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EVALUATION

of

SULPHUR PROSPECTING PERMITS 133 and 134

FORT VERMILION AREA, ALBERTA

Prepared By

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1968

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FORT VERMILION AREA, ALBERTA

INTRODUCTION

Reports of a discovery of elemental sulphur at or near the surface began circulating in western Canada during the late summer of 1967. The location of the discovery at that time was unknown although it was indicated to be in the north country. Some people indicated that it was in the southern part of the N.W.T. and considerable effort was initiated to verify the reports. However, as more concrete information became available the area of interest appeared to center about the Fort Vermilion area of north-central Alberta. Records show that Sulphur Prospecting Permit #8 was issued to J. J. O'Connor on September 29th, 1967 covering some 19,840 acres centered about Tp. 110, Rge. 5 W/5M. Permit #8 covers the reported discovery in Section 8 of Tp. 110, Rge. 5 W5M. Additional sulphur prospecting permits were acquired shortly thereafter. By the end of 1967 approximately 60 permits had been issued in the general Fort Vermilion area. The rush continued and by the first of March, 1968 more than 175 permits had been issued covering 5-1/2 million acres.

Little hard, factual data on the discovery has been released to the public nor have many details been made available. Much of the information has been derived through rumours and innuendo. Information released by operators in the area has been meagre. Study of information published in Oilweek, Nickle's Daily Oil Bulletin and the Northern Miner suggests that native sulphur is at or near the surface at several places on Permit 8 and appears to be associated with flat-lying beds. Several pits and 200 nine-foot-deep auger holes outlined the sulphur deposit over an area measuring 1,400 feet by 1,400 feet closing off only one side of the deposit. The thickness of the deposit has not yet been established. Assay results have indicated a sulphur content ranging up to 90%. However, some reports infer high grade areas appear small and may not be economically feasible for exploitation under present production techniques. Nevertheless, considerable exploration work and interest is present in the area.

The reaction to reports of the sulphur discovery varied. Most people and organizations appear to have maintained an open mind and believe insufficient facts and information are available at present to make a sound judgment at this time. Considerable evaluation work must be done before a definite conclusion can be reached.

This preliminary investigation portrays the local geologic setting of Permits 133 and 134 and also the setting of some other known surficial occurrences of sulphur. The results of the evaluation are incorporated into the accompanying map which attempts to predict possible locations of other deposits. The evaluation also offers some concepts dealing with the origin of the deposits and presents recommendations concerning future evaluation work.

A photomosaic showing an interpretation of areal geology and an analysis of the terrain was prepared at the scale of 1" to 1 mile to cover the area of interest. It extends from Tp. 100 to Tp. 105, Rge. 2 to 5, W5M. The area covered by the map consists of about 1,000 square miles.

The areal geologic interpretation was based on examination and interpretation of air photography and air photomosaics that were acquired from the Provincial government. Topographic

maps and published geologic maps were also examined. The map shows the interpreted distribution of bedrock which is mantled at most places by extensive deposits of glacial drift. The mapping also shows several other features such as distinctive alignments (which may indicate fractures or faults), location of outcrops of bedrock and exposures of surficial deposits. Other special features are shown as indicated in the legend of the map. The map also incorporates the results of some geologic observations made along Harper and Lambert Creeks in January, 1968.

The Fort Vermilion area is located in north-central Alberta about 250 miles north of Edmonton. The area is reasonably accessible and an all-weather gravel road reaches the settlement of Fort Vermilion located on the Peace River located about 40 miles west of the discovery on Permit No. 8. Regularly scheduled commercial airline service by PWA operates three times a week between Fort Vermilion and Peace River.

REGIONAL GEOLOGIC SETTING

Physiography

The Fort Vermilion area lies in the Interior Plains located between the Precambrian Shield to the east and the Cordilleran belt to the west. The area has been subjected to multiple continental glaciation. The landscape consists of two main subdivisions which are made up by a low-lying plain, through which the Peace River flows, and plateaus which rise abruptly above the plain. Permits 133 and 134 lie within the plain. Topographic elevations in the vicinity of the permits range from about 1,200 to 1,500 feet. Little variation in local topographic relief exists except along some of the streams which have been incised below the level of the plain. Although the plain is moderately drained in places, lakes, swamps, muskegs and bogs are common in many parts. Rock outcrops are very scarce because bedrock is mantled by a variable thickness of glacial drift. Some outcrops were observed in the field in the vicinity of Tp. 106 and 107, Rge. 2 W5M, north of permits 133 and 134.

Stratigraphy

Consolidated sediments in the Fort Vermilion area consist of Paleozoic clastics, carbonates and evaporities which are mainly Devonian in age. The Paleozoic assemblage is overlain unconformably by Cretaceous clastics. The Paleozoic section ranges in thickness from about 2,500 to 3,000 feet. The Cretaceous System is made up of shale and sandstone which is about 500 to 600 feet thick in the vicinity of the permits. However, it thins to a thin edge and disappears northeast of the permit acreage where the ancestral Peace River drainage system removed the Cretaceous cover during late Tertiary time prior to the Pleistocene Epoch. In this area Upper Devonian carbonates of the Grosmont and underlying Mikkwa Formations are interpreted to form bedrock. A small area of Upper Devonian shale is mapped in the extreme northeast corner of the map. Although a detailed discussion of the stratigraphy is beyond the scope of this report, the accompanying stratigraphic log of the Hudson's Bay Fort Vermilion No. 1 well, located in lsd 15, sec. 32, Tp. 104, Rge. 8, W/5M a few miles west of the project, illustrates the stratigraphic nomenclature, age, lithology and thickness of the stratigraphic section.

Structure

The Fort Vermilion area lies in the Interior Plains structural province where beds are relatively undisturbed. Paleozoic strata strike regionally to the north-northwest and dip very gently to the southwest at about 25 feet per mile. Overlying Cretaceous beds are almost flat-lying and dip regionally to the southwest at rates of 5 to 10 feet per mile. Local structures are probably present. One should expect high angle faults, probably related to basement trends, gentle tectonic flexures, compaction folds over reefs or irregularities on unconformities and solution-collapse structures.

Some distinctive alignments were mapped during the evaluation. They are shown on the accompanying areal geologic map by heavy lines labelled DA. These alignments may indicate faults or fractures. Two dominant trends are apparent: northwest and northeast. Three long persistent alignment trends suggest the possibility of basement faults in the southeast corner of the project area. These alignments cut across the southern part of Permit 133.

CHARACTERISTICS, ORIGIN, PRODUCTION and USEAGE of SULPHUR

Sulphur is frequently recognized by and associated with its bright sulphur-yellow color. However, it can be straw and honey-yellow, yellow-brown, yellow-grey and, in fact, greenish and reddish. It is relatively light and rather brittle. It is a nonconductor of electricity and a poor conductor of heat. Sulphur melts at 108° C. and burns at 270° C. with a bluish flame yielding sulphur dioxide gas. It is insoluable in water and not acted on by acids, but is soluble in carbon disulphide.

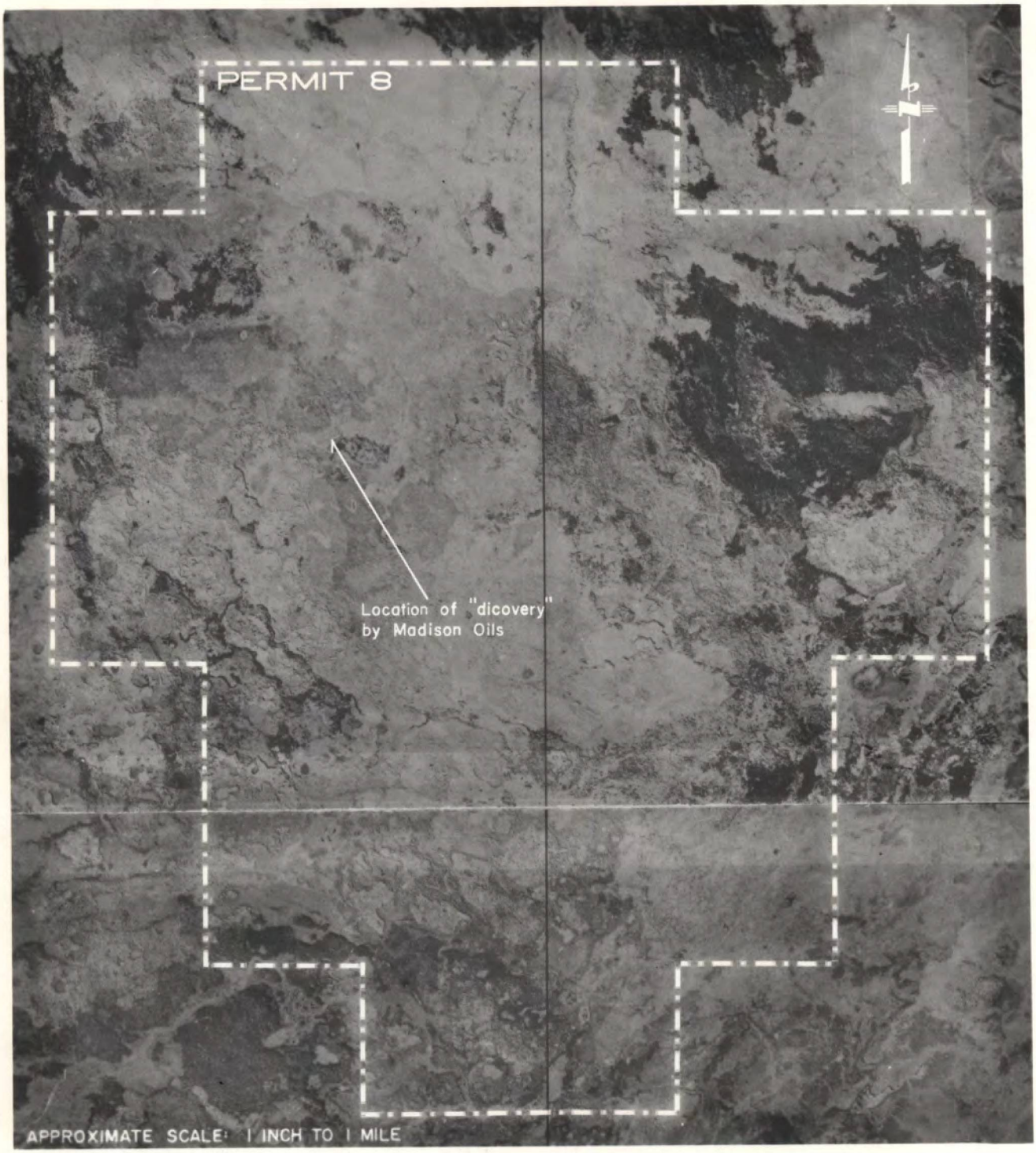
Elemental sulphur originates in various ways. It is frequently associated with volcanic activity and occurs in gases emanating from fumeroles. Sulphur is deposited directly by sublimation or the incomplete oxidation of hydrogen sulphide gas being given off. Sulphur may also be associated with thermal spring waters and derived either from volcanic sources or by the reduction of sulphates, especially gypsum, which is aided by certain bacterial action. Sulphur may also be formed by decomposition of metallic sulphides. Sulphur is produced by the living action of some bacteria. Some

believe sulphur can originate from cold groundwaters carrying sulphate and hydrogen sulphide through certain geo-electro-chemical processes.

Commercial production of elemental sulphur has a long history. Prior to the 1800's most sulphur was derived by hand picking from volcanic deposits and was used in medicines and gun powder. Demand for sulphuric acid in the 1800's accounted for its increased production from the metallic sulphide, pyrite. The recovery of sulphur from natural gas and other hydrocarbon deposits has recently become a very important source of elemental sulphur. Pilot studies in Texas have achieved some encouragement in the production of sulphur from gypsum deposits.

Elemental sulphur deposits are relatively widespread and are mainly volcanic or sedimentary in origin. They contain sulphur in varying concentrations up to about 75%. Native surficial deposits usually are worked by normal mining methods and, when not amenable to Frasch techniques, sulphur is recovered by a variety of processes involving either burning, distillation, floatation, melting or solvent extraction. In any case, most processing techniques developed todate eventually require the use of heat. Commercial deposits and production occur in Sicily, Italy, Central and South America, Japan and in the United States. More than three-fourths of the sulphur produced today goes into the manufacture of sulphuric acid which is used largely in the production of fertilizer. Many other uses for sulphur exist.

PLATE I



AIR PHOTOMOSAIC

of

Sulphur Prospecting Permit No.8

SULPHUR OCCURRENCES

in the

FORT VERMILION AREA, ALBERTA

The presence of sulphur at or near the surface in the Fort Vermilion area has been known for a long time. The Indians were probably the first to have been aware of the presence of sulphur associated with a great number of gassy, salty cool water springs that are known in parts of the area. Some of these were observed during the field work done in January, 1968 along Lambert and Harper Creeks (see Plates 3 and 4). The local population in the Fort Vermilion area have referred for years to Harper Creek as "Stinking River" because it is polluted along part of its course due to the emanation of gassy sulphurous salty waters into it. Stream gravels and boulders are coated with a thin deposit of sulphur. The presence of these deposits have been common knowledge for years to many individuals.

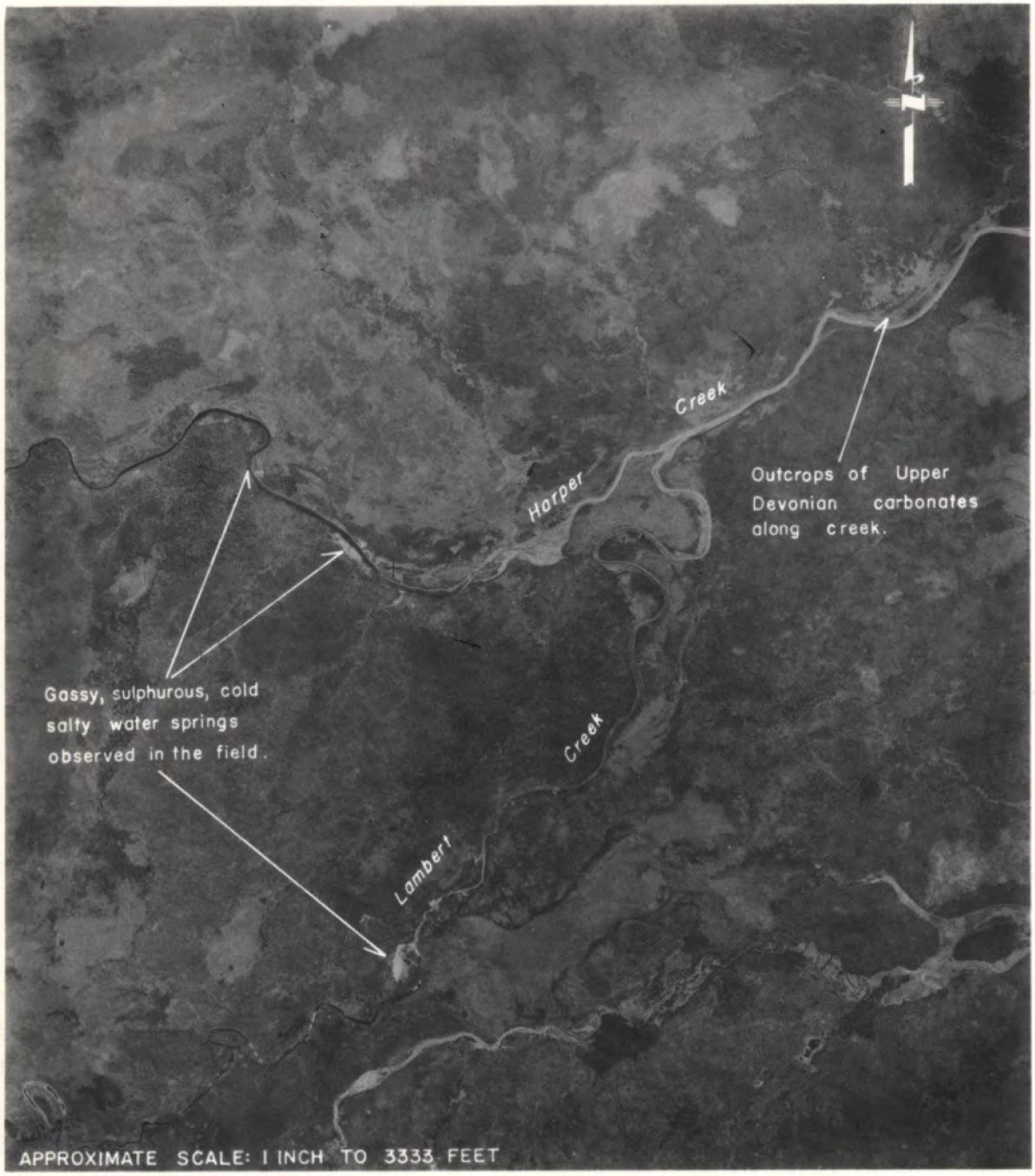
One of the most publicized occurrences is located on Sulphur Prospecting Permit No. 8 in the northeast corner of section 8, Tp. 110, R. 5 W5M. Snow covered much of the area around the "discovery" location during the field work in January. Consequently, details concerning the precise geologic setting of the "discovery" must await investigation in the spring. However, Plate 1. shows the general setting. Plate 1. is part of an air photomosaic at the scale of 1 inch to 1 mile showing the location of the "discovery". It is situated in flat-lying terrain and appears associated with a muskeg-like area. Parts of the land are moderately stocked by trees and bush although scattered bare patches are present. At first glance very little is apparent to distinguish the location of the deposit as it appears on government vertical air photographs. However, its relation to the muskeg is interesting. Closer inspection of air photographs shows several very light-toned patches of ground and potholes and this could be significant.

According to published reports (OILWEEK, Dec. 18,1967), the "surface deposit about 40 miles' northeast of Fort Vermilion was burning in a large pit-like area". The report stated more

than 150 shallow auger holes were drilled to a maximum depth of 9 feet in an area covering approximately a quarter section (160 acres). The shallow holes define the limit of the deposit on one side. Assays of samples from the area reportedly showed sulphur content ranging from 35 to 89% with no serious impurities. The deposit was covered with overburden of clay and gravel ranging from approximately 6 inches to 2 feet in depth. The bottom of the deposit was not reached by the holes drilled.

Another area containing known occurrences of sulphur at the surface is located in the Harper and Lambert Creek areas in Tp. 105 and 106, R. 3, W5M. The sulphur appears associated with several gassy, sulphurous, salty water springs. The locations of those confirmed in the field during January are shown on the accompanying areal geologic map. Several other suspected locations were observed from a helicopter over a broad area but they could not be verified because of snow cover. A water analysis of a selected spring sample showed the spring water to be salty having an abundance of Na and Cl elements but a low sulphate content. However, some hydrogen sulphide gas appears to bubble to the surface at some springs, as at this locality. The elemental sulphur may have been brought to the surface and derived from the hydrogen sulphide gas. An analysis of a grab sample of surficial deposits associated with the area in section 36, Tp. 105, R.3 W5M can be summarized as follows: it consists of a pale yellow-grey unconsolidated and crumbly assemblage of multisized particles and balls of clay and silty material. The assemblage provides a slight sulphurous odor. When ignitied it burns with a rich royal blue flame and gives off a strong acrid sulphurous smell. A microscopic examination and assay carried out by Core Laboratories-Canada Ltd. revealed the presence of chert, mica, quartz and feldspar. These rock minerals are distributed throughout the material from grain to pebble diameters, and the particles show the result of water or glacial erosion. A small amount of deposited calcite was also present. Elemental sulphur present was deposited by water action as a halo effect upon the surface of the rock particles. A screen test on the sample yielded the following:

PLATE 2



AIR PHOTOGRAPH

of

Harper—Lambert Creeks Area

Elemental Sulphur

Pebbles	5.5% (not assayed for S.)		
Plus 20 Mesh	66.5%	----------	31.9%
Plus 40 Mesh	18.2%	----------	26.9%
Minus 40 Mesh	9.8%	----------	36.1%

Elemental sulphur content of sample --- 28.8% (calculated)

Most of the sulphur occurrences visited in the field are circular to the elliptical in shape and from 200 to 1,000 feet in diameter. The associated spring water appears clear, cold and salty. Bubbles of hydrogen sulphide and methane gas are associated with some of the springs; sulphur and bitumen material are deposited around the edges of the springs, and all boulders, pebbles and alluvial particles are coated with sulphur. Other surface features, which probably represent dried-up springs, were seen.

The location of the springs and associated sulphur deposits visited in the field can be recognized on air photographs. (See Plate 2.) They are indicated on the accompanying areal geology map in Tps. 105 and 106, R 3, W5M. The areas appear as very light toned patches on air photographs and are practically devoid of vegetation. Some appear associated with small muskegs or bogs. Several somewhat similar appearing features can be identified on air photographs in the vicinity, but these have not been verified in the field. However, they are shown on the accompanying areal geologic maps by special symbols. Some of these features appear to have game trails leading to them, and it is visualized that animals in need of salt visited these areas. The anomalies should be examined in the field to determine the presence or absence of sulphur. Other surface anomalies which are either unusual or appear to have some of the characteristics similar to known or suspected springs and sulphur occurrences are shown on the map by other special symbols.

Reports of other sulphur occurrences in the Fort Vermilion area have not been accompanied by information describing their nature nor precise location. Consequently, they have not been verified at this time. Inferences indicate they may be located in

areas where Cretaceous strata are interpreted to form bedrock. As more data become available, each occurrence should be studied to determine its geologic setting.

Observations todate indicate that some of the surficial sulphur occurrences in the Fort Vermilion area are associated with gassy sulphurous, salty water springs which emanate at the surface. It is conceived that this process has been more or less continuous over a long period of time but has been variable as to geographic location.

Several possible origins for the gassy springs are visualized. It is possible that the waters and associated gas originate from porous zones in Upper Devonian carbonates of the Grosmont and Mikkwa Formations where they rise to the Paleozoic surface in the area where Cretaceous cover has been removed. An allied concept is that some waters could have risen to the sub-Cretaceous unconformity and then migrated updip to the northeast and be emanating in the vicinity of the Cretaceous-Devonian boundary. Another contention is that faults and fractures play a fundamental role and permit the ascent of formation waters, either from Upper Devonian carbonates, Middle Devonian carbonates or the evaporites of the Elk Point Group. Waters that had access to the evaporites of the Elk Point Group could contain large amounts of calcium sulphate.

Insufficient information and facts are available to determine the true cause of the emanations. At present emphasis should be placed on examining the outcrop bands of the Upper Devonian carbonates because two of the known and reported surface sulphur occurrences overlie the outcrop belt of these rocks. Thus, a sulphur producing process, whatever its origin, is currently active, has been confirmed in the field, appears to be operating at various spots over an area of several square miles and is suspected over a much broader area.

If one visualizes that gassy, sulphurous salty waters have been emanating from Upper Devonian beds and principally the carbonates of the Grosmont and Mikkwa Formations, the process could have been going on periodically over a long period of time: ever since the removal of Cretaceous cover during the Tertiary Period. Evidence shows that Cretaceous cover had been removed prior to glaciation. Thus, Upper Devonian strata

have been exposed to atmospheric pressure at least since the late Tertiary when the emanation process could have originated. One can visualize sulphur forming at the bedrock surface at that time. As one area became clogged and choked, other gassy springs could have broken through elsewhere. Thus, a thin, patchy, but fairly extensive deposit of elemental sulphur could have formed at the pre-Pleistocene bedrock surface. Pleistocene glaciation could have disturbed and eroded part of the surficial sulphur and dispersed and scattered it depositing sulphur elsewhere intermixed with glacial drift. This could account for small local deposits dispersed in the drift. However, it is highly probable that some protected areas were not subjected to glacial scouring and remnants of the original surficial sulphur rest on bedrock in scattered places along a belt extending from Tp. 103, R. 1 to 4, W5M northwesterly to Tp. 110, R.4 to 7, W5M. During and following deglaciation, the process has probably reocurred more or less continuously but at different geographic locations and at different times. Thus, one could anticipate encountering sulphur deposits in a variety of places not only at the surface but at different levels within the glacial drift and on bedrock itself at depths ranging up to 150 feet.

CONCLUSIONS and RECOMMENDATIONS

The presence of native sulphur at the surface in the Fort Vermilion area has been verified. Evidence shows that at some places it is widespread and associated with gassy sulphurous salty water springs. Speculation suggests that it could be encountered, not only at the surface but at depths up to 150 feet resting directly on bedrock. Thus, field work should be undertaken to examine indicated surface anomalies and exposures. Those anomalies indicated on the accompanying map in Permits 133 and 134 should be examined in the field to determine the presence or absence of sulphur. Some of these anomalies are associated with distinctive alignments which could be indicating fractures. Fractures would offer avenues for the migration of gassy subsurface waters and the development of surface springs. Those surface features which offer some encouragement should be drilled in order to map the distribution, thickness and determine the grade and concentration of any associated sulphur. If sufficient volume of sulphur can be proved, then an economic solution to the recovery and transportation by established or new techniques revealed by research and development is warranted.

Respectfully submitted,

V. ZAY SMITH ASSOCIATES LTD.

[redacted]

George M. Collins, P. Geol.

Plate 3

Plate 4

Gassy, sulphurous, salty cold water springs along Lambert Creek in Tp. 105, R 3 W5M. Yellow cast on alluvium caused by associated sulphur.

Plate 5

Plate 6

Outcrops of nearly flat-lying carbonates of Mikkwa Formation (Upper Devonian) along banks of Harper Creek in Tp. 106, R 2 W5M.

LEGEND

FORMATIONS

CRETACEOUS	K	Loon River and younger; shale and sandstone.
UPPER DEVONIAN	Du	Upper Devonian undivided; (may be Cretaceous)
	Dg	Grosmont: dolomite.
	Dmu	Mikkwa, upper member: limestone and shale.
	Dml	Mikkwa, lower member: limestone.
	Ds	Shale unit: calcareous shale.

GEOLOGICAL SYMBOLS

- Active gassy sulphurous salt water spring associated with surficial sulphur deposit.
- Possible active or inactive spring, interpreted from air photographs.
- Surficial anomaly interpreted from air photographs; warrants investigation in the field.
- FOP — Field observed published dip.
- Horizontal bedding.
- Gentle dip based on geomorphic evidence.
- FO — Field observed.
- DA — Distinct alignment.
- Glacial lineation indicating direction of ice movement.
- Shore line.
- Formational contact.
- X — Probable bedrock outcrop.
- X — Probable exposure of surficial deposits.

CULTURAL AND TERRAIN SYMBOLS

- Road or trail
- Town
- Village or settlement
- Exploratory well; dry and abandoned
- Muskeg, swamp, bog and wet low-lying land area; usually covered by low bush. Accessibility difficult when not frozen during winter months.
- Permit outline

INDEX MAP

AIR PHOTOMOSAIC

SHOWING

AREAL GEOLOGY AND TERRAIN ANALYSIS

OF

SULPHUR PROSPECTING PERMITS 133 & 134

IN THE

FORT VERMILION AREA

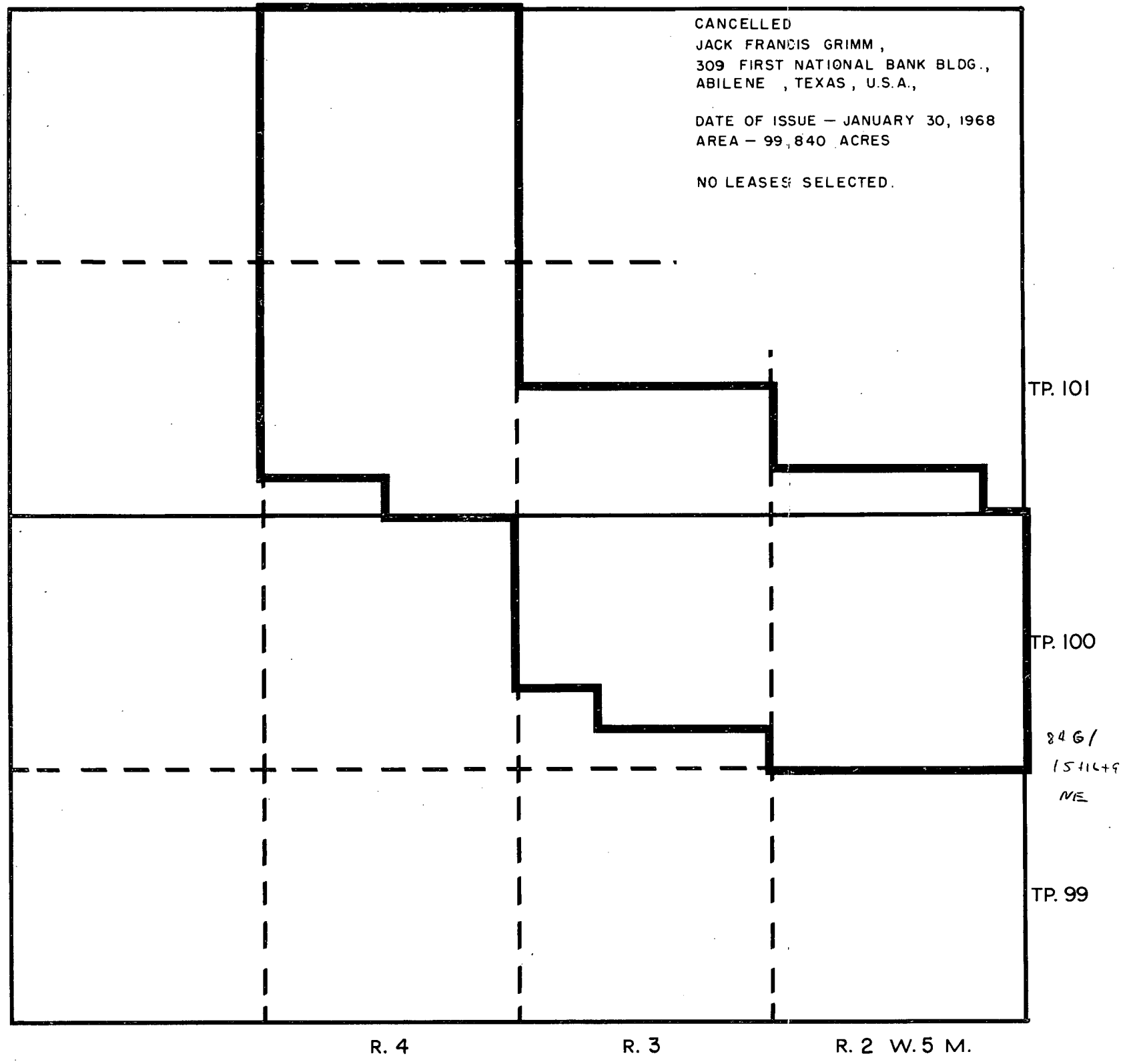
ALBERTA

SCALE: 1 INCH TO 1 MILE

Prepared by

19680115
Map No-1

SULPHUR PROSPECTING PERMIT No. 133



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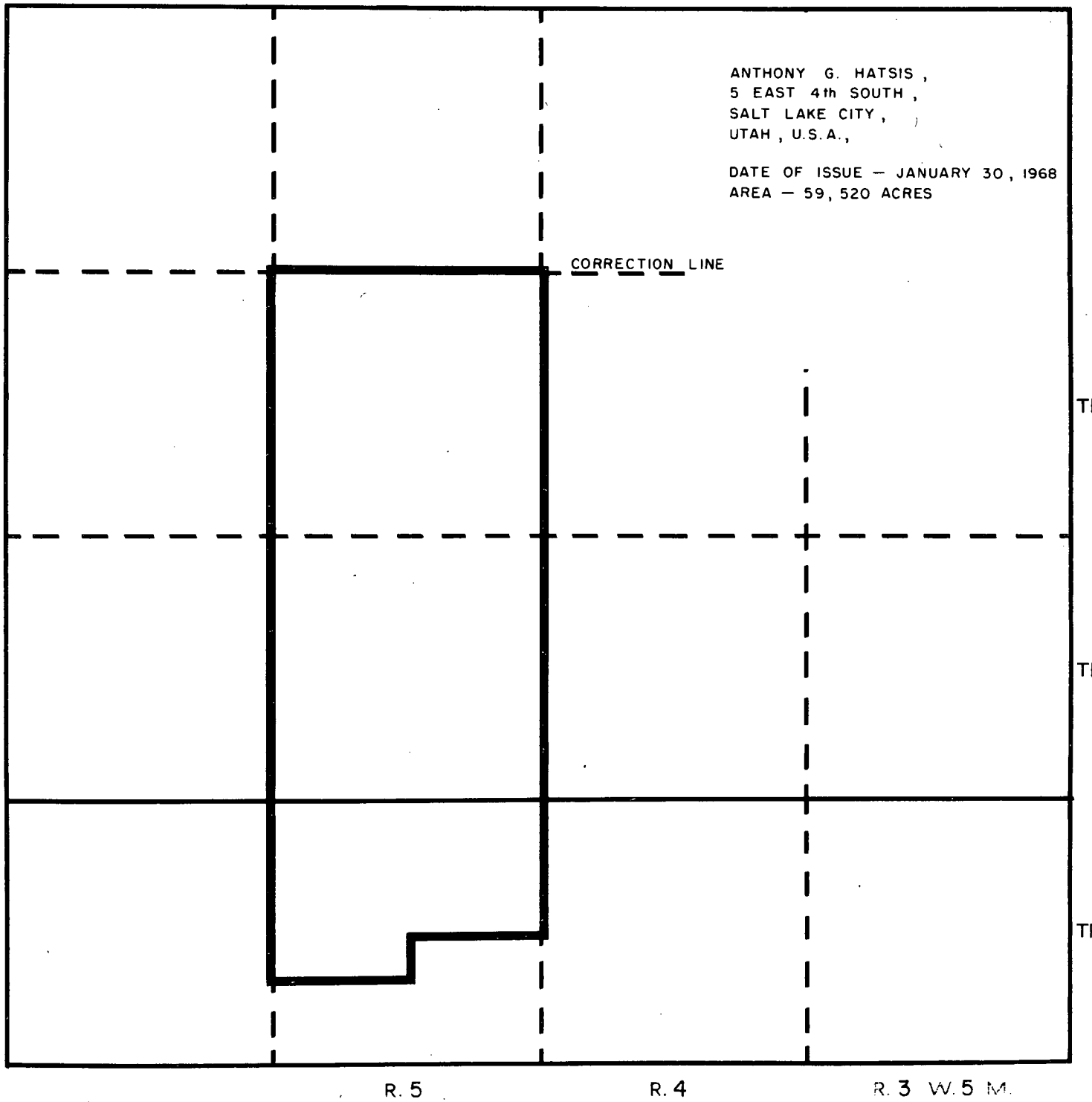
NE

SULPHUR PROSPECTING PERMIT No. 134



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