strongly suggest that the sulphur occurs in surficial or glacial deposits.

3. Cores belonging to Madison Oils are reported to "look good."

4. Some of the sulphur permits cover the area of subcrop of the carbonate-shale formations of Upper and Middle Devonian age.

5. Other sulphur permits cover the unconformable contact between formations of Cretaceous and Devonian age.

6. Officers of the Research Council of Alberta have reason to believe that the area around Fort Vermilion may be a groundwater discharge area of sulphur-rich waters which have migrated up-dip from the Edmonton area along the Grosmont reef trend.

7. Groundwater springs enriched with sulphur and derived from Devonian formations would be capable of depositing large amounts of sulphur in an adequate host material since the end of glacial time (9000 - 11000 years ago). Favourable host materials would be porous silts and sands of alluvial or glacial origin and both kinds of deposits are present in the area.

8. Some groundwater springs sustain small lakes and sulphur may accumulate in these lacustrine basins.

9. Burning pits are present in the area presumably developed in the Loon River-Shaftsbury shale units of Cretaceous age. Sulphur deposits could form from incomplete spontaneous combustion of pyrite contained in these shales.

10. Some lineations (structural?) are detectable on aerial photographs in the area; fractures and/or faults would offer an avenue of migration for connate waters that are enriched with sulphur, therefore the location of these lineations will help delineate exploration objectives.

Conclusions: Native sulphur deposits occur in the Vermilion area and may be related to a variety of geological features including surficial deposits, sink-holes developed in rocks of Devonian age, groundwater sulphur springs, structural lineations, burning pits in the Cretaceous shales and geological contacts. It is not known whether or not economic accumulations of sulphur are present in the area but there is a strong possibility.

Pine Point Area, N. W. T.

Worthy of mention are the recorded sulphur deposits of the Pine Point area since these may have a similar origin to some of the deposits in northern Alberta.

1. Sulphurous encrustations are common in some outcrops of the Horn River shale of Middle Devonian Age in the Great Slave Lake area (Norris, 1965).

2. Warm and cold water springs with associated sulphur deposits have been reported from Sulphur Point and west of the Buffalo River in the Pine Point area, and in the Sulphur Bay area on the north shore of Great Slave Lake. Elemental sulphur has also been described from the Pine Point ore bodies but it post-dates ore deposition.

Conclusion: Sulphur deposits associated with groundwater springs occur in the Pine Point area but these have not been explored to the writer's knowledge.

Exploration Techniques

Geological exploration for sulphur deposits in northern Alberta would be directed toward the location of structures, the major Cretaceous-Devonian unconformity, groundwater discharge areas, sink-holes, burning pits and porous surficial material.

Photogeologic interpretation of existing aerial photographs is the first logical task, followed by detailed ground surveys, or in areas where there is no exposure, by hand or power auger test drilling.

An additional exploration tool is infrared aerial photography which may outline thermal anomalies. It is believed that thermal anomalies would in turn locate areas of sink-holes, sulphur springs, faults and fractures filled with groundwater, and burning pits. The greatest contrast of temperature would be obtained during the winter providing the snow is not too deep, when groundwater springs, fires etc., would show up as "hot spots" relative to the surrounding cool ground surface. Coordination of this information and conventional photogeology offers the best method of outlining anomalous surface targets for further exploration.

Ore Grade and Other Sedimentary Sulphur Deposits

Near-surface sedimentary sulphur deposits occur in Poland, U. S. S. R., and Italy. The Polish deposit occurs with gypsum interbedded with clay, limestone and fluviatile sand of Miocene age; the sulphur grade is 28 -30% and up to 80% locally. In the U. S. S. R. native sulphur occurs interbedded with bituminous limestone and gypsum of Permian age. Italian sulphur-bearing formations consist of limestone and shale sequences of Pliocene - Miocene age containing native sulphur as incrustations and small pockets or thin seams; sulphur grade averages 26%.

Other deposits in surficial deposits and fumarole origin occur in the United States but no tonnage of any consequence was ever mined.

Ore grade depends on many factors but generally Lamey (1966, p. 520) indicates that the sulphur content of commercial material in the United States is 15 to 30%. Rock containing less than 5% is not classed as ore.

Sulphur Recovery

Each mining operation for sulphur ore bodies requires a detailed engineering study before the economics of processing can be defined, but a brief comment on some sulphur recovery methods is included here to serve as a general guide.

1. Subsurface sulphur deposits are recovered by the Frasch process of extraction wherein hot water is injected under pressure into the formation; thin molten sulphur is then collected and returned to the surface.

2. Certain flotation agents have been developed to recover sulphur as for example in Java, Indonesia.

3. The use of selective solvents to extract sulphur is a well known method, and possibly it is the best method for near-surface ore bodies of the kind envisaged in northern Alberta.

4. Direct oxidation of surface ores is employed in Nevada to give sulphur dioxide which is then converted to sulphuric acid.

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PROFESSIONAL QUALIFICATIONS

1. I, Murray A. Roed, reside at [redacted] Edmonton, Alberta.

2. I have a B. A. (1959) and a M. A. (1961) in Geology from the University of Saskatchewan, Saskatoon. I am presently completing a Ph. D. in Geology at the University of Alberta, Edmonton.

3. I am a Professional Geologist registered with the Alberta Association of Professional Engineers.

4. M. A. Roed Geological Explorations Ltd. was registered in the Province of Alberta May 4, 1966.

5. I possess experience in the following fields of geology: Surficial and glacial geology; groundwater geology; geomorphology; structural and stratigraphic geology; photogeology; geophysics; subsurface drilling in coal, mining and petroleum exploration; and in engineering geology investigations; economic geology; paleontology.

6. I have worked in south and central Alberta, Saskatchewan, British Columbia, Rocky Mountains and Foothills, Mackenzie Mountains, Franklin Mountains, Richardson Mountains, Old Crow Mountains, Keel Range, Eagle Plain and Mackenzie River Valley.

7. I belong to the following professional societies: Alberta Association of Professional Engineers; Association of Engineering Geologists; Canadian Institute of Mining and Metallurgy; Geological Society of America; Edmonton Geological Society; Association of Professional Engineers of Saskatchewan.

8. I have no material interest in these subject properties, contemplated or otherwise.

Within the scope of this study, all information contained within this report is believed to be accurate.

Respectfully submitted,

M. A. ROED GEOLOGICAL EXPLORATIONS LTD.

per: [redacted]

Murray A. Roed, P. Geol.

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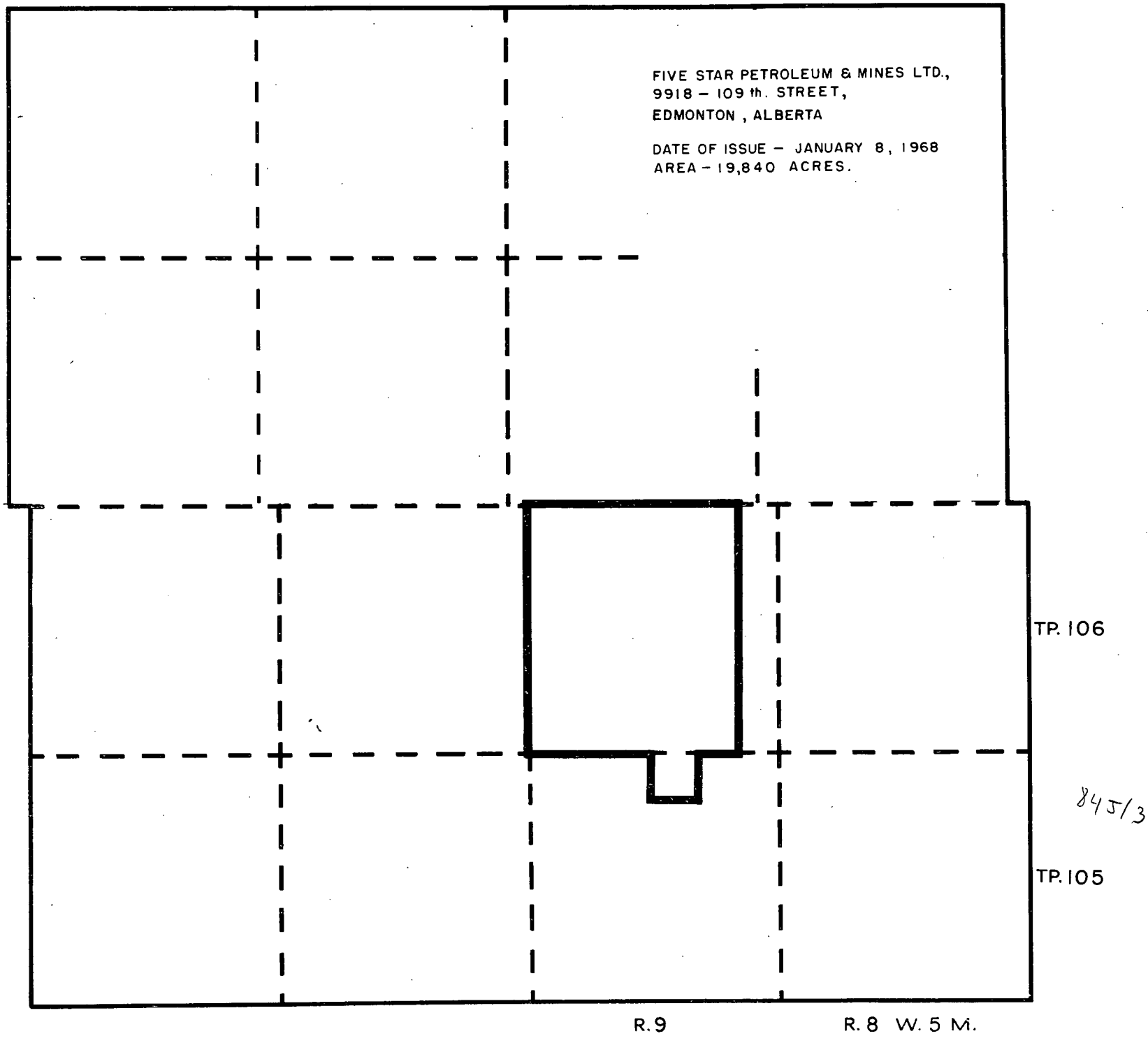
SULPHUR PROSPECTING PERMIT No. 83



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