MAR 19680134: NORTHERN ALBERTA

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PHOTOGEOLOGICAL STUDY

SULPHUR PROSPECTING PERMIT NO. 168

NORTHERN ALBERTA

Prepared For

Quintana Petroleum Corporation

September, 1968

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PHOTOGEOLOGICAL STUDY

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NORTHERN ALBERTA

INTRODUCTION

This report has been prepared at the request of Mr. Marvin Morris, acting for Quintana Petroleum Corporation, hereinafter referred to as the "Company." The request made was for a photogeological analysis of the Company's Sulphur Prospecting Permit No. 168, integrated with other available geological information. A map of north-central Alberta, Figure 1, shows the general geological setting of the Company's 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. 168 totals approximately 59,520 acres, and was filed on in the name of Gordon William Goettler.

BEDROCK GEOLOGY AND TOPOGRAPHY

Sulphur Prospecting Permit No. 168 is located on the Athabasca River, approximately 65 miles north of Fort McMurray.

The Permit straddles the Cretaceous-Devonian boundary which runs in a northwest-southeast direction through the area. The Cretaceous rocks are confined to the southwestern portion of the Permit and consist, in part, of the McMurray Oil Sands.

Topography in the area ranges from nearly level to gently rolling. Surface elevations vary from approximately 750 feet in the vicinity of the Athabasca River to 950 feet in the extreme western portion of the Permit.

Extensive muskeg development is absent in this area due to the lack of widespread depressional topography together with reasonably good drainage and sandy surficial deposits. Wind blown sand has formed into dunes, now for the most part stationary, and has locally modified some of the pre-existing features. Typical U-shaped and longitudinal sand dunes are characteristic of the area.

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 origin 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 important 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 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 EVALUATION

Sulphur Prospecting Permit No. 168 contains scattered groups of generally small muskegs. Numerous photo-alignments that show on the photos are interpreted to indicate the surface expression of bedrock faulting or fracturing. The predominant fracture trend is northwest-southeast with less well-developed north-south and east-west trends. Experience has shown that sulphur springs are commonly associated with such fractures.

In general, Permit No. 168 does not have large depressional or muskeg areas that might serve as catchment basins for waters emitted by sulphur springs. The Permit, however, is believed to be quite favourably located in relationship to the Cretaceous-Devonian contact, and certain areas have been defined that appear to possess attractive characteristics that should be investigated in the field.

'Area 1-a' through 'Area 1-h' includes a number of small to medium sized catchment basins that are associated with fractures located to the west of the Athabasca River in the northern portion of the Permit. The bedrock here is believed to be Devonian and surface deposits are composed of what appears to be largely sandy material.

The sampling of selected areas here is recommended.

'Area 2' is a large feature located on the western side of the Company Permit. This is an area of general flattening of topography where muskeg has developed and alluvium has collected. Numerous fractures crossing the area makes it worthy of investigation in the field.

'Area 3' and 'Area 4' are small muskegs located along trend with the main fracture system within the Permit and should be checked.

'Area 5' is a small basinal feature developed at the intersection of two prominent fractures.

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 to be prospective on a basis of our photo-geological study. This field check would be that indicated as Step 1 of Phase II in our letter of June 15, 1968, to Mr. C.C. Huston & Associates. For your information, a similar letter is attached to this report.

[redacted]

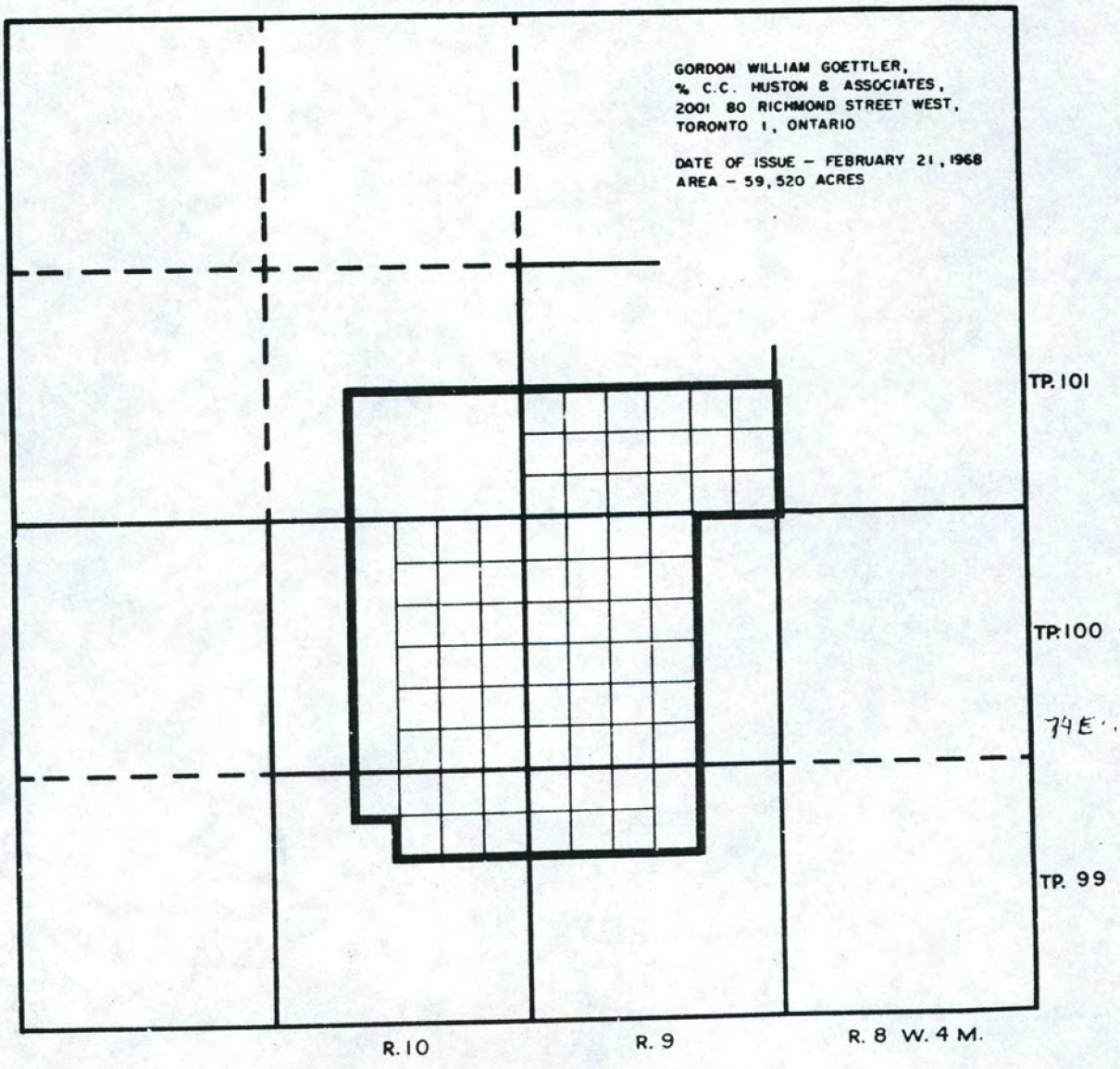
V.A. Farley.

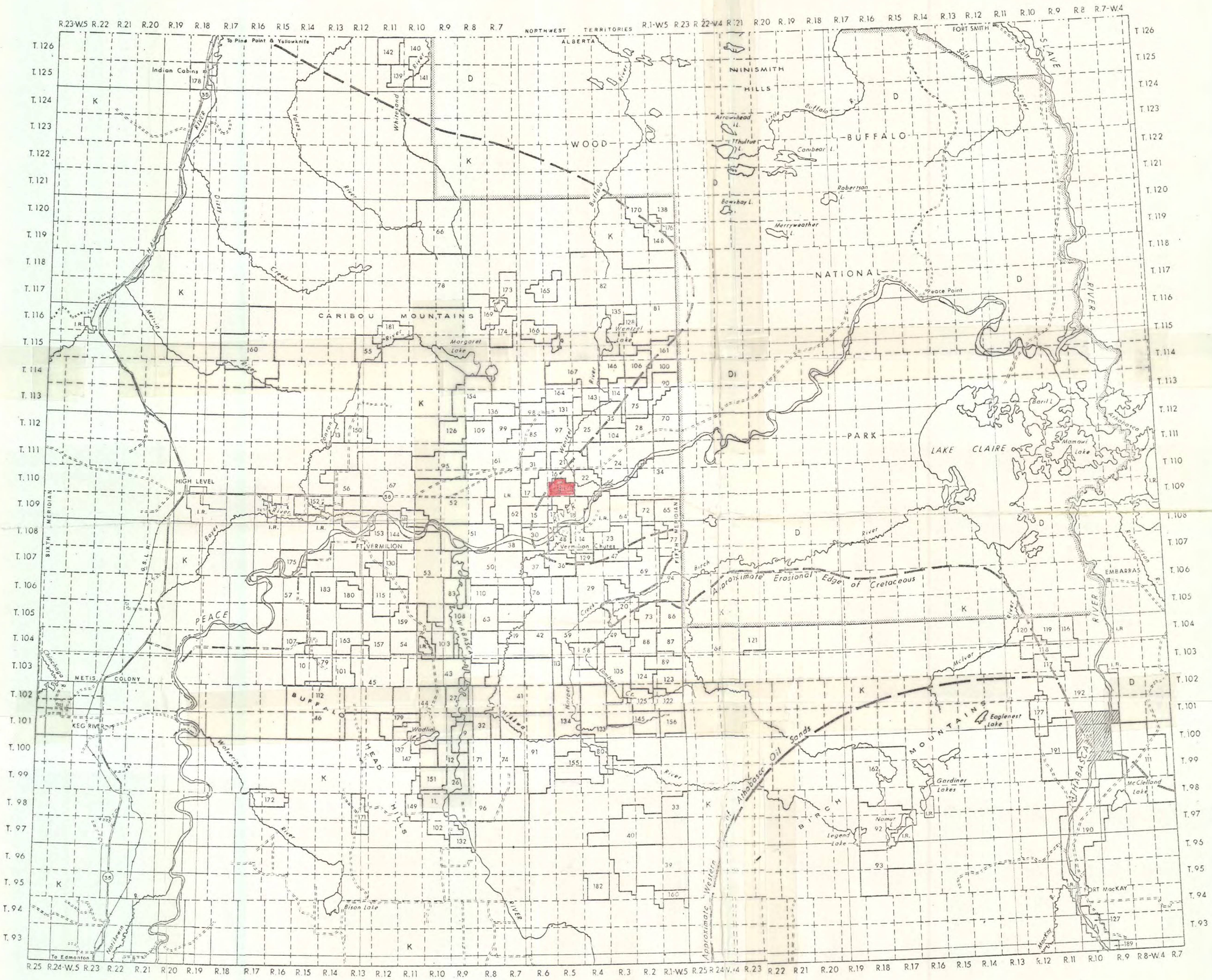
[redacted]

J.C. Sproule, P. Geol.

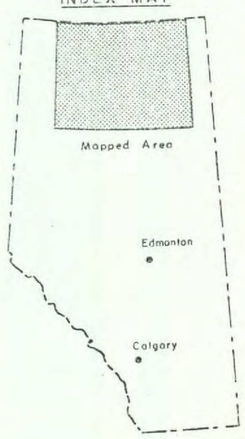
1009 Fourth Avenue S.W.,
Calgary 2, Alberta.
September 23, 1968.
VAF:JCS:ldl

SULPHUR PROSPECTING PERMIT No. 168





INDEX MAP



LEGEND

- K — Cretaceous Formations
- D — Devonian Formations
- 94 — Sulphur Prospecting Permits
- Subject Permit (No. 168)
- Highway - Gravelled
- All Weather Road - Gravelled
- Dry Weather Road - Dirt - Truck Trail

NORTH - CENTRAL ALBERTA

SHOWING

SULPHUR PROSPECTING PERMITS

16 0 16 32

SCALE: 1" to 16 MILES

Prepared for

QUINTANA PETROLEUM CORPORATION

NOTE: Permits as Published to: March 29, 196 (Data on later permits not yet available)

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1968/134 FIGURE - 1

T. 101

57° 45'

T. 100

57° 40'

T. 99

R. 10

111° 30'

R. 9 W. 4

AREA 1

AREA 2

AREA 3

AREA 4

AREA 5

1a 1b 1c 1d 1e 1f 1g 1h

168-1 168-2 168-3 168-4 168-5 168-6 168-7 168-8A 168-9A 168-10 168-11 168-12

168-A+1B

Plate I A

Plate I B

SSp

D

K

Qal

APPROXIMATE EROSIONAL EDGE OF CRETACEOUS

Redclay Creek

Firebag River

Athabasca River

Corral Creek

Dalkin I.

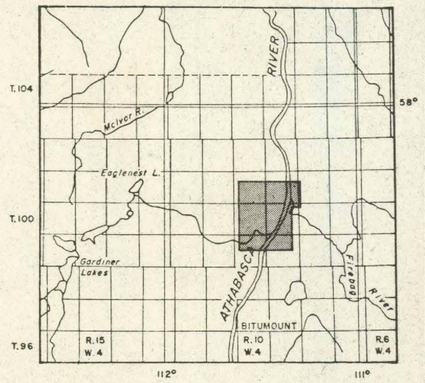
Lorna I.

Shot I.

Turlough L.

Boule Campsite

INDEX MAP



LEGEND

SURFICIAL DEPOSITS

Qal — Alluvium

Muskeg

BEDROCK FORMATIONS

K — Cretaceous (Undifferentiated)

D — Devonian (Undifferentiated)

PHOTOGEOLOGICAL SYMBOLS

Approximate erosional edge of Cretaceous

Alignment interpreted to indicate faulting or fracturing in bedrock

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

168 — Sulphur prospecting permit outline

SSp — Sulphur Spring

Sample Location

Area Recommended for Retention

PHOTOGEOLOGICAL MOSAIC

SULPHUR PROSPECTING PERMIT

No. 168

REDCLAY CREEK AREA

ALBERTA

PREPARED FOR

QUINTANA PETROLEUM CORPORATION

Mi. 1/2 0 1 2 3 Mi.

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

1968134 FIGURE # 2