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PRELIMINARY GEOLOGICAL REPORT AND PHOTOGEOLOGICAL STUDY

SULPHUR PROSPECTING PERMITS NOS. 138 TO 142

NORTHERN ALBERTA

Prepared For

Montclair Oil Ltd.

June, 1968

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INTRODUCTION

This report has been prepared at the request of Mr. Robert Sparrow, acting for Montclair Oil Ltd., hereinafter referred to as the "Company." The request made was for a photogeological analysis of the Company's Sulphur Prospecting Permits Nos. 138 to 142, inclusive, integrated with other available geological information. A sketch map, Figure 1, shows the general geological setting of the Company permits and their relationship to known sulphur occurrences in the area. Figure 2 presents the results of the 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 from the standpoint of the occurrence of sulphur. Such areas could then be examined in the field to determine the presence or absence of sulphur.

The five Sulphur Prospecting Permits involved in this report total approximately 99,200 acres.

BEDROCK GEOLOGY AND TOPOGRAPHY

Most of the area of the Permits concerned is located within the area underlain by Paleozoic (Devonian) rocks, although the Mesozoic-Paleozoic boundary passes from the northwest to the southeast corner of Sulphur Prospecting Permit No. 138, thus placing the entire southwest half of the Permit in the Mesozoic. From the standpoint of the regional occurrence of sulphur, therefore, these Permits are relatively well located (see Figure 1).

The Cretaceous rocks consist of shales, sandy shales and sandstones. The underlying Devonian rocks consist of limestones, dolomites, shales and evaporites. Outcrops of bedrock are sparse. Cretaceous rocks are poorly consolidated and bentonitic in character. Slumping is common in these sediments along the steeper slopes and stream cuts. The Devonian limestones and dolomites, beneath the unconformity present a relatively uniform surface, being competent and, therefore, resistant to normal erosion.

The bedrock in the general area, whether of Devonian or Cretaceous age, is overlain by a variable thickness of glacial till, glacio-lacustrine and recent deposits.

The general topography of the area has not been altered significantly by glaciation. Large topographic features, such as the nearby Caribou Mountains, represent pre-glacial erosional remnants rising abruptly from 1,000 feet to 2,000 feet above the surrounding lowlands.

The general area of the Permits is situated in broad lowlands with very little topographic relief, although Sulphur Prospecting Permit No. 138 is located at the base of the Caribou Mountains, on the northern flank.

MODE OF OCCURRENCE AND RELATIONSHIP OF SULPHUR TO GENERAL GEOLOGY

Within the general area of interest, 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 geological setting is quite similar to that which exists in the Fort Vermilion area where the sulphur play originated.

Surface outcrops of both Paleozoic and Cretaceous age are widespread but not numerous. No outcropping bedrock is evident from the photos within the Permit area. Outcrops may, however, be present. The number of faults and fracture lines indicates that the bedrock is in many places at or near the surface.

The bedrock, whether of Devonian or Cretaceous age, is overlain by a variable thickness of glacial and related sediments. The thickness of the glacial beds varies from zero to several hundred feet. The thickness is generally at a minimum in those areas where river valleys are deeply incised and greatest in the hilly portions of the area.

It is, at this time, not clear as to what extent the sulphur is developed in surficial deposits and to what extent it is present within the stratified deposits of the Cretaceous and/or Devonian, but it is believed that both modes of occurrence may exist. The most likely commercial deposits are, however, 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 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 slump, possibly because the slumping brings the combustible material, which may include sulphur, in contact with the surface. The original cause of the combustion is, at this time, purely conjectural, but lightning causing forest fires is the most likely source.

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 occurrences 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 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 million barrels of McMurray oil-in-place in the Oil Sands. This oil contains four percent to five percent sulphur (close to saturated) 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.

SURFICIAL GEOLOGY IN RELATION TO SULPHUR OCCURRENCE

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 (Bayrock, 1960)(1) and the average direction of flow in the subject area was to the west-southwest.

The 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 area.

As the glacier retreated, the lowland to the northwest was blocked by ice and meltwaters and could not drain freely. Extensive proglacial and super-glacial lakes were formed, resulting in the deposition of glacio-lacustrine deposits which vary in thickness from a few inches to 50 feet.

Several periods of still-stand of one of these Pleistocene lakes are suggested by R.S. Taylor (1960) from mapped deposits in the Peace River Valley. Three large areas of sandy aeolian and alluvial material, adjacent to the modern Peace River at elevations of approximately 1,400 feet, 1,100 feet and 900 feet above sea-level, are interpreted as deltas that have been partly reworked into dunes by wind action. The lowest occurring, and by far the largest, of these sandy deposits is in the subject area. It commences on the west side of the mapped area, near Vermilion Chutes, and extends to the northeast adjacent to the Peace River. It

(1) Names and dates in brackets are referred to in the Bibliography at the end of this report.

also covers most of the area south of the Peace River with the exception of some of the areas of higher ground. The eastern limits extend beyond the mapped area.

Present-day drainage was established soon after the lakes were drained and conforms generally to preglacial lowlands.

PHOTOGEOLOGICAL STUDY

WITH RECOMMENDATIONS FOR FIELD EVALUATION

Sulphur Prospecting Permit No. 138

The surface of the subject Permit is inclined gently to the northeast with the exception of two northwest-trending regional depressional features within which the principal areas of interest are located. Glacial till appears to cover a large part of the area. Numerous small intermittent tributary streams, cutting into the unconsolidated surface deposits, drain the area to the northeast where they intersect larger streams flowing in a general southeasterly direction. Forest cover throughout the Permit area is very light and is confined to the vicinity of drainage channels and to slight topographic highs.

Photo alignments, interpreted to indicate bedrock faulting or fracturing are the dominant structural features in the study area. A general northwest-southeast, fractured trend is present here. Developed along this fracture trend in the southwest and northeast parts of the Permit area are two depressional features which are currently inhabited by muskeg and a series of small lakes. From our present knowledge, we believe that these areas are the most favourable for the occurrence of sulphur and that such deposits are likely to be at or near the surface.

The following areas of special interest within Sulphur Prospecting Permit No. 138 are recommended for field examination.

'Area 1' is drained to the southeast but local undrained portions appear to exist. The line of small lakes occurring along the fracture (and fault?) trend is of some importance here in that they may be fed by springs. The entire 'Area 1' feature should be checked with special attention given to the three muskeg areas away from the main drainage channel.

'Area 2' is a large, poorly drained depressional area in the northeastern corner of this Permit. Fractures and/or faults are also well developed in this area.

The region between the two regional trends appears too well drained to be of much interest, at this time.

Sulphur Prospecting Permits Nos. 139 to 142

This group of four Sulphur Prospecting Permits is characterized by nearly level to depressional topography. Muskeg inhabits a major portion of the area, being interrupted only by a series of sluggish drainage channels flowing to the northeast. Major drainage of the general area is by way of the Whitesand River, which flows north to Buffalo Lake.

A number of small lakes occur within the boundaries of these Permits, but generally away from drainage channels. In most all cases, these lakes appear to drain into the channels and there is little evidence of surface run-off feeding into the lakes in appreciable amounts. It is possible that these bodies of water are, in part at least, due to the accumulation of spring flows.

Photo alignments, interpreted to indicate bedrock faulting or fracturing, are the dominant structural features in the area. The general direction of this fracture trend is northeast-southwest, which essentially parallels the Pine Point-

Hay River-Rainbow, etc. tectonic trend just to the northwest. Along this latter mentioned tectonic trend, in the Northwest Territories, the Pine Point lead-zinc deposits occur. The implication is that mineral-bearing solutions are controlled by large fault and/or fracture systems and that these solutions are capable of transporting, and under certain conditions, depositing enormous quantities of minerals.

The following areas of special interest within Sulphur Prospecting Permits Nos. 139 through 142 are recommended for field examination.

'Area 3' is located in the extreme southeastern corner of Sulphur Prospecting Permit No. 139. A number of small lakes occur in a depression that appears to have been inhabited by a larger lake at one time. It is recommended that this area be examined for evidence of sulphur in the lake bottoms and in lacustrine deposits in the immediate vicinity. Special attention should be given the southwest-trending fracture zones passing through the area.

'Area 4' in the southeastern portion of Sulphur Prospecting Permit No. 139, can be described as being similar to 'Area 3' and should be field checked. The mottled appearance of this feature on the mosaic is indicative of a "dried up" vegetation-filled lake. If any evidence of sulphur is encountered here, then those muskeg areas to the northeast and on the south side of the Whitesand River, should also be examined.

'Area 5' is located just southeast of the Whitesand River in Sulphur Prospecting Permit No. 141. This oval-shaped feature resembles a filled-in lake bed. The material on the surface appears to be alluvium, which supports some scattered vegetation. Field checking of this area should include some augering through the alluvial material.

'Area 6' is in the northern and central portions of Sulphur Prospecting Permit No. 140. Of interest here are several alignments of small lakes along fracture zones. A reconnaissance of this area should be made to determine if these lakes are related to spring flows. If springs are present, then additional work, including augering along fault trends, is recommended.

'Area 7' is located in the northwestern corner of Sulphur Prospecting Permit No. 142. On the photographs, this appears to be an area of springs that drain into a nearby stream.

In addition to the above areas of principal interest, many other muskeg and lacustrine features shown on the photomosaic should also be checked on the ground.

The subject Permits have an extensive cover of muskeg making local areas of interest somewhat more difficult to determine, however, a good fracture system is indicated by the strong photo alignments, and reasonably good evidence suggests the presence of springs. Although currently flowing sulphur springs are not mandatory for the presence of sulphur in an area, it is believed that they are reliable "shows" or indicators of possible deposits of this mineral.

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 in 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 Figure 2, a photogeological mosaic and Figure 1, a regional geological map.

In view of the above, it is recommended that a field check of representative localities within the subject Permits be made by a helicopter-borne geological crew. This crew should be prepared to conduct spot-sampling trenching and/or auger testing as the occasion demands. We are, however, not yet prepared to recommend that the Company conduct the full detailed field geological survey described in our letter of February 6th. It is proposed rather that the Company authorize the preliminary field check referred to above at a total cost of $750 per permit for each of the five permits. The results of that preliminary field work will then inform the Company as to whether or not a full-scale field operation should be proceeded with. If the preliminary results do not indicate that further work should be done, it would then be recommended that the Company apply immediately for return of their $2,500 deposit in each of the Permits for which abandonment is indicated.

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[redacted]

V.A. Farley

[redacted]

J.C. Sproule, P. Geol.

1009 Fourth Avenue S.W.,
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June 29, 1968.
VAF:JCS:ldl

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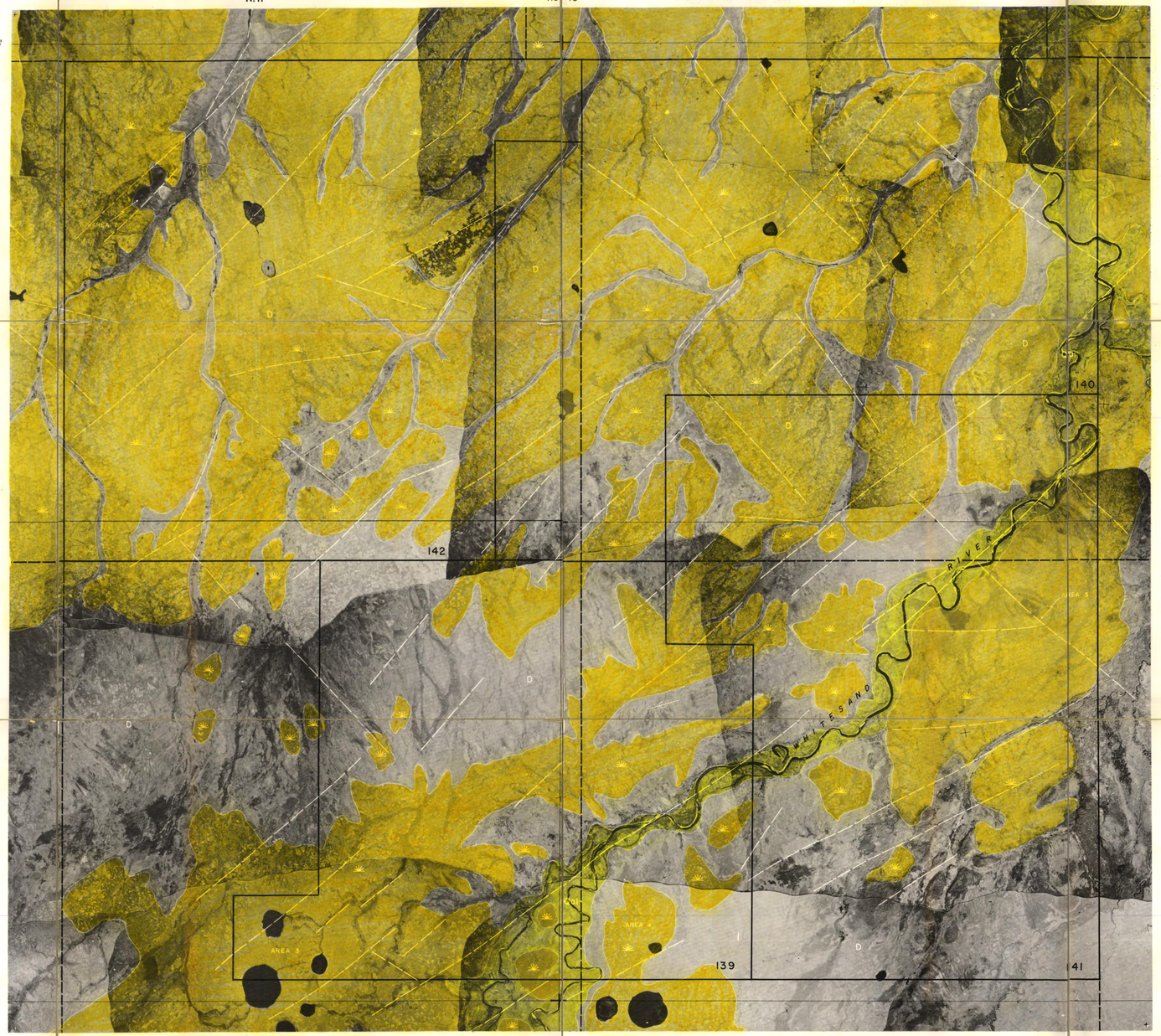
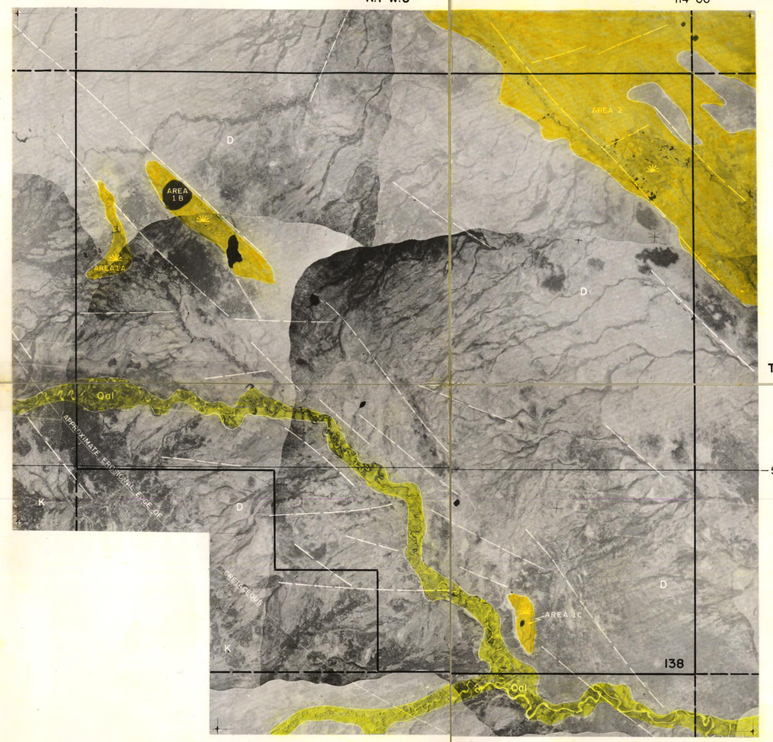
To accompany Report to Montclair Oil Ltd., June 1968





T. 125

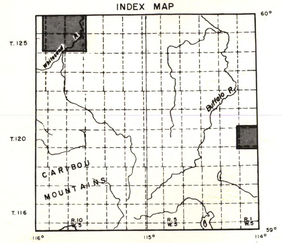
LEGEND

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
- 21 — Sulphur prospecting permit outline

INDEX MAP



PHOTOGEOLOGICAL MOSAIC
SULPHUR PROSPECTING PERMIT
Nos. 138, 139-142

WHITESAND RIVER AREA
ALBERTA

PREPARED FOR
MONTCLAIR OIL LTD.

MI 1/2 0 1 2 3MI

APPROXIMATE SCALE IN MILES

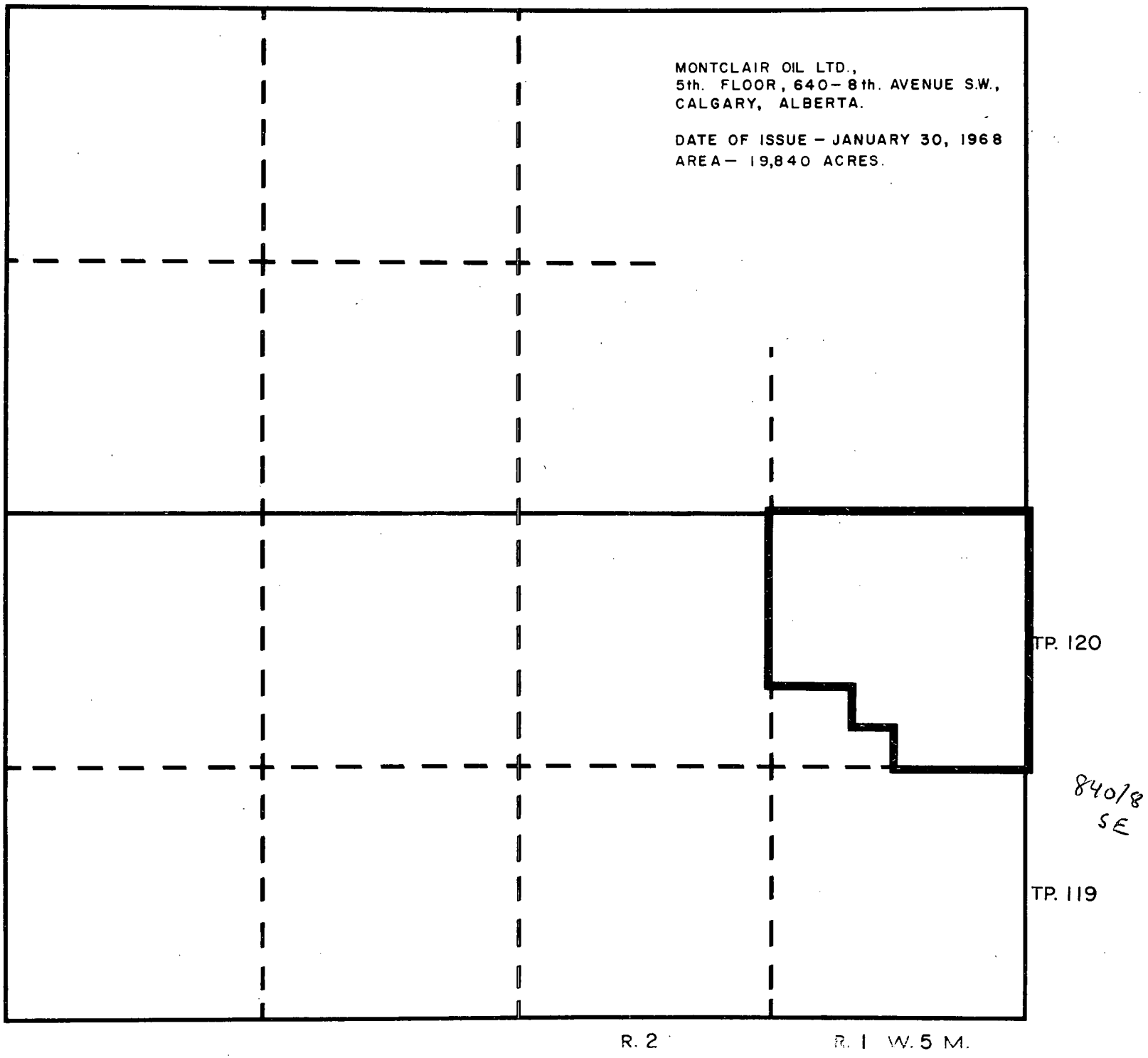
THIS IS A SEMICONTROLLED MAP-MOSAIC AND SHOULD NOT BE MISTAKEN FOR AN ACCURATE GEOGRAPHIC BASE

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

JUNE 1968

1968120 FIGURE 2

SULPHUR PROSPECTING PERMIT No. 138



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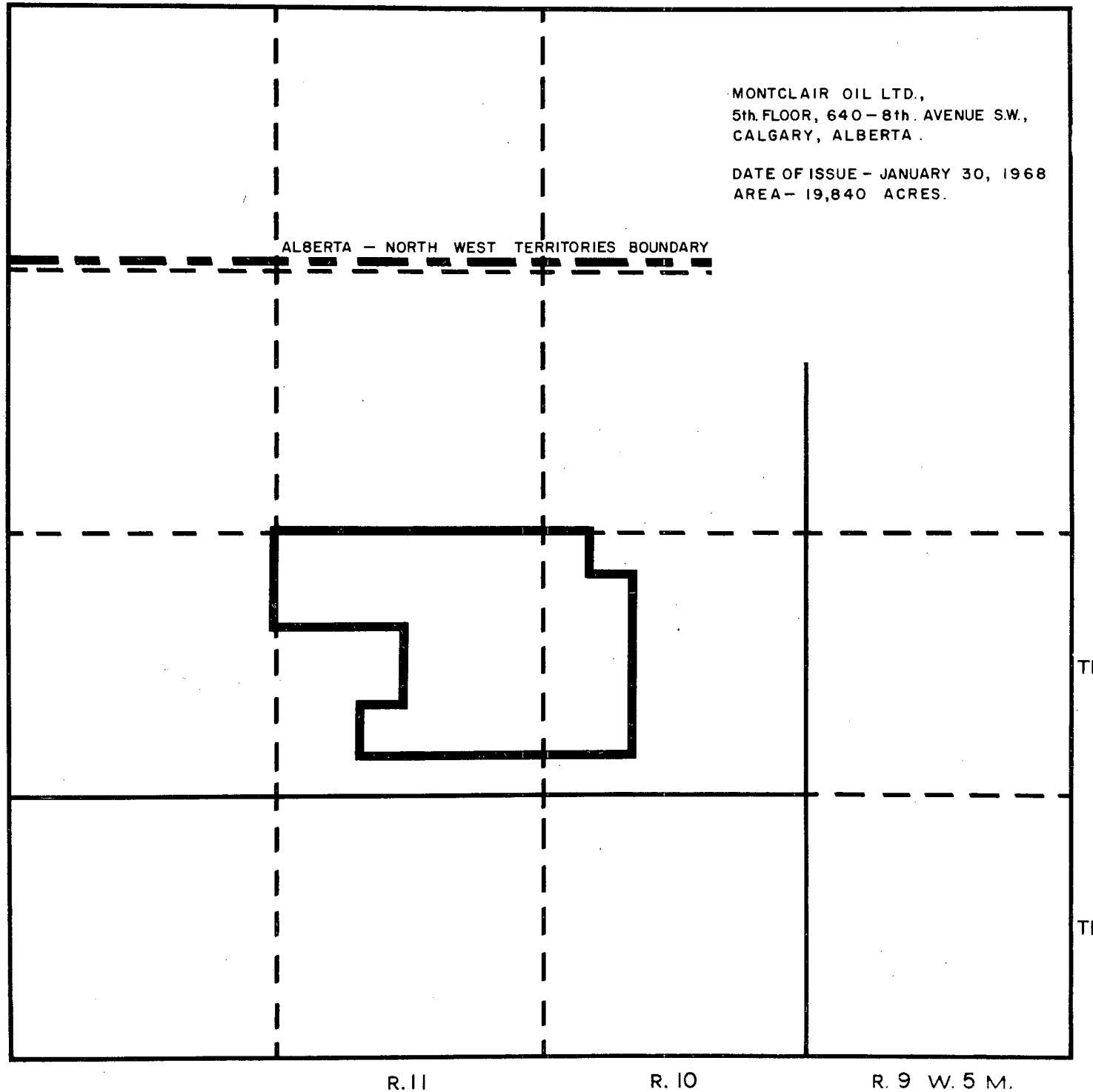

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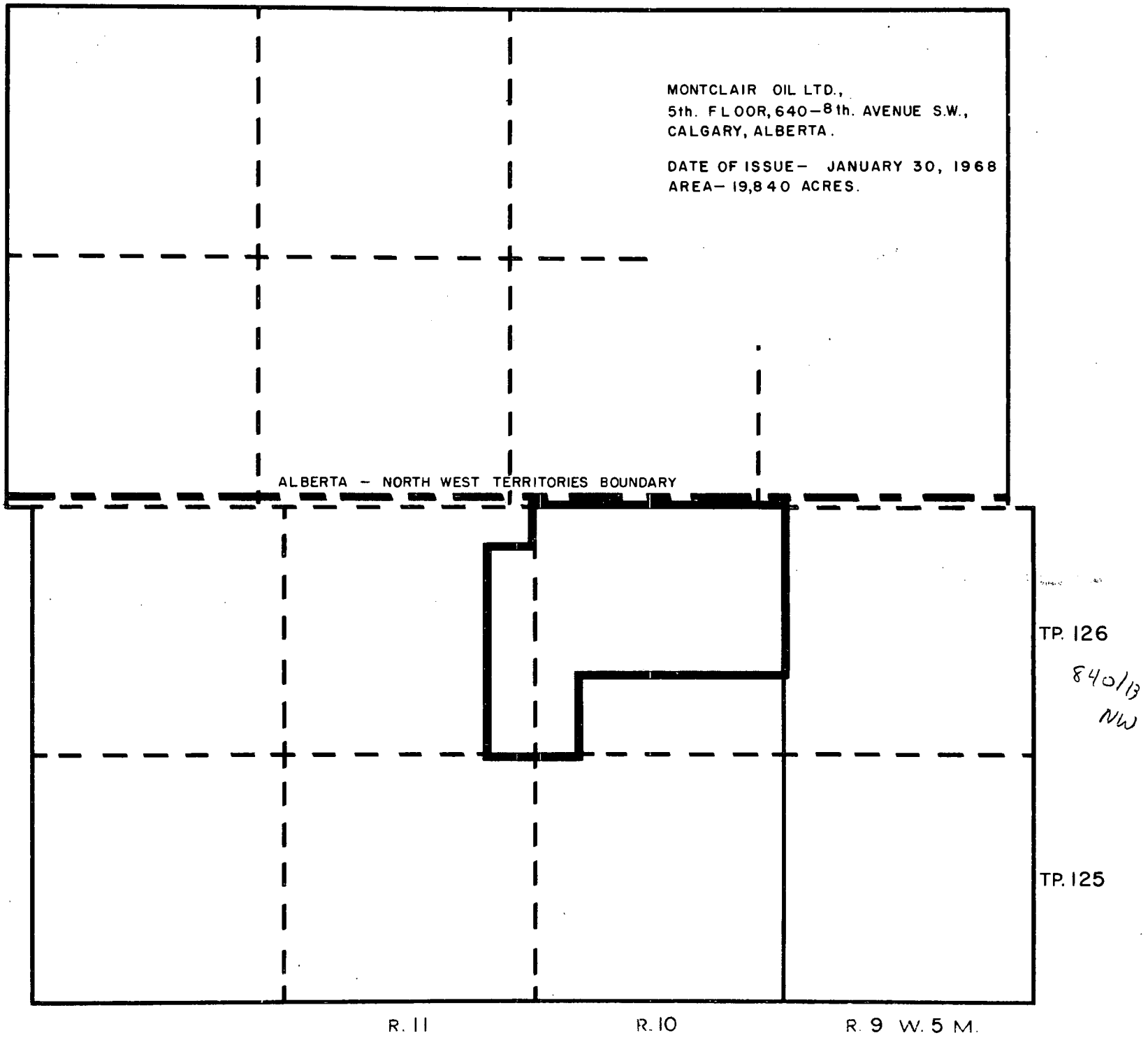

840/13
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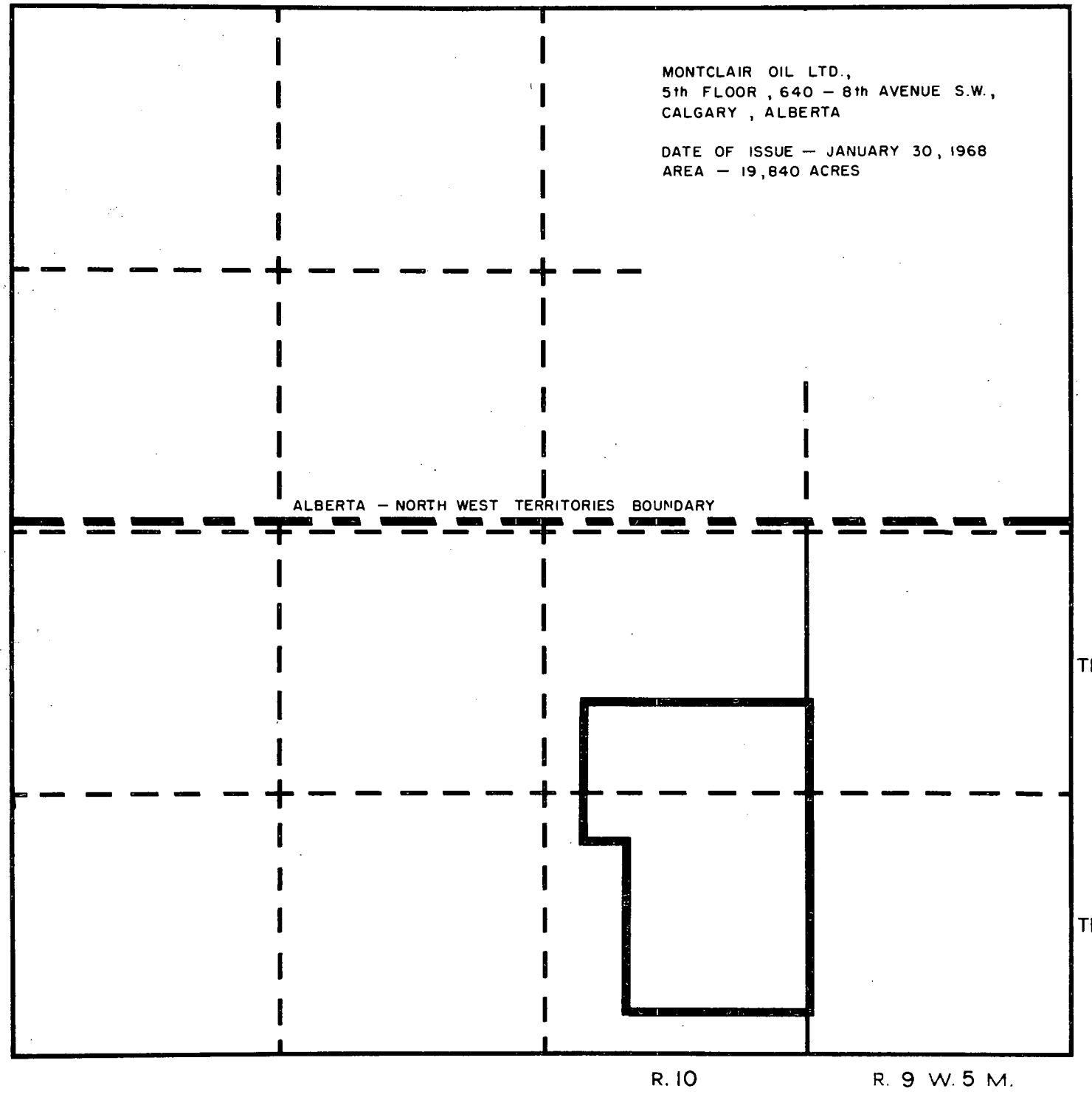

84 O/13 NW.

SULPHUR PROSPECTING PERMIT No. 142