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PHOTOGEOLOGICAL STUDY

SULPHUR PROSPECTING PERMIT NO. 83

NORTHERN ALBERTA

Prepared For

Five Star Petroleum & Mines Ltd.

July, 1968

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INTRODUCTION

This report has been prepared at the request of Mr. J. Reyda, acting for Five Star Petroleum & Mines Ltd., hereinafter referred to as the "Company." The request made was for a photogeological analysis of the Company's Sulphur Prospecting Permit No. 83, integrated with other available geological information. A map of north-central Alberta, Figure 1, shows the general geological setting of the Company Permit and its relationship to other sulphur permits in the area. Figure 2 represents the results of this preliminary study on a photogeological mosaic.

The immediate objective of this photogeological study was to identify from the study of aerial photographs those areas that, from our present knowledge, would be the most favourable for the occurrence of sulphur. Such areas could then be examined in the field to determine the presence or absence of sulphur.

Sulphur Prospecting Permit No. 83 totals approximately 19,840 acres.

BEDROCK GEOLOGY AND TOPOGRAPHY

Sulphur Prospecting Permit No. 83 is in an area underlain by Cretaceous rocks. The thickness of Cretaceous above the Paleozoic within the Permit area is estimated to be in the order of 100 feet.

The Cretaceous rocks consist of shales, sandy shales and sandstones. These rocks are poorly consolidated and bentonitic in character. The underlying Devonian rocks consist of limestones, dolomites, shales and evaporites. Outcrops of bedrock are expected to be sparse.

The bedrock in the general area is overlain by a variable thickness of glacial till, glacio-lacustrine and Recent deposits.

Sulphur Prospecting Permit No. 83 occupies both sides of the Wabasca River, approximately six miles south of its intersection with the Peace River and twenty-five miles southeast of Fort Vermilion. The generally level nature of the topography in this area has resulted in somewhat impeded drainage, but muskeg is not extensive.

The Wabasca River follows a meandering path from south to north through the subject Permit. Where the river enters the south boundary of Sulphur Prospecting Permit No. 83, there are several rapids. These rapids are probably caused by a formation that is more resistant than the normal sequence of soft Cretaceous shales.

MODE OF OCCURRENCE AND RELATIONSHIP OF SULPHUR TO GENERAL GEOLOGY

Within the general area of interest in which sulphur prospecting permits have been issued (Figure 1), the principal bedrock formations are of Cretaceous age, but, to the north and northeast, erosion has stripped off the Cretaceous beds exposing older Devonian rocks. The Devonian, as well as overlying Cretaceous rocks, are generally inclined gently westward into the Alberta Syncline so that progressively younger rocks of both Paleozoic and Mesozoic ages are present in that direction.

The bedrock, whether of Devonian or Cretaceous age, is overlain by a variable thickness of glacial and related sediments. The thickness of these overlying sediments is generally at a minimum in those areas where river valleys are deeply incised and greatest in the hilly portions of the area.

The surficial geology of the area is of particular interest to the subject of possible economic occurrences of sulphur because of the probability that any economic deposits in this area are in surficial deposits.

The last glacier to cover the subject area was of Wisconsin age. Dating by 'carbon 14' method indicates that this advancement over the region occurred over 31,000 years ago. Ice flow features on the Glacial Map of Canada indicate that this glacier came from an area west of Hudson Bay. The thickness of the glacier is estimated to have been approximately 5,000 feet and the average direction of flow in the subject area was to the west-southwest.

The general absence of terminal moraines and other ice marginal features indicates that the retreat of the glacier was mainly by rapid stagnation. Dead-ice moraine forms the surface or underlies lacustrine deposits over much of the regional area.

As the glacier retreated, the lowland to the north was blocked by ice and meltwaters and could not drain freely. Extensive proglacial and superglacial lakes were formed, resulting in the deposition of glacio-lacustrine deposits that vary in thickness from a few inches to fifty feet or more.

It is, at this time, not clear as to what extent the sulphur is developed in surficial deposits and to what extent it may be present within the stratified deposits of the Cretaceous and/or Devonian, but both modes of occurrence may exist. The most likely commercial deposits are, however, probably surficial.

Sulphur occurrences in the general region may be broken into three groups, as follows:

(1) In muskeg or other poorly drained lacustrine or "dried lacustrine" areas. The most important known apparent example of this type is the Sulphur Prospecting Permit No. 8 discovery occurrence.

(2) Deposits of elemental sulphur in connection with active springs with or without associated gas. One such known occurrence involved gas, which was, at least in part, combustible.

(3) Cretaceous shales in the area frequently contain finely disseminated sulphur. Although we know of no reported concentrations of significant size from the Cretaceous, the possibility of such economic occurrences cannot be entirely eliminated.

In many parts of the general area, burnt shales have also been reported. These usually appear to be associated with recent slumps, possibly because the slumping brings the combustible material, which may include sulphur, in contact

with the surface. The origin of the combustion is, at this time, purely conjectural, but lightning produced forest fires are the most likely cause.

We are not prepared, at this time, to enter into detailed discussions of theories of the origin of the sulphur because of the large number of presently uncertain factors in this new area. Studies in the area are, however, likely to yield substantial information over the coming field season. Meanwhile, theories of origin from Paleozoic connate waters or from bedded Devonian and other gypsum and anhydrite deposits are of principal interest.

The manner of occurrence of sulphur deposits will determine whether they can be mined at the surface by stripping or from deeper strata by the Frasch process.

Solution of many of the questions of origin and occurrence is of prime economic importance and should be given very detailed attention as the present permit areas are evaluated.

Meanwhile, it is of general interest to the overall sulphur problem in this region that continuous flowing sulphur springs have been known in the area for nearly 200 years and that such springs are still known along a broad area along the Mesozoic-Paleozoic surface geological contact that extends from Western Saskatchewan, through the McMurray oil sands area, and across the present region of sulphur permits into the southern part of the Northwest Territories near Pine Point and westward along the Liard River. It is of further possible significance that there appears to be a genetic relationship between these sulphur occurrences and the McMurray oil, which has a four percent to five percent sulphur content. In addition to this, there is considerable free sulphur associated with the McMurray oil sands, both within and outside of the oil saturated area. As a measure of the amount of sulphur already known to have been deposited, probably

from the same type of connate waters that can be expected to have deposited the sulphur under study, we might refer to the "reserve" of the sulphur in the McMurray oil sands. Most recent estimates indicate that there is over 600 billion barrels of oil-in-place in the McMurray oil sands. This oil contains four to five percent of sulphur weighing approximately eight to ten billion long tons.

The above and other evidence available would indicate that what is needed to produce an economic sulphur deposit in this area is a favourable combination of faults and fractures for sulphate spring exits, sulphur supply in the connate waters and poorly drained lacustrine or other flat basin areas immediately adjacent to the spring exits. All these individual circumstances are known to exist. Under the proper combination of circumstances, there is no definite limit to the amount of sulphur that could be formed. Whether or not, or where, commercial deposits are present remains to be seen.

PHOTOGEOLOGICAL STUDY WITH RECOMMENDATIONS FOR FIELD EVALUATIONS

Prominent photo-alignments, interpreted to represent surface expressions of bedrock faulting or fracturing, are present here. These fractures assume a northwest-southeast direction, except in the vicinity of the Wabasca River, where the trend is dominantly north-south, paralleling the river. Irregular patches of muskeg are developed within the Permit boundaries. In the northern portion of the area, the trend of these poorly drained features follows the main fracture pattern. To the south, the trend is more aligned with the direction of glaciation.

Discussions of areas of interest follow:

'Area 1' and 'Area 2' include those muskeg areas in the northwestern and central portions of the subject Permit. These features, which are oriented along prominent fractures, should be examined. In conjunction with the checking of these areas on the ground, limited shallow augering is recommended.

Included in 'Area 3' are those irregular shaped patches of muskeg in the southwestern part of the Permit. Shallow augering of selected locations is also suggested here.

'Area 4', in the southeastern portion of the Permit, includes the horseshoe-shaped area and the small area near the river. These should be examined in a manner similar to that described above.

'Area 5' includes that area along the Wabasca River, most of which is overlain by alluvium. It is unlikely that any large deposits of sulphur will be found here, however, a cursory examination of small streams emptying into the river may provide clues as to the location of springs in the area.

CONCLUSIONS AND RECOMMENDATIONS

From our overall sulphur studies in the general area, we conclude that the most likely sources of commercial sulphur are surficial deposits.

We also conclude, from our regional studies of the sulphur prospects of the subject area, that surficial deposits of sulphur are likely to occur in muskegs, lakes, or abandoned lacustrine depressions, with particular reference to such areas that are along or adjacent to fractures and/or faults responsible for sulphate water springs.

We have determined that a number of such features show well on the air photographs and these areas have been outlined on the accompanying photo-geological mosaic, Figure 2.

In view of the above, it is recommended that a field check be made of the localities that have been indicated by the photogeological study to be prospective. This field check would be that indicated as Step 1 of Phase II in our letter of June 8, 1968.

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[redacted]

V. A. Farley

[redacted]

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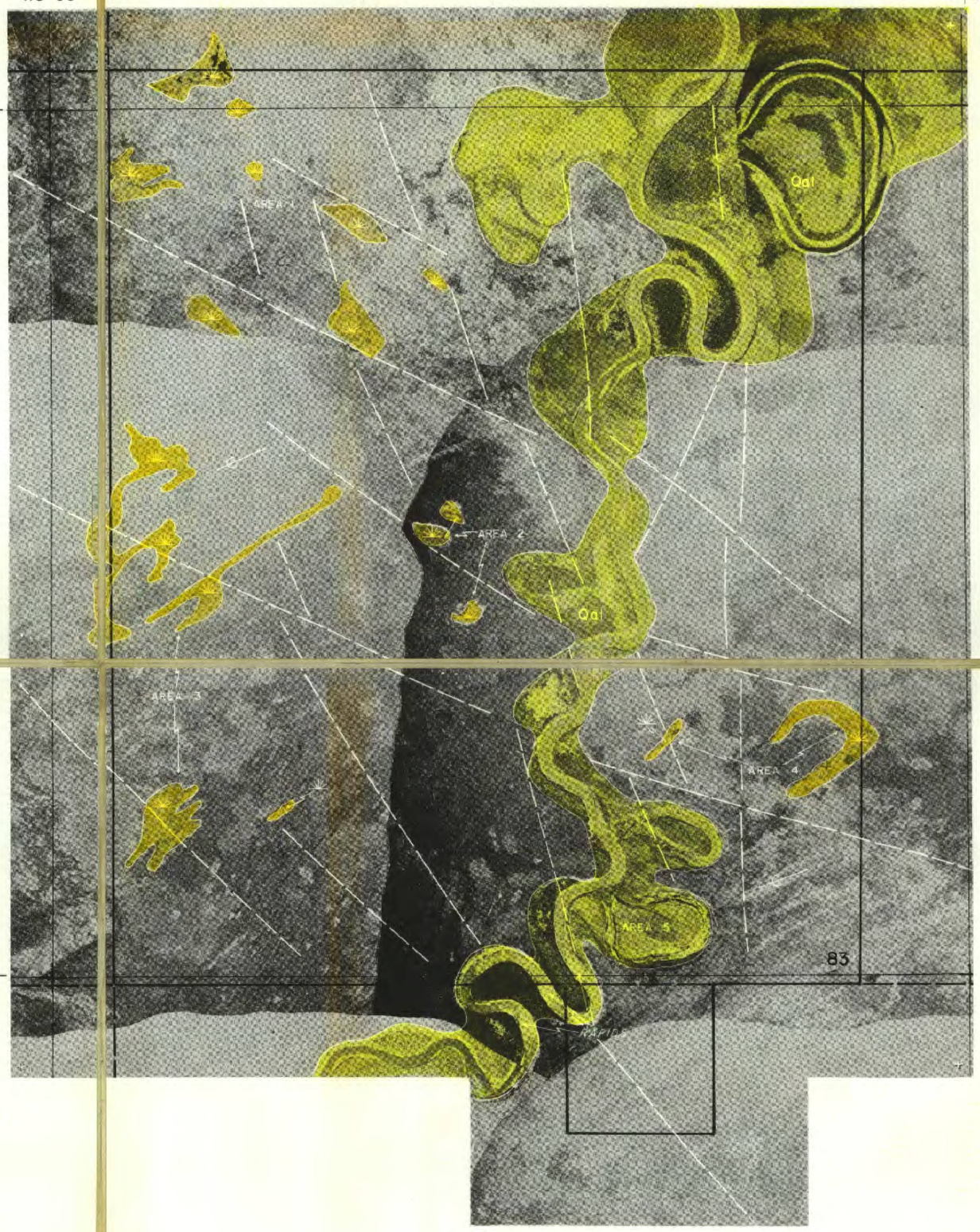
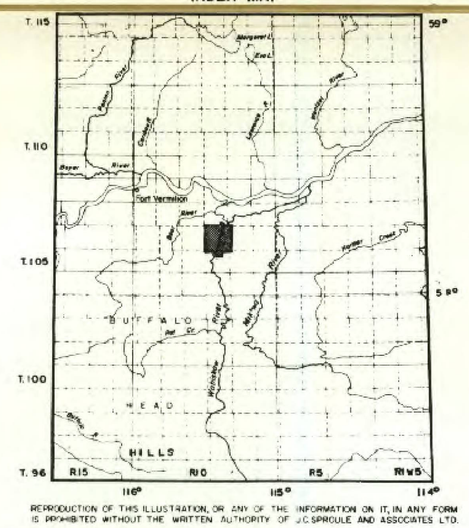


INDEX MAP



LEGEND

SURFICIAL DEPOSITS

Qal — Alluvium

Muskeg

PHOTOGEOLOGICAL SYMBOLS

Alignment interpreted to indicate faulting or fracturing in bedrock

Direction of glacial movement

AREA 1, 2 etc. — Areas of interest discussed in report

83 — Sulphur prospecting permit outline

19680078
FIGURE 2

PHOTOGEOLOGICAL MOSAIC
SULPHUR PROSPECTING PERMIT
No. 83

FORT VERMILION AREA
ALBERTA

PREPARED FOR

FIVE STAR PETROLEUM & MINES LTD.

Mi. 1/2 0 1 2 3Mi.

APPROXIMATE SCALE IN MILES

THIS IS A SEMICONTROLLED MAP-MOSAIC AND SHOULD NOT BE MISTAKEN FOR AN ACCURATE GEOGRAPHIC BASE

J.C. SPROULE AND ASSOCIATES LTD. CALGARY, ALBERTA

AUGUST 1968