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SUPPLEMENT TO

PRELIMINARY GEOLOGICAL REPORT

SULPHUR PROSPECTING PERMIT

MIKKWA RIVER AREA

NORTH-CENTRAL ALBERTA

19680085

Prepared for

A. Andrekson

April, 1968

J. W. Worobec
Geological Consultant

October 15, 1968

Eugene T. Hall

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PRELIMINARY GEOLOGICAL REPORT

SULPHUR PROSPECTING PERMIT #91

Mikkwa River Area North Central Alberta

Prepared for Alexander Andrekson, Edmonton, Alberta

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INTRODUCTION

This report has been prepared at the request of Mr. Alexander Andrekson, the present holder of sulphur prospecting permit #91. This permit, covering a total of 99,840 acres, was issued on January 11, 1968. Winter conditions did not permit a preliminary field examination of the properties; therefore, this report covers only that information available from the published and unpublished data.

The property is described as follows:

(A) Township 99 Range 6 West of the Fifth Meridian

1. Sections 3 to 11, inclusive
2. Sections 14 to 23, inclusive
3. Sections 26 to 35, inclusive

(B) Township 100 Range 6 West of the Fifth Meridian

1. Sections 1 to 36, inclusive

(C) Township 101 Range 6 West of the Fifth Meridian

1. Sections 1 to 36, inclusive

(D) Township 99 Range 7 West of the Fifth Meridian

1. Section 36

(E) Township 100 Range 7 West of the Fifth Meridian

1. Sections 1, 2, 3

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2. Sections 10 to 15, inclusive
3. Sections 22 to 27, inclusive
4. Sections 34 to 36, inclusive

(F) Township 101 Range 7 West of the Fifth Meridian

1. Sections 1 to 36, inclusive

The permit is located approximately 70 miles southeast of the town of Fort Vermilion. The property is readily accessible during the winter months to wheeled drilling equipment via several seismic lines that cross the area and bulldozing new lines where necessary. Summer drilling can be accomplished by tracked equipment by using existing seismic lines; however, the cost of opening new lines during summer months would be prohibitive.

Deposits of elemental sulphur beds have been reported from many localities in northern Alberta and the southern portion of the Northwest Territories as early as 1910. In many instances, these deposits were often found around sulphur water springs and/or gas seeps. Sulphur deposits have also been observed as thin inter-beds with shale deposits and infilling of cavities in porous carbonate rocks at a few localities where outcrops are exposed along stream channels.

Very little attention was given to these sulphur occurrences in past because the supply of sulphur exceeded the demand. Price increases and growing world demand for sulphur renewed interest in these deposits. H. L. Hunt and associates, after several months of surface reconnaissance, filed sulphur prospecting permits #8, #9 and #10. Surface samples assayed as high as 95% elemental

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sulphur. This announcement activated a large land play wherein some six million acres in the vicinity of the Hunt permits were filed on. The permittees included many major companies as well as small companies and individuals.

The time element precluded the opportunity of detailed study or surface reconnaissance, and many permits were filed solely on the basis of proximity.

Relation of Regional Geology to the Sulphur Deposits

The geologic process by which the sulphur deposits were emplaced, their frequency of occurrence, the possible extent or size of an individual deposit are as yet unknown. On the basis of what little exploratory work that has been done at this time, the prospects are highly encouraging that this area will eventually be a commercial producer.

Over the past three months, several companies have carried out preliminary shallow drilling programs to take advantage of winter drilling conditions. The results are being held confidential; however, in several instances, additional follow-up drilling is planned for the 1968-69 winter season. At least two tracked drilling units will be located in this area to carry out summer drilling programs.

The sulphur occurs in the amphorous state and in the mono-clinic and rhombic crystalline forms. Two hypothesis as to the origin of sulphur are currently in use. The first theory suggests that the sulphur deposits are the result of sulphur bearing waters and gases moving up to dip to outcrop or sub-crop edges of the Upper Devonian Grosmont reef and the Middle Devonian Keg River or its equivalent termed the Methy Dolomite. In other instances, fault planes are believed to be the escape route of the waters and gases from the underlying reefs. Several sulphur springs, bubbling water and gas surrounded by elemental sulphur deposits support this theory.

The second possible source of the sulphur is believed to be the decomposition of the vast sulphate deposits of the Middle Devonian Elk Point Group. The chemistry of the decomposition of calcium-magnesium sulphates into elemental sulphur can be accomplished experimentally. In nature, it is assumed that the process involves bacterial action in conjunction with moving subterranean waters and hydrocarbons. The impurities of both magnesium and sulphate in widely varying proportions found with elemental sulphur tend to support this hypothesis.

It is highly likely that future study will demonstrate that both processes contributed to the origin of these sulphur deposits. The presence of magnesium as an impurity could develop into a valuable by-product.

Recommended Evaluation Program

The photogeologic evidence of faulting in the near vicinity and the occurrence sulphur springs nearby, particularly on

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Lambert Creek, indicates the likelihood of finding sulphur deposits on permit #91. The following evaluation program is recommended.

1. A photogeologic study of the aerial photographs to locate surface expression of faulting, sulphur springs and possible vegetation kill.
2. The possible use of infra-red photography to determine a relationship between thermal activity and sulphur deposition.
3. A surface examination to verify data revealed through the air-photo study. A portable augur for shallow holes to test any surface deposits of sulphur.
4. A shallow drilling program be initiated, if warranted, to roughly delineate any sulphur deposits found.

Respectfully submitted,

[redacted]

J. W. Worobec
Geologist

PROCESSES FOR NATIVE SULPHUR ORES

INTRODUCTION

Until the birth of the modern chemical industry in the middle of the 18th Century, sulphur had been used through the years as a medicinal substance and in a somewhat more spectacular manner as one of the ingredients of gunpowder. Traditionally the world's supply of the yellow element had been secured by hand sorting at high grade volcanic deposits and, to a lesser extent, by crude refining of lower grade ores. The rising demand for sulphuric acid in the 19th Century caused a boom in the sulphur industry and was responsible for the entry of iron pyrites as a source of sulphuric acid. Subsequently, the production of sulphuric acid from relatively high capital cost pyrite roasting plants has traditionally acted as a check on the world price of sulphur. Although not reviewed in this article, the recovery of elemental sulphur from natural gas and other hydrocarbon sources and from industrial stack gases has steadily risen to become a significant factor in world sulphur production.

DEMAND FOR SULPHUR

The world demand for sulphur is growing at the approximate rate of 7% per annum. This growth in consumption can be attributed to the more intensive use of fertilizers in developing countries and the high level of activity in the chemical industry in developed countries. Approximately 85% of all sulphur produced ends up as sulphuric acid, of which nearly half goes into the production of fertilizer.

In 1967 free world sulphur production rose to a new high of about 26 million tons, of which over half was produced in North and Central America. It has been estimated that free world sulphur reserves amount to over 400 million tons of sulphur, to which should be added some 150 million tons in Communist countries. To date, by far the greatest single source of production is from Frasch sources; however, the currently prevailing market prices, coupled with improved technology, will tend to bring other sources into production at an increased rate in the foreseeable future.

FRASCH SULPHUR PRODUCTION

The Frasch process by which large underground deposits of sulphur can be mined economically is simple in theory, but complex in practice. Given the ideal conditions of a domal structure with a covering of impervious caprock, sulphur is recovered by injecting superheated water to the sulphur bearing horizon and raising the molten sulphur to the surface by means of compressed air.

1. Direct Burning
2. Distillation
3. Autoclaving and Agglomeration
4. Flotation
5. Melting and Filtering
6. Solvent Extraction

Most current research and process development is devoted to improving one or more of these processes.

Direct Burning Processes:

(a) Colcarella Process:

This primitive process consists of piling the ore and burning it freely. The major part of the sulphur burns out and the heat produced melts the balance. Recovery is only in the order of 30%, the product is of poor quality; hence this process has fallen into disuse.

(b) Calcarone and Gill Process:

These processes are used in Italy. They both use heat liberated by burning part of the sulphur in the ore to liquefy and vaporize the remaining sulphur which is recovered by solidification or condensation.

The Calcarone kiln usually consists of a cone 35 feet at the base and some 18 to 20 feet high. A kiln of 25, 000 cu. ft. capacity would yield about 200 tons of sulphur after two months of combustion.

The Gill furnace consists of a series of chambers with domed roofs. Sulphur is burned and melted in the first chamber and the hot combustion gases are used to heat the charge in the subsequent chambers. Combustion in these cells will last between four and eight days.

Minimum grade of ore for feed in both the above systems is 20% sulphur, and the recovery varies between 50% and 60%. Sulphur produced ranges from 95% to 99% purity and does not meet modern commercial requirements.

Distillation:

In the early part of this century a number of distillation plants were in use in Europe. These installations utilized coal fired cast iron retorts to bring the sulphur to the boiling point (447.5° C.). The sulphur vapor produced was collected and cooled in brick lined condensers. A good grade of sulphur was produced, but high fuel consumption (450 pounds coal per ton of sulphur produced) rendered the process expensive. Attempts to reduce fuel consumption by using rotary retorts did not prove generally satisfactory.

Some distillation plants are in production today in Italy and Japan. These plants, utilizing modern methods of waste heat recovery, apparently produce a good product at a competitive cost.

Autoclaving:

Autoclaving to recover sulphur from ore is widely used in Japan and in some parts of South America. Autoclaves are of either stationary or rotary type. In Chile cast iron stationary autoclaves with a capacity of one to two tons of feed are common. These are charged with high grade concentrates and steam is injected at 50 to 60 pounds pressure. The sulphur melts away from the gangue and is tapped through a door below a grate supporting the charge. With stationary autoclaves typical operating conditions would be as follows:

Water	0.7-1.0 tons per ton of sulphur
ph	8±
Steam pressure	50-60 p.s.i.
Steam time	30-40 minutes
Grinding	-48 mesh
Complete cycle time	2 to 2-1/2 hours
Grade of feed	+ 70% S
Sulphur recovery	50%
Grade of product	99.0% S

Rotary autoclaves are now proving popular and it is claimed that the added capital cost is offset by reduced steam requirements and a higher purity product. One process involving autoclaving in a coiled tube type of autoclave apparently shows promise.

Agglomeration:

An agglomeration process was developed in Chile in 1942 and has been used with some success. In this process a 75% flotation concentrate is heated to its melting point in an autoclave. Sulphuric acid is added to wet the gangue and the sulphur collects in the bottom of the vessel. The gangue agglomerates and is filtered from the sulphur. Acid used is in the order of 240 pounds per ton of sulphur.

Both the autoclaving and agglomeration processes possess the inherent disadvantages of batch operation and, consequently, production costs are relatively high.

Flotation:

Sulphur is readily amenable to separation from its ore by flotation utilizing hydrocarbons as reagents. A two or three stage cleaning circuit can give a 90% grade of concentrate with an 85% recovery of the originally contained sulphur. Further processing by autoclaving or melting and filtering is normally required to remove finely occluded gangue particles and thus to improve marketability. Flotation, being a continuous process, lends itself to high tonnage operations and promises good possibilities of economic recovery of native sulphur. Commercial flotation plants are in operation in many areas of the world, including Sicily, Italy and Latin America, and treat ores ranging in sulphur content upwards from 20%.

Solvent Extraction:

Sulphur will dissolve in a variety of solvents, usually best at the melting point (246° F.). The principal solvents in commercial use are carbon disulfide, carbon tetrachloride, benzine and some of the aromatic petroleum solvents. Some salts such as calcium magnesium and zinc chloride have been used as solvents; however, with these, there is an appreciable loss of salt in the residue and the product is of relatively low quality. With organic solvents, a grade of 99.7% sulphur can be achieved at very high recovery rate (98.5%).

The main steps in the solvent extraction process are fine grinding, mixing with solvent at a temperature of approximately 250° F., gangue separation, recovery of solvent from gangue, solvent distillation and sulphur purification. Some solvents present hazards of toxicity and flammability, and in general the process requires especially developed equipment and expert care in its manipulation. This process has the advantage of continuous operation and should undoubtedly be considered in any process assessment for new plants.

New Plant Design:

When determining the process to use for the recovery of sulphur from a native deposit not suited to Frasch mining, the most economical process will likely be a combination of two or more of those described in the foregoing. Each process must be studied on its own merits and, in most instances, laboratory and pilot plant work will be required before process design and capital and operating costs can be accurately determined.

EVALUATION OF PRODUCTION ECONOMICS

In arriving at the decision of whether and how to bring a given deposit into production, a number of important factors must be clearly identified and their significance assessed in economic terms. A proper feasibility study is essential to document fully the following important aspects of a project as an aid to decision making:

- Sponsor's objectives
- Nature and scope of the project
- Definition of feasible alternatives
- Process selection and preparation of preliminary flow sheets and design
- Estimates of capital investment and operating costs, transportation costs, revenues and rates of return
- Sensitivity analysis of rate of return to key variables
- Assessment of technical, financial and other risks associated with the project
- Outline of additional development work before major capital authorizations

Sponsor's Objectives. All too often these are left unquestioned and based on untested assumptions - unless clearly spelled out, the various parties involved in launching a project can easily be working at odds.

Nature and Scope of the Project: A full and thorough documentation of this aspect will force consideration of the physical, technical, financial and economic limitations of the project being considered.

Feasible Alternatives: A general assessment may be all that is required to narrow down alternatives which are technically feasible to a few for more detailed consideration in order to select the best process combination and scale of operation.

Estimates of Capital and Operating Cost and Measures of Profitability: Great care must be taken to ensure that all major items of cost chargeable to the project are foreseen and estimated. In order to project realistic cash flows, due consideration must be given to the effect of income taxes, capital cost allowances, depletion, depreciation, royalties and taxes, start-up costs, working capital requirements, marketing and transportation costs, and any items of cost which would not otherwise be incurred if the project were not initiated. In this stage ranges of probability for the major items of cost should be bracketed and detailed cash flows and measures of profitability (discounted cash flow rate of return) prepared for each alternative identified; graphs should be prepared showing the variation in rate of return as each major item is charged over its probable range. Such analysis, commonly called a sensitivity analysis, is an invaluable management tool which can be used to assess the financial and economic risks associated with a project. The major items that normally require sensitivity analysis are:

- selling price
- level of production
- reserves
- scope of operation
- capital cost
- key operating costs, i.e. as reflected from water rate in a Frasch operation

It is apparent that this analytical technique becomes onerous to apply manually and a computer is an invaluable aid to such computations. The readily available use of computers to anyone at modest cost today is a boon to such decision-making tools. Exhibit 1 attached shows a simplified example of a sensitivity analysis calculated for a Frasch operation.

Financing Charges: One of the most common fallacies prevalent in economic evaluations today is the inclusion of interest, financing charges and certain other capital charges in the projection of cash flows for purposes of the economic evaluation of a project. When this procedure is followed, the true economic merit of the project itself is seldom discovered and the resultant comparisons of alternatives are distorted. Only after the most economic alternative has been selected, and rate of return criteria have been assessed, based on the true economic merit of the project, should financing costs, ownership costs, interest and the like be superimposed on the resulting cash flow series to determine the project's ability to support a contemplated capital structure.

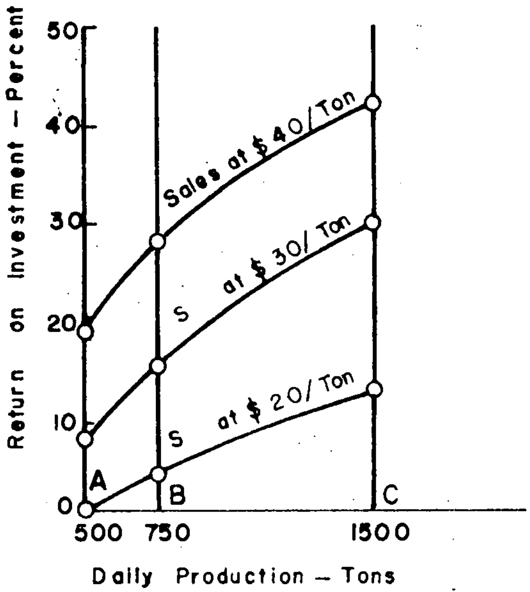
Additional Development Work: On the basis of a thorough assessment of risks, the need and justification for additional development work, to produce more detailed information, often becomes apparent. If such is not the case, and if profitability criteria have been met, management has documented before it the basis for effective decision-making and may then authorize detailed design, contract negotiations, financing arrangements and firm planning for the commissioning of the project.

THE FUTURE OF SULPHUR

The sulphur industry appears to be one which possesses good prospects for long term stability. The effect of alternate methods of fertilizer and sulphuric acid production will undoubtedly continue to discourage excessive price fluctuations for brimstone, but on the other hand, a steadily increasing demand, coupled with the development of new processes will aid in placing low grade and remote ore sources into production. Provided the basic precepts of modern management are followed, the operator considering an entry into the sulphur field should have excellent prospects for financial success.

February 13, 1968

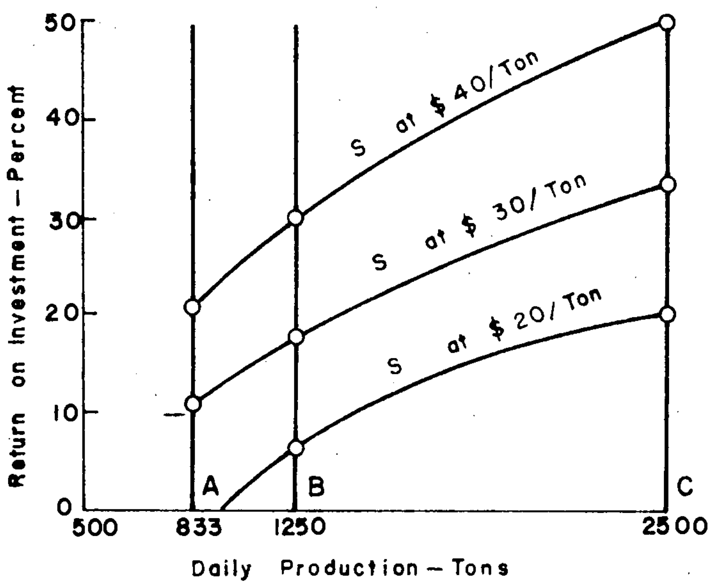
EXAMPLE OF A SENSITIVITY ANALYSIS FOR A FRASCH MINING OPERATION



BOILER CAPACITY
3,000,000 G.P.D.

INVESTMENT (Millions)		
A	B	C
$ 7.5	8.5	10.0

WATER RATE
A — 6,000 Gals / Ton.
B — 4,000 Gals / Ton.
C — 2,000 Gals / Ton.



BOILER CAPACITY
5,000,000 G.P.D.

INVESTMENT (Millions)		
A	B	C
$ 11.0	12.5	15.0

WATER RATE
A — 6,000 Gals / Ton.
B — 4,000 Gals / Ton.
C — 2,000 Gals / Ton.

Exhibit 1

THE DUBOW TECHNIQUE

The Dubow Technique is applicable to the extraction of elemental sulphur from almost any ore. The free sulphur deposits, which have been found in north-central Alberta, appear to be ideally suited to use of this technique. Dubow Chemical Corporation reserves a 5% royalty of product in kind from every installation producing by its technique.

The Joseph L. Prosser & Co. of Glenarm, Maryland, has had previous experience in turnkeying the design of a plant, supervision of construction and placing it on stream with a warranty of production of 99.6% sulphur in liquid or dry state in a quantity predicated on feed-stock grade. The higher the sulphur content, the lower the extraction cost. 99.6% pure molten sulphur is produced for a cost bearing from $8.00 to $16.00 per net ton consistent on grade and feed-stock, labor and mining cost, proximity to water, power and fuel.

Although the present domestic price of sulphur in the United States is $39.00 per ton, and Canadian prices are relatively comparable, only old contracts are filled at this price. New contracts are being made for prices which have been considerably higher and this condition should persist for at least another five years, based on present circumstance. Current conditions will probably cause the price of sulphur to stabilize at $50.00.

Current production is from the Frasch Process since present known means of extracting deposits are not economical. However, with the Dubow Technique this situation is changed and an opportunity is available to exploit previously uneconomical sulphur deposits. Estimated costs of plant construction, etc., are available through the office of Parkman Petroleums Limited.

COST OF PLANT AND FACILITIES

Plant	$1500000.00
Water to installation	50000.00
Power	25000.00
Road	225000.00
Camp site	100000.00
	$1900000.00
Working capital	600000.00
Total investment	$2500000.00

PRODUCTION COST PER TON

Utilities and chemicals	$ 6.50
Labor, supervision, maintenance	1.10
Taxes, insurance, overhead, interest	1.20
Depreciation	.45
Mining, etc.	3.00
Total extraction cost	$ 12.25

TYPICAL PLANT

Capacity-750 TPD   Annual operating time-330 days

CONSTRUCTION COST

Ore storage and grinding		$ 250000.00
Equipment		
Ore feeder	$ 8000.00	
Ore heater & accessories	36500.00	
Ore storage-ground	12000.00	
Mixer tanks w/mixer, coils	11000.00	
Thickener tank w/mechanism	20000.00	
Wash tank	5500.00	
Wash separator tank	19000.00	
Pump tanks	5000.00	
Solvent heater	16000.00	
Solvent cooler	21500.00	
Sulphur melter	6000.00	
Occluded sulphur tank	5000.00	
Melt tank	4000.00	
Pumps-12	18000.00	
Boiler	40000.00	
Sub-total		222500.00
Building-60X120 @ $4.00/sq. ft.		28800.00
Electrical-1500 HP @ $40.00/HP		60000.00
Lighting and miscellaneous		8200.00
Instruments		25000.00
Earthwork and foundations		8000.00
Piping		40000.00
Insulation		20000.00
Molten sulphur storage		250000.00
Installation, field, freight		142500.00
Engineering		55000.00
Contractor O. H. & P.		125000.00
Grand total		$1235000.00

PRODUCTION COST

Utilities		
Power- 50 KWH/T @ 1¢	$ .50	
Fuel- 1.5MM BTU/T @ 50¢	.75	
Solvent- 40 G/T @ 10½¢	4.10	
Pine oil- 5 #/T @ 12¢	.60	
Wetting agent- 10 #/T @ 5¢	.50	
Sub-total		$ 6.45
Direct cost		
Labor- 4 men/shift, 4 shifts	$116500.00	
Supervisors- 4	48000.00	
Maintenance- 8% of investment	98800.00	
Subtotal		1.10
Indirect cost		
Taxes, insurance- 3%	$ 37000.00	
Plant, office overhead	200000.00	
Interest on investment- 7%	113200.00	
Sub-total		1.40
Depreciation		.50
Mining and into plant		3.00
Cost of sulphur/T without any royalty provision		$12.45

For 1000TPD plant, increased size of components will raise the total construction cost to $1465000.00

For 1000TPD plant, production cost reduced to $ 11.95

comparable price for the product in the country of export. There must also be proof of actual injury or real threat of injury to a domestic industry. The principle is sound, but actual practice may present some problems.

The machinery item is the most significant and also the most complex ever put into effect, from Jan. 1. There is no class or kind qualification. The primary rate will be 15 percent MFN and 2½ percent British Preference. Department officials have estimated that importers will be able to cut their machinery costs by $45 million a year by importing machinery not available from production in Canada free of duty. We recommend that this item is important enough to have senior management attention.

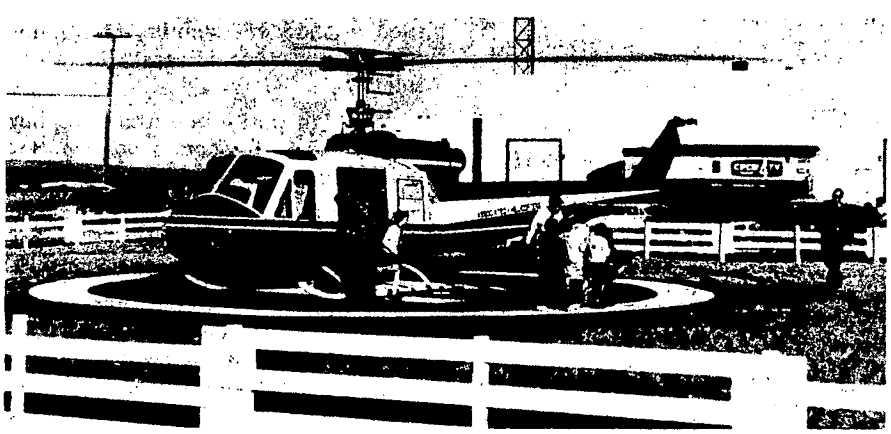
Effective communications, by Robert L. Switzer, Atlantic Richfield Company, Dallas.

The perfection of communications is a never-ending quest. Effective writing is an important feature of it, but even PhD's cannot all express themselves in writing.

Problems in the field of communications are mostly people and their personal communications, more often than mechanical and technical expressions.

We have some of the most ingenious communications media ever known. We are on the threshold of even more dramatic items. But still the major problem of dealing with people around us results in less than optimum use of these elaborate facilities.

Nearly everything starts with a better idea, but it has to be developed and sold to management before it can be put into operation. The ability to express and sell the idea is the key to its survival.



Associated Helicopters took advantage of CFCN Calgary's newly licensed heliport to introduce families of their clients in the oil and mining industries to the Bell 204 turbine helicopter. Rides kept the crew busy for two days.

How sulphur deposits are formed in Northern Alta.

By Edward Lewis Jones, Consulting Engineer, Calgary

Sulphur deposits at the surface in northern Alberta have attracted a lot of attention in recent months. The method by which the sulphur is deposited is of considerable interest since the sulphur itself is quite pure, and suitable for the manufacture of sulphuric acid, being free of arsenic, selenium and tellurium, the catalyst poisons.

The surface deposits, however, are mixed with sand and silt, which could indicate that the sulphur was being deposited while the wind was blowing in the gangue material from elsewhere. Even so, the deposits are quite high in percentage of sulphur.

While there are several theories on the formation of sulphur deposits, the writer prefers the geochemical theory outlined below, rather than the others discussed first:

Volcanic sulphur

The existence of sulphur from volcanic fissures is known, but many deposits of volcanic origin contain the catalyst poisons mentioned above, thereby disqualifying them from producing marketable sulphur. Volcanic sulphur, like that from sour natural gas, may be deposited by burning hydrogen sulphide.

Geo-bacterial reducation of sulphate

Several kinds of bacteria can reduce sulphate to sulphur. Much comparison of isotope ratios in sulphur has lent credence to the theory that bacteria formed the large sulphur deposits in the salt domes near the Gulf of Mexico. But no rates of deposition or material balances have been made, particularly relating the ratio of the remains of the bacteria to the sulphur deposited. Geo-bacterial reduction is very slow, particularly in cold climates like Canada's. British Petroleum in Libya has not produced substantial quantities of sulphur from bacterial reduction of sulphate, even in a hot climate.

Inorganic reduction of sulphate

Chemical equations showing the formation of sulphur from sulphate minerals, such as anhydrate, generally require far too drastic conditions of temperature to be given serious consideration in a natural environment. One example is the reduction of calcium sulphate with carbon, generally practiced in England. Even there, sulphur dioxide is the main product from which sulphuric acid is made, **not sulphur, the marketable product, in demand since it is shipped most economically.**

However, elemental sulphur is always found in association with carbonate and sulphate, complete with sulphurous water containing hydrogen sulphide. Usually salt is nearby also, creating differential voltages between salt solutions.

Geochemical theory

Once the assumption has been made that water containing ions of sulphate minerals and hydrogen sulphide is exposed to small electro chemical voltages, possibly generated through fractures and contacts with underlying salt beds, certain equilibria relating to mineral solutions may be used to define the conditions under which native sulphur could be deposited in natural environments.

Recent developments in computing mineral stability diagrams explain how native sulphur deposits can develop.

In an environment of water carrying sulphate and hydrogen sulphide at 60 F and atmospheric pressure, elemental sulphur can be formed under certain conditions of low electro chemical voltage and low pH.

G. Valensi (Contribution au diagramme potential-pH du soufre, Comp. rendu, 2eme Reunion) shows that the naturally occurring ionic species, which are stable, are sulphate ion, bisulphate, hydrogen sulphide, bisulphide ion, sulphide ion, and native sulphur.

The electrochemical voltage is measured against a background of salt (which is usually found associated in nature), and is commonly termed the half-cell voltage, and labelled E_h.

A plot of E_h against the pH, which measures the acidity or alkalinity of **the** water solution (7.0 pH being neutral), defines the borders between which the several ions exist, including native sulphur.

Where the solution is acid, hydrogen sulphide exists in the low pH range. As the solution becomes more alkaline, HS^- and S^{--} are formed:

$$^{K}H_2S = \frac{(H^+)(HS^-)}{H_2S} \text{ or}$$

$$\frac{(HS^=)}{(H_2S)} = \frac{^{K}H_2S}{(H^+)} = \frac{10^{-7}}{(H^+)}$$

The equilibrium between the species is **one** when pH = 7. Similarly,

$$^{K}HS^- = \frac{(H^+)(S^{--})}{(HS^-)} \text{ or}$$

$$\frac{(S^{--})}{(HS^-)} = \frac{^{K}HS^-}{(H^+)} = \frac{10^{-14}}{(H^+)}$$

and $(S^{--}) = (HS^-)$ when pH = 14, so the boundaries between the species are vertical lines on the diagram at pH7 (Line 1) and pH14 (Line 2) regardless of electrochemical voltage.

However, oxidation of sulphur-containing ions will be as follows:

$H_2S_{aq} + 4\,H_2O$ gives $HSO_4^- + 9H^+ + 8e$

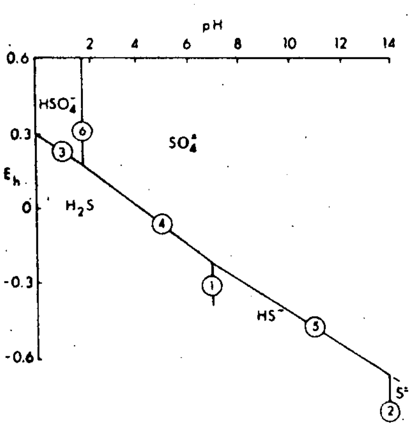


FIGURE 1

LINES OF EQUAL IONIC CONCENTRATIONS OF SULPHUR IONS IN WATER SOLUTIONS AT 60°F.

$H_2S_{aq} + 4\,H_2O$ gives $SO_4^= + 10H^+ + 8e$

$HS^- + 4\,H_2O$ gives $SO_4^= + 9H^+ + 8e$

$S^=_{aq} + 4\,H_2O$ gives $SO_4^= + 8H^+ + 8e.$

From the free-energy equation the electrochemical voltage may be determined in terms of pH and ionic concentrations. The boundaries between sulphur species at **equal concentrations** occur when the ionic ratio is **one**, leaving only equations in terms of E_h and pH which may be plotted on the diagram too.

$$\text{Line 3 } E_h = 0.290 - 0.066\text{ pH} + 0.0074 \log \frac{(HSO_4^-)}{(H_2S)} = 0.290 - 0.066\text{ pH}.$$

Similarly, Line 4 for the boundary between $SO_4^=$ & H_2S is $E_h = 0.30 - 0.073$ pH,

and Line 5 for the boundary between $SO_4^=$ & HS^- is $E_h = 0.25 - 0.067$ pH

and the boundary between (HSO_4^-) and $(H^+) + (SO_4^=)$

$$\frac{(SO_4)}{(HSO_4)} = \frac{^{K}HSO_4^-}{(H^+)} = \frac{10^{-1.9}}{(H^+)}$$

is line six at a pH of 1.9. See Figure 1.

The diagram shows the boundaries of equal concentrations of the ions, **independently of the total dissolved sulphur.**

Crystalline (yellow) sulphur precipitates

Where the total dissolved sulphur has an activity corresponding to 10^{-1}, similar to that of hydrogen sulphide in water at 60° F., the activity of the sulphide ion may be shown to be

$$H_2S_{aq} = S^=_{aq} + 2H^+ \text{ and}$$

$$\frac{(S^=)(H^+)^2}{(H_2S)} = K = 10^{-21}$$

$$\text{or } \log S^= = -22 + 2\text{pH}.$$

Similarly boundaries between crystalline sulphur with an activity of **one**, and the other sulphur ions may be computed, and are shown on the diagram in Figure 2, for a total sulphur of 10^{-1}, from the equations

$$H_2S_{aq} = \text{solid S} + 2H^+_{aq} + 2e$$

$$HS_{aq} = \text{solid S} + H^+_{aq} + 2e$$

$$S^=_{aq} = \text{solid S} + 2e$$

$$\text{Solid S} + 4H_2O = HSO_4^-{}_{aq} + 7H^+_{aq} + 6e$$

$$\text{Solid S} + 4H_2O = SO_4^={}_{aq} + 8H^+_{aq} + 6e.$$

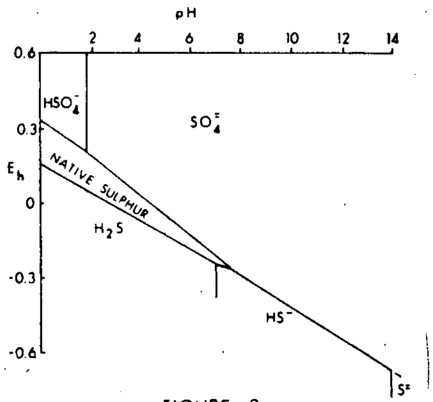


FIGURE 2

CONDITIONS FOR DEPOSITS OF NATIVE TO FORM FROM WATER SOLUTIONS OF SULPHATE
1. SOME ELECTROCHEMICAL VOLTAGE IN NEUTRAL SOLUTIONS AND;
2. NO VOLTAGE DIFFERENCES IN ACID SOLUTIONS

Practical application

The theory shows that elemental sulphur may form enormous deposits from solutions, as apparently has occurred in the surface deposits of sulphur in the Northwest Territories and northern Alberta.

The voltage differences are small, and within that range expected in the field from ionic solutions in springs or in faulted areas, or downhole in wells.

Where the pH is low, i.e., where hydrogen sulphide gas is present, solid sulphur is deposited faster, even at minimal voltage differences.

Other sulphides such as pyrite can form sulphur from water solution. Similar diagrams may be prepared for sulphur deposition from pyrite. This may account for some sulphur formations in northern Alberta, where iron compounds are found mixed with sulphur.

The E_h—pH diagrams can be used to show the stability of sulphur relative to other minerals in water solution.

The high purity of surface sulphur deposits, i.e., freedom from catalyst poisons like arsenic, is explained.

The pH range of waters in the Northwest Territories falls within that required for sulphur deposition.

Particularly since the sulphate is more soluble in cold water than hot, a possible process for recovering sulphur from calcium sulphate is evident, although the economics are indefinite.

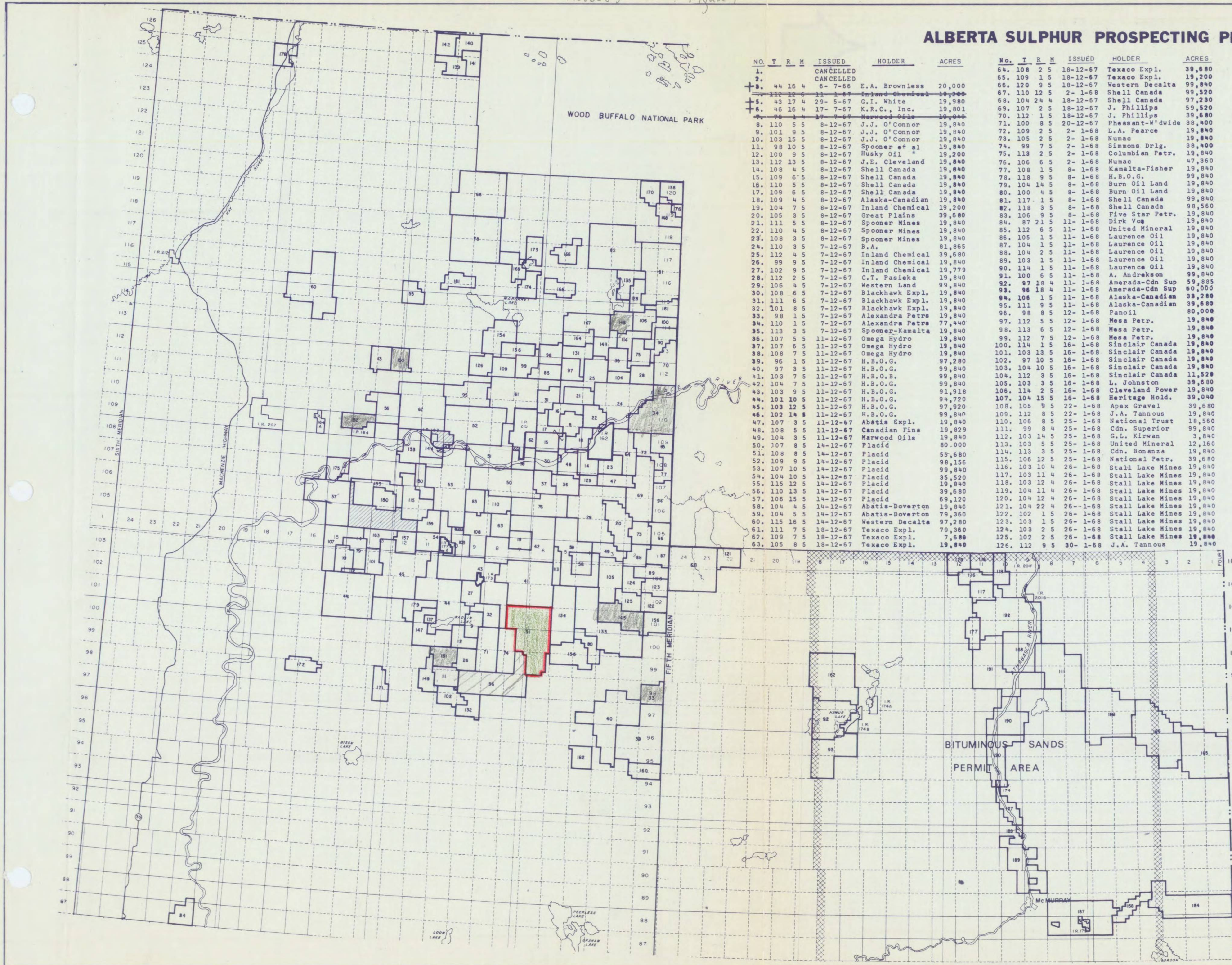
Reference — M. J. Pourbaix, Thermodynamics of Dilute Aqueous Solutions, 1949.

19680085 Figure 1

ALBERTA SULPHUR PROSPECTING PERMITS

NO.	T	R	M	ISSUED	HOLDER	ACRES
1.				CANCELLED		
2.				CANCELLED		
+3.	44	16	4	6- 7-66	E.A. Brownless	20,000
~~4.~~	~~112~~	~~12~~	~~6~~	~~11- 1-67~~	~~Inland Chemical~~	~~18,200~~
+5.	43	17	4	29- 5-67	G.I. White	19,980
+6.	46	16	4	17- 7-67	K.R.C., Inc.	19,801
~~7.~~	~~76~~	~~1~~	~~4~~	~~17- 7-67~~	~~Marwood Oils~~	~~19,840~~
8.	110	5	5	8-12-67	J.J. O'Connor	19,840
9.	101	9	5	8-12-67	J.J. O'Connor	19,840
10.	103	15	5	8-12-67	J.J. O'Connor	19,840
11.	98	10	5	8-12-67	Spooner et al	19,840
12.	100	9	5	8-12-67	Husky Oil	19,200
13.	112	13	5	8-12-67	J.E. Cleveland	19,840
14.	108	4	5	8-12-67	Shell Canada	19,840
15.	109	6	5	8-12-67	Shell Canada	19,840
16.	110	5	5	8-12-67	Shell Canada	19,840
17.	109	6	5	8-12-67	Shell Canada	19,840
18.	109	4	5	8-12-67	Alaska-Canadian	19,840
19.	104	7	5	8-12-67	Inland Chemical	19,200
20.	105	3	5	8-12-67	Great Plains	39,680
21.	111	5	5	8-12-67	Spooner Mines	19,840
22.	110	4	5	8-12-67	Spooner Mines	19,840
23.	108	3	5	8-12-67	Spooner Mines	19,840
24.	110	3	5	7-12-67	B.A.	81,865
25.	112	4	5	7-12-67	Inland Chemical	39,680
26.	99	9	5	7-12-67	Inland Chemical	19,840
27.	102	9	5	7-12-67	Inland Chemical	19,779
28.	112	2	5	7-12-67	C.T. Pasieka	19,840
29.	106	4	5	7-12-67	Western Land	99,840
30.	108	6	5	7-12-67	Blackhawk Expl.	19,840
31.	111	6	5	7-12-67	Blackhawk Expl.	19,840
32.	101	8	5	7-12-67	Blackhawk Expl.	19,840
33.	98	1	5	7-12-67	Alexandra Petrs	19,840
34.	110	1	5	7-12-67	Alexandra Petrs	77,440
35.	113	3	5	7-12-67	Spooner-Kamalta	19,840
36.	107	5	5	11-12-67	Omega Hydro	19,840
37.	107	6	5	11-12-67	Omega Hydro	19,840
38.	108	7	5	11-12-67	Omega Hydro	19,840
39.	96	1	5	11-12-67	H.B.O.G.	97,280
40.	97	3	5	11-12-67	H.B.O.G.	99,840
41.	103	7	5	11-12-67	H.B.O.B.	99,840
42.	104	7	5	11-12-67	H.B.O.G.	99,840
43.	103	9	5	11-12-67	H.B.O.G.	91,918
44.	101	10	5	11-12-67	H.B.O.G.	94,720
45.	103	12	5	11-12-67	H.B.O.G.	97,920
46.	102	14	5	11-12-67	H.B.O.G.	99,840
47.	107	3	5	11-12-67	Abatis Expl.	19,840
48.	108	5	5	11-12-67	Canadian Fina	19,829
49.	104	3	5	11-12-67	Marwood Oils	19,840
50.	107	8	5	14-12-67	Placid	80.000
51.	108	8	5	14-12-67	Placid	55,680
52.	109	9	5	14-12-67	Placid	98,156
53.	107	10	5	14-12-67	Placid	99,840
54.	104	10	5	14-12-67	Placid	35,520
55.	115	12	5	14-12-67	Placid	19,840
56.	110	13	5	14-12-67	Placid	39,680
57.	106	15	5	14-12-67	Placid	69,120
58.	104	4	5	14-12-67	Abatis-Doverton	19,840
59.	104	5	5	14-12-67	Abatis-Doverton	79,360
60.	115	16	5	14-12-67	Western Decalta	97,280
61.	111	7	5	18-12-67	Texaco Expl.	79,360
62.	109	7	5	18-12-67	Texaco Expl.	7,680
63.	105	8	5	18-12-67	Texaco Expl.	19,840
64.	108	2	5	18-12-67	Texaco Expl.	39,680
65.	109	1	5	18-12-67	Texaco Expl.	19,200
66.	120	9	5	18-12-67	Western Decalta	99,840
67.	110	12	5	2- 1-68	Shell Canada	99,520
68.	104	24	4	18-12-67	Shell Canada	97,230
69.	107	2	5	18-12-67	J. Phillips	59,520
70.	112	1	5	18-12-67	J. Phillips	39,680
71.	100	8	5	20-12-67	Pheasant-W'dwide	38,400
72.	109	2	5	2- 1-68	L.A. Pearce	19,840
73.	105	2	5	2- 1-68	Numac	19,840
74.	99	7	5	2- 1-68	Simmons Drlg.	38,400
75.	113	2	5	2- 1-68	Columbian Petr.	19,840
76.	106	6	5	2- 1-68	Numac	47,360
77.	108	1	5	8- 1-68	Kamalta-Fisher	19,840
78.	118	9	5	8- 1-68	H.B.O.G.	99,840
79.	104	14	5	8- 1-68	Burn Oil Land	19,840
80.	100	4	5	8- 1-68	Burn Oil Land	19,840
81.	117	1	5	8- 1-68	Shell Canada	99,840
82.	118	3	5	8- 1-68	Shell Canada	98,560
83.	106	9	5	8- 1-68	Five Star Petr.	19,840
84.	87	21	5	11- 1-68	Dirk Vos	19,840
85.	112	6	5	11- 1-68	United Mineral	19,840
86.	105	1	5	11- 1-68	Laurence Oil	19,840
87.	104	1	5	11- 1-68	Laurence Oil	19,840
88.	104	2	5	11- 1-68	Laurence Oil	19,840
89.	103	1	5	11- 1-68	Laurence Oil	19,840
90.	114	1	5	11- 1-68	Laurence Oil	19,840
91.	100	6	5	11- 1-68	A. Andrekson	99,840
92.	97	18	4	11- 1-68	Amerada-Cdn Sup	59,885
93.	96	18	4	11- 1-68	Amerada-Cdn Sup	60,000
94.	106	1	5	11- 1-68	Alaska-Canadian	33,280
95.	111	9	5	11- 1-68	Alaska-Canadian	39,680
96.	98	8	5	12- 1-68	Panoil	80,000
97.	112	5	5	12- 1-68	Mesa Petr.	19,840
98.	113	6	5	12- 1-68	Mesa Petr.	19,840
99.	112	7	5	12- 1-68	Mesa Petr.	19,840
100.	114	1	5	16- 1-68	Sinclair Canada	19,840
101.	103	13	5	16- 1-68	Sinclair Canada	19,840
102.	97	10	5	16- 1-68	Sinclair Canada	19,840
103.	104	10	5	16- 1-68	Sinclair Canada	19,840
104.	112	3	5	16- 1-68	Sinclair Canada	11,520
105.	103	3	5	16- 1-68	L. Johnston	39,680
106.	114	2	5	16- 1-68	Cleveland Power	19,840
107.	104	15	5	16- 1-68	Heritage Hold.	39,040
108.	105	9	5	22- 1-68	Apex Gravel	39,680
109.	112	8	5	22- 1-68	J.A. Tannous	19,840
110.	106	8	5	25- 1-68	National Trust	18,560
111.	99	8	4	25- 1-68	Cdn. Superior	99,840
112.	103	14	5	25- 1-68	G.L. Kirwan	3,840
113.	103	5	5	25- 1-68	United Mineral	12,160
114.	113	3	5	25- 1-68	Cdn. Bonanza	19,840
115.	106	12	5	25- 1-68	National Petr.	39,680
116.	103	10	4	26- 1-68	Stall Lake Mines	19,840
117.	103	11	4	26- 1-68	Stall Lake Mines	19,840
118.	103	12	4	26- 1-68	Stall Lake Mines	19,840
119.	104	11	4	26- 1-68	Stall Lake Mines	19,840
120.	104	12	4	26- 1-68	Stall Lake Mines	19,840
121.	104	22	4	26--1-68	Stall Lake Mines	19,840
122.	102	1	5	26- 1-68	Stall Lake Mines	19,840
123.	103	1	5	26- 1-68	Stall Lake Mines	19,840
124.	103	2	5	26- 1-68	Stall Lake Mines	19,840
125.	102	2	5	26- 1-68	Stall Lake Mines	19,840
126.	112	9	5	30- 1-68	J.A. Tannous	19,840
127.	93	10	4	30- 1-68	Tobe Mines	19,582
128.	116	2	5	30- 1-68	Nugent Sales	19,840
129.	107	4	5	30- 1-68	C.E. Dolan	5,120
130.	107	11	5	30- 1-68	Abtec Equip.	19,840
131.	113	4	5	30- 1-68	H.P. Killoran	19,840
132.	97	9	5	30- 1-68	H.P. Killoran	19,840
133.	101	3	5	30- 1-68	J.F. Grimm	99,840
134.	101	5	5	30- 1-68	A.G. Hatsis	59,520
135.	116	3	5	30- 1-68	Bata Resources	19,840
136.	113	7	5	30- 1-68	Bata Resources	19,840
137.	101	11	5	30- 1-68	G.L. Kirwan	3,840
138.	120	1	5	30- 1-68	Montclair	19,840
139.	125	11	5	30- 1-68	Montclair	19,840
140.	126	10	5	30- 1-68	Montclair	19,840
141.	125	10	5	30- 1-68	Montclair	19,840
142.	126	11	5	30- 1-68	Montclair	19,840
143.	113	4	5	30- 1-68	H.P. Killoran	19,840
144.	108	11	5	7- 2-68	Western Land	19,576
145.	101	3	5	7- 2-68	J. Superstein	39,680
146.	114	3	5	7- 2-68	Alexandra Petr.	19,840
147.	100	11	5	7- 2-68	Spartan Devel.	39,680
148.	119	1	5	7- 2-68	D.A. Campbell	19,840
149.	98	11	5	7- 2-68	H.P. Killoran	19,840
150.	112	13	5	7- 2-68	R. Superstein	19,840
151.	99	10	5	7- 2-68	R. Superstein	19,840
152.	109	14	5	7- 2-68	R. Superstein	19,840
153.	108	12	5	7- 2-68	Milo Building	39,680
154.	113	8	5	7- 2-68	Milo Building	39,680
155.	99	5	5	7- 2-68	Milo Building	39,680
156.	101	1	5	8- 2-68	Ranger Oil	19,840
157.	104	12	5	8- 2-68	Ranger Oil	19,840
158.	89	5	4	8- 2-68	H.L. Banting	19,840
159.	105	11	5	12- 2-68	Abidonne Oils	19,840
160.	94	1	5	12- 2-68	Abidonne Oils	19,840
161.	115	1	5	12- 2-68	Abidonne Oils	18,560
162.	99	17	4	12- 2-68	Imperial Oil Ent	99,840
163.	104	13	5	12- 2-68	Abidonne Oils	19,840
164.	113	5	5	12- 2-68	Abidonne Oils	19,840
165.	117	5	5	16- 2-68	Peyto Oils	19,840
166.	116	6	5	16- 2-68	Buffalo Minerals	19,840
167.	114	4	5	16- 2-68	Heritage Hold.	39,680
168.	100	9	4	21- 2-68	G.W. Goettler	59,520
169.	116	7	5	21- 2-68	Peyto Oils	19,840
170.	120	2	5	21- 2-68	D.A. Campbell	19,840
171.	98	13	5	21--2-68	Amerada	19,840
172.	98	16	5	21- 2-68	Amerada	19,840
173.	117	7	5	21- 2-68	Farmers Chem.	19,840
174.	116	7	5	21- 2-68	Farmers Chem.	19,840
175.	107	15	5	21- 2-68	D.L. Hope	19,840
176.	119	1	5	26- 2-68	R. Thomas	8,320
177.	101	11	4	26- 2-68	R.E. Harris	19,840
178.	125	18	5	26- 2-68	Aztec Oil & Gas	19,840
179.	101	12	5	27- 2-68	G. Lonn	19,840
180.	106	13	5	27- 2-68	G. Lonn	19,840
181.	116	11	5	5- 3-68	Syracuse	19,840
182.	95	4	5	21- 3-68	G.S. Splane	19,840
183.	106	13	5	21- 3-68	Arco	39,680
184.	89	3	4	29- 3-68	Sinclair	99,840
185.	96	2	4	29- 3-68	Sinclair	97,280
186.	97	4	4	29- 3-68	Sinclair	98,560
187.	88	6	4	29- 3-68	Sinclair	96,334
188.	88	8	4	29- 3-68	Sinclair	99,840
189.	90	9	4	29- 3-68	Sinclair	73,069
190.	97	10	4	29- 3-68	Sinclair	99,137
191.	99	11	4	29- 3-68	Sinclair	98,560
192.	102	10	4	29- 3-68	Sinclair	98,906

TOTAL ACREAGE - 6,845,952



+ – PERMIT IS NOT SHOWN ON THIS MAP.

– LANDS SURROUNDED BY SULPHUR PERMITS AND STILL AVAILABLE

I.R. – INDIAN RESERVES – NO DISPOSITION.

LINE THROUGH PARTICULARS INDICATES PERMIT CANCELLED.

MAINTAINED UP TO DATE FREE OF CHARGE TO ANYONE AT ALL TIMES

FIELD TITLE SERVICE

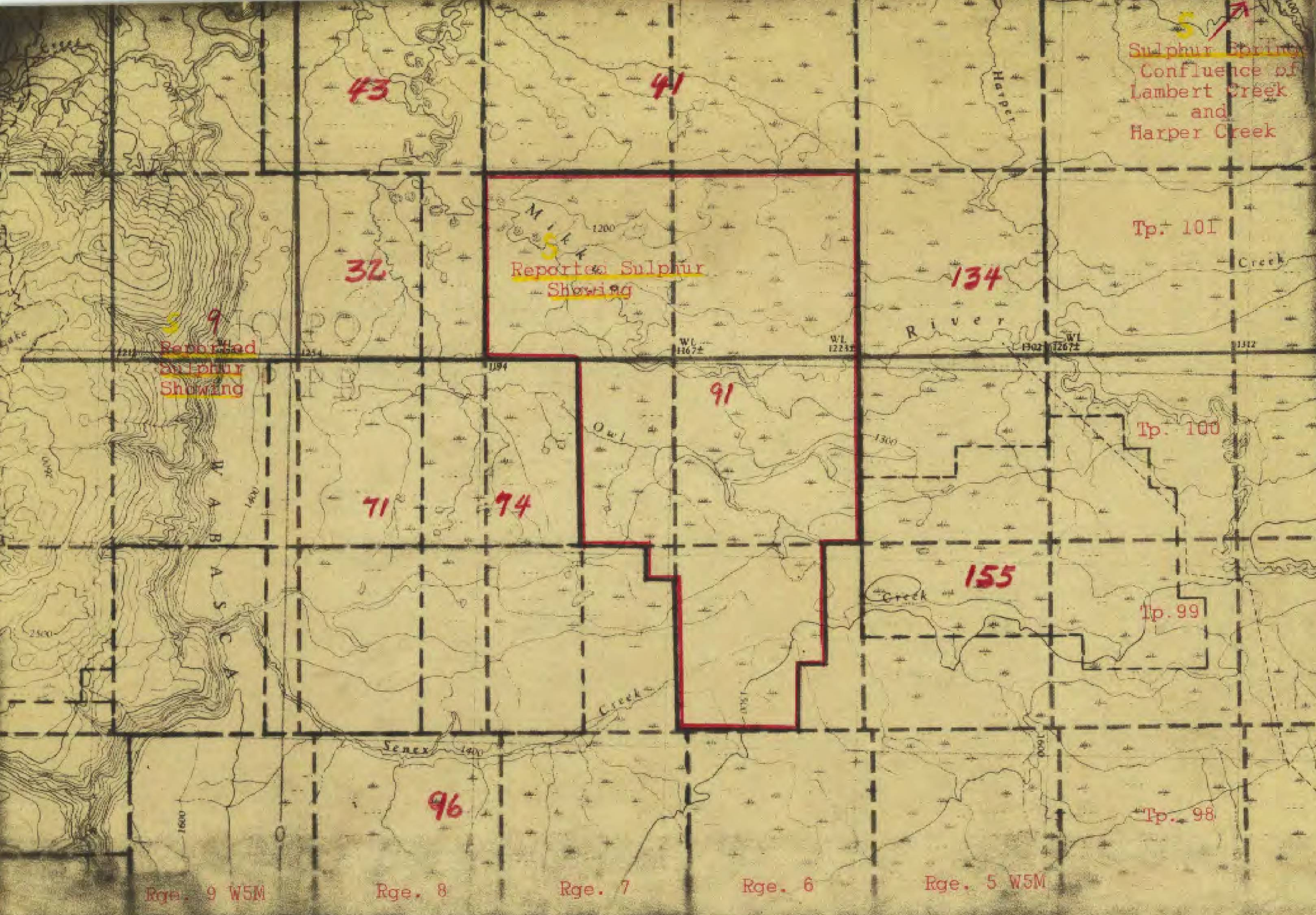
560 GUINNESS HOUSE
CALGARY
Tel. 263-3750

Scale: 1 in. = 24 mi.

Figure 2 - Reproduction of Topographical Sheet, Wadlin, Alta

Figure 2

19680085



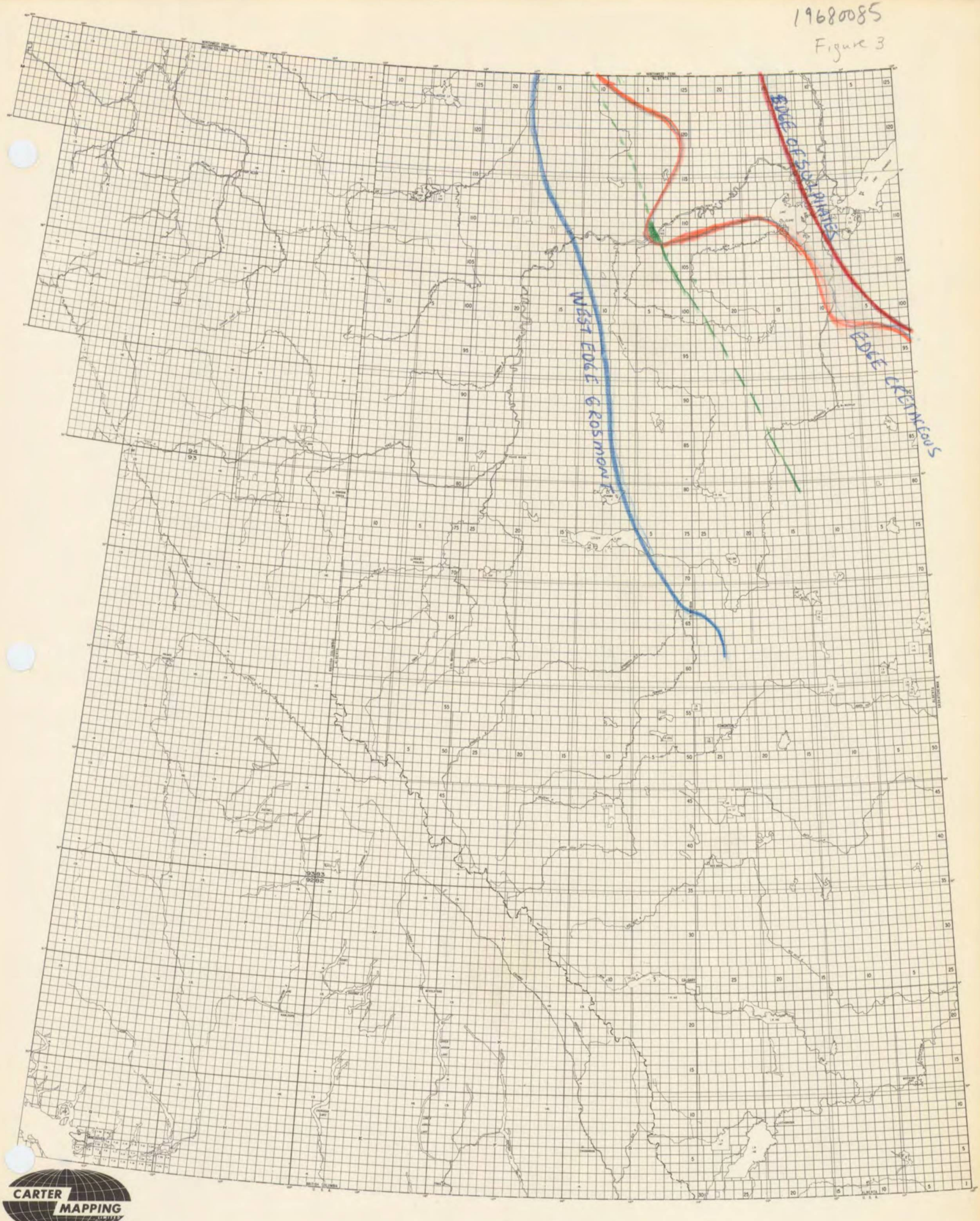
Sulphur Springs
Confluence of
Lambert Creek
and
Harper Creek
43
41
Harper
32
Reported Sulphur
Showing
1200
134
Tp. 101
Creek
River
9
Reported
Sulphur
Showing
WL 1167±
WL 1223±
WL 1267±
1302
1312
1211
1254
1194
91
Owl
1300
Tp. 100
WABASCA
1400
71
74
155
Creek
Tp. 99
2500
Creek
Senex
1400
1600
96
Tp. 98
Rge. 9 W5M
Rge. 8
Rge. 7
Rge. 6
Rge. 5 W5M

Figure 2 - Reproduction of Topographical Sheet, Wadlin, Alta

Figure 2
19680085

19680085

Figure 3



ALBERTA

AND EASTERN BRITISH COLUMBIA

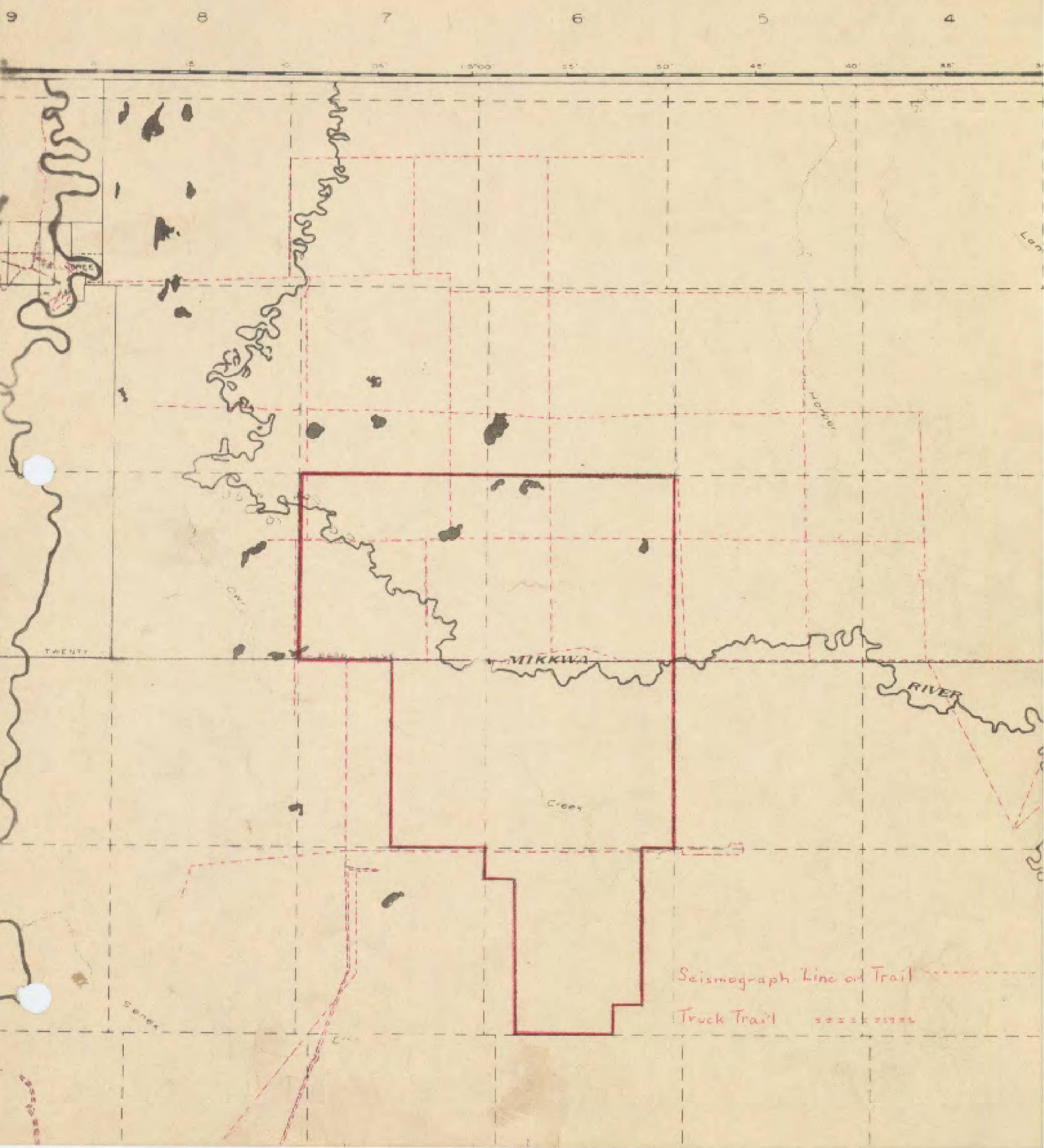
Figure 4

ALBERTA

DEPARTMENT OF
LANDS AND FORESTS

Map Sheet
84 G/B

19680085



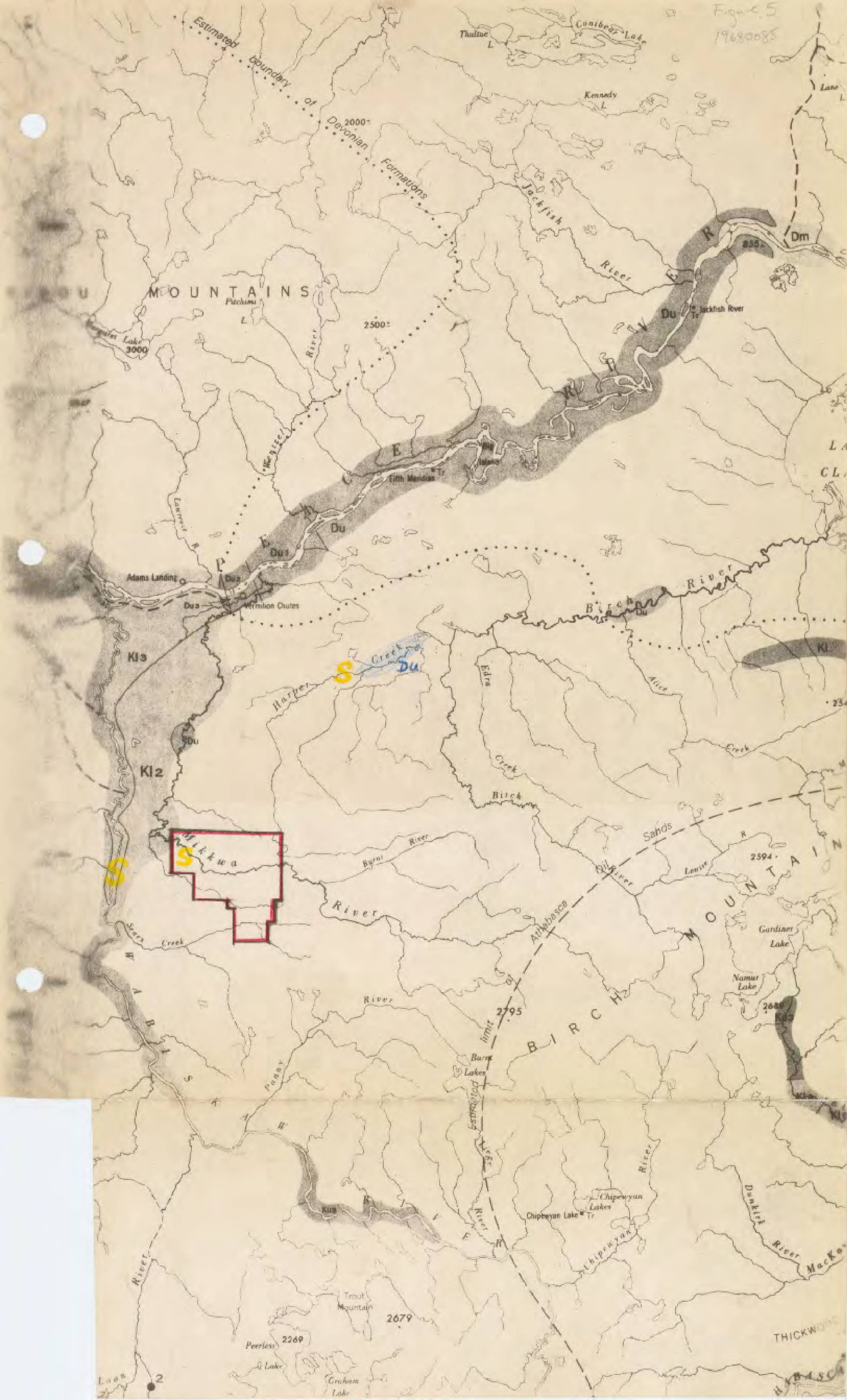


Figure 5
19680085
Estimated boundary of Devonian Formations
2000±
2500±
MOUNTAINS
Pitchimi L
Lake 3000
Thultue L
Conibear Lake
Kennedy L
Jackfish River
Jackfish River
Tr
Du
Dm
855±
PEACE RIVER
Big Island
Fifth Meridian
Tr
Wentzel River
Laurence R
Du3
Du
Adams Landing
Du3
Du3
Vermilion Chutes
Birch River
Du
Kl
Kl3
Kl2
Du
Harper Creek
Du
S
S
S
Edra Creek
Alice Creek
Creek
Birch
Mikkwa
Burnt River
River
Sears Creek
Athabasca Oil Sands
Louise R
2594
River
Gardiner Lake
Namur Lake
2680
BIRCH MOUNTAINS
2795
Estimated limit of
Burnt Lakes
WABASKA RIVER
Panny
Kus
River
Chipewyan Lakes
Chipewyan Lake Tr
Chipewyan
Dunkirk River
River
Loon River
Trout Mountain
2679
2269
Peerless Lake
Graham Lake
THICKWO
2

Vermilion Chutes on Peace River
Looking north toward Caribou Mtns.
Top Devonian

"Rough Water"
Vermilion Chutes on Peace River
Top Devonian

Outcrop Grosmont
below Sulphur Springs
on Lambert Creek

View of Lambert Creek
below Outcrop of Grosmont Reef

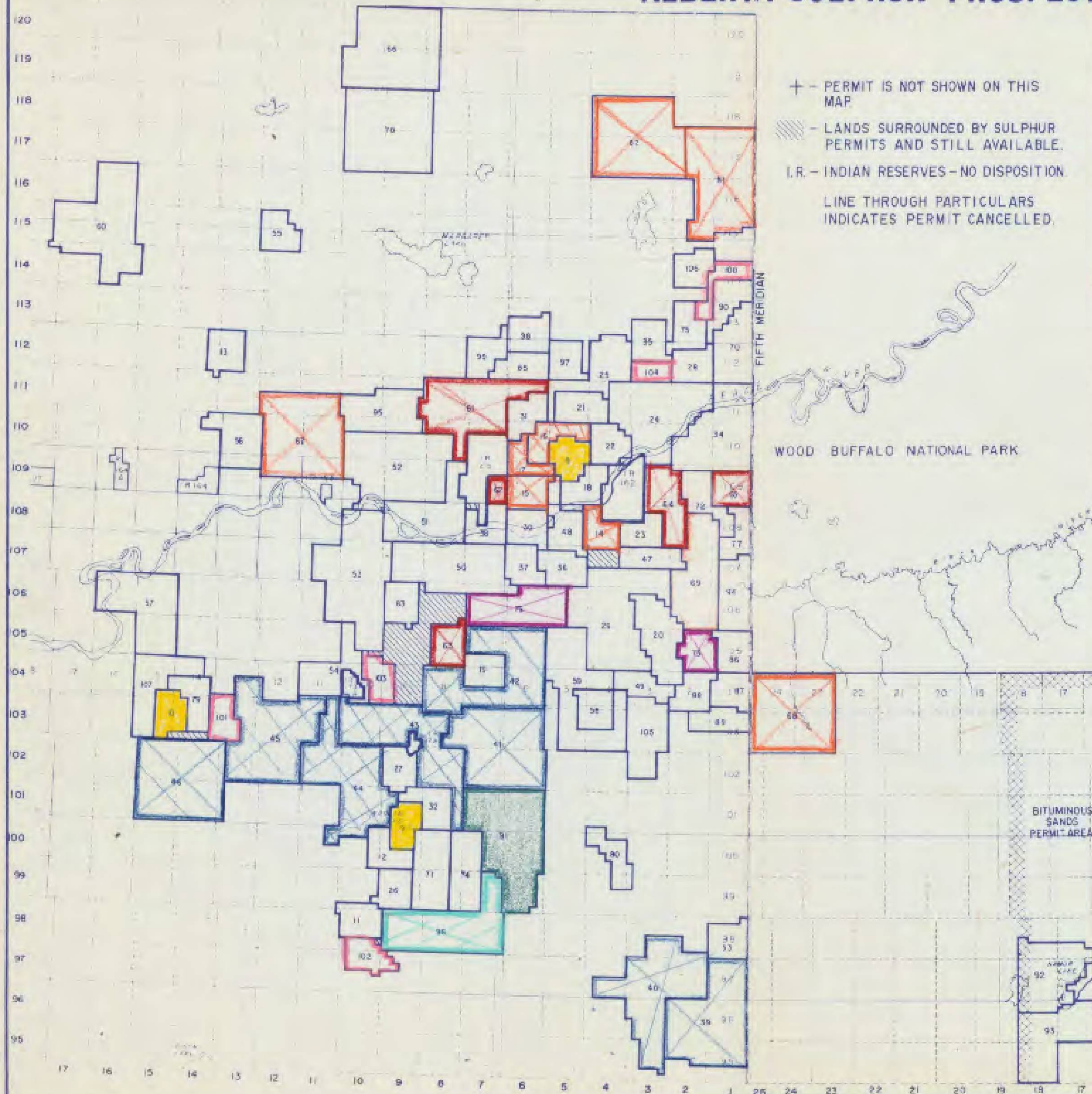
Sulphur Springs
Lambert Creek

Sulphur Springs
Lambert Creek

Sulphur Springs
Lambert Creek

19680085 Figure 1a

ALBERTA SULPHUR PROSPECTING PERMITS



No.	T	R	M	ISSUED	HOLDER	ACREAGE
1.				CANCELLED		
2.				CANCELLED		
+3.	44	16	4	6- 7-66	E.A. Brownless	20,000
~~4.~~	~~112~~	~~12~~	~~6~~	~~11- 1-67~~	~~Inland Chemical~~	~~19,200~~
-5.	43	17	4	29- 5-67	G.I. White	19,980
+6.	46	16	4	17- 7-67	K.R.C., Inc.	19,801
+7.	76	1	4	17- 7-67	Marwood Oils	19,840
8.	110	5	5	8-12-67	J.J. O'Connor	19,840
9.	101	9	5	8-12-67	J.J. O'Connor	19,840
10.	103	15	5	8-12-67	J.J. O'Connor	19,840
11.	98	10	5	8-12-67	Kamalta-Fisher	19,840
12.	100	9	5	8-12-67	L.A. Pearce	19,200
13.	112	13	5	8-12-67	J.E. Cleveland	19,840
14.	108	4	5	8-12-67	Shell Canada	19,840
15.	109	6	5	8-12-67	Shell Canada	19,840
16.	110	5	5	8-12-67	Shell Canada	19,840
17.	109	6	5	8-12-67	Shell Canada	19,840
18.	109	4	5	8-12-67	C.B. Clark	19,840
19.	104	7	5	8-12-67	Inland Chemical	19,200
20.	105	3	5	8-12-67	Great Plains	39,680
21.	111	5	5	8-12-67	Spooner Mines	19,840
22.	110	4	5	8-12-67	Spooner Mines	19,840
23.	108	3	5	8-12-67	Spooner Mines	19,840
24.	110	3	5	7-12-67	B.A.	81,865
25.	112	4	5	7-12-67	Inland Chemical	39,680
26.	99	9	5	7-12-67	Inland Chemical	19,840
27.	102	9	5	7-12-67	Inland Chemical	19,779
28.	112	2	5	7-12-67	C.T. Pasieka	19,840
29.	106	4	5	7-12-67	Western Land	99,840
30.	108	6	5	7-12-67	Blackhawk Expl.	19,840
31.	111	6	5	7-12-67	Blackhawk Expl.	19,840
32.	101	8	5	7-12-67	Blackhawk Expl.	19,840
33.	98	1	5	7-12-67	Alexandra Petrs	19,840
34.	110	1	5	7-12-67	Alexandra Petrs	77,440
35.	113	3	5	7-12-67	Kamalta	19,840
36.	107	5	5	11-12-67	Omega Hydro	19,840
37.	107	6	5	11-12-67	Omega Hydro	19,840
38.	108	7	5	11-12-67	Omega Hydro	19,840
39.	96	1	5	11-12-67	H.B.O.G.	97,280
40.	97	3	5	11-12-67	H.B.O.G.	99,840
41.	103	7	5	11-12-67	H.B.O.B.	99,840
42.	104	7	5	11-12-67	H.B.O.G.	99,840
43.	103	9	5	11-12-67	H.B.O.G.	91,918
44.	101	10	5	11-12-67	H.B.O.G.	94,720
45.	103	12	5	11-12-67	H.B.O.G.	97,920
46.	102	14	5	11-12-67	H.B.O.G.	99,840
47.	107	3	5	11-12-67	J.F. Conrad	19,840
48.	108	5	5	11-12-67	Canadian Fina	19,829
49.	104	3	5	11-12-67	Transalta	19,840
50.	107	8	5	14-12-67	Placid	80,000
51.	108	8	5	14-12-67	Placid	55,680
52.	109	9	5	14-12-67	Placid	98,156
53.	107	10	5	14-12-67	Placid	99,840
54.	104	10	5	14-12-67	Placid	35,520
55.	115	12	5	14-12-67	Placid	19,840
56.	110	13	5	14-12-67	Placid	39,680
57.	106	15	5	14-12-67	Placid	69,120
58.	104	4	5	14-12-67	J.F. Conrad	19,840
59.	104	5	5	14-12-67	J.F. Conrad	79,360
60.	115	16	5	14-12-67	Western Decalta	97,280
61.	111	7	5	18-12-67	Texaco Expl.	79,360
62.	109	7	5	18-12-67	Texaco Expl.	7,680
63.	105	8	5	18-12-67	Texaco Expl.	19,840
64.	108	2	5	18-12-67	Texaco Expl.	39,680
~~65.~~	~~109~~	~~1~~	~~5~~	~~18-12-67~~	~~Texaco Expl.~~	~~15,200~~
66.	120	9	5	18-12-67	Western Decalta	99,840
67.	110	12	5	2- 1-68	Shell Canada	99,520
68.	104	24	4	18-12-67	Shell Canada	97,230
69.	107	2	5	18-12-67	J. Phillips	59,520
70.	112	1	5	18-12-67	J. Phillips	39,680
71.	100	8	5	20-12-67	Pheasant	38,400
72.	109	2	5	2- 1-68	L.A. Pearce	19,840
~~73.~~	~~105~~	~~2~~	~~5~~	~~2- 1-68~~	~~Numac~~	~~19,840~~
74.	99	7	5	2- 1-68	Simmons Drlg.	38,400
75.	113	2	5	2- 1-68	Columbian Petr.	19,840

No.	T	R	H	ISSUED	HOLDER	ACRE
~~76.~~	~~106~~	~~6~~	~~5~~	~~2- 1-68~~	~~Numac~~	~~47,360~~
77.	108	1	5	8- 1-68	Kamalta-Fisher	19,840
78.	118	9	5	8- 1-68	H.B.O.G.	99,840
79.	104	14	5	8- 1-68	Burn Oil Land	19,840
80.	100	4	5	8- 1-68	Burn Oil Land	19,840
81.	117	1	5	8- 1-68	Shell Canada	99,840
82.	118	3	5	8- 1-68	Shell Canada	98,560
83.	106	9	5	8- 1-68	Five Star Petr.	19,840
+84.	87	21	5	11- 1-68	Dirk Vos	19,840
85.	112	6	5	11- 1-68	United Mineral	19,840
86.	105	1	5	11- 1-68	Laurence Oil	19,840
87.	104	1	5	11- 1-68	Laurence Oil	19,840
88.	104	2	5	11- 1-68	Laurence Oil	19,840
89.	103	1	5	11- 1-68	Laurence Oil	19,840
90.	114	1	5	11- 1-68	Laurence Oil	19,840
~~91.~~	~~100~~	~~6~~	~~5~~	~~11- 1-68~~	~~A. Andrekson~~	~~99,840~~
92.	97	18	4	11- 1-68	Amerada-Cdn Sup	59,885
93.	96	18	4	11- 1-68	Amerada-Cdn Sup	60,000
94.	106	1	5	11- 1-68	Alaska-Canadian	33,280
95.	111	9	5	11- 1-68	Alaska-Canadian	39,680
~~96.~~	~~98~~	~~8~~	~~5~~	~~12- 1-68~~	~~Pancil~~	~~80,000~~
97.	112	5	5	12- 1-68	Western Land	19,840
98.	113	6	5	12- 1-68	Western Land	19,840
~~99.~~	~~112~~	~~7~~	~~5~~	~~12- 1-68~~	~~Western Land~~	~~19,840~~
100.	114	1	5	16- 1-68	Sinclair Canada	19,840
101.	103	13	5	16- 1-68	Sinclair Canada	19,840
102.	97	10	5	16- 1-68	Sinclair Canada	19,840
103.	104	10	5	16- 1-68	Sinclair Canada	19,840
~~104.~~	~~112~~	~~3~~	~~5~~	~~16- 1-68~~	~~Sinclair Canada~~	~~11,520~~
105.	103	3	5	16- 1-68	L. Johnston	39,680
106.	114	2	5	16- 1-68	Cleveland Power	19,840
107.	104	15	5	16- 1-68	Heritage Hold.	39,040

MAINTAINED UP TO DATE FREE OF CHARGE TO ANYONE AT ALL TIMES

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CALGARY
Tel. 263-3750

Scale: 1 in. = 20 mi.

SULPHUR PROSPECTING PERMIT No. 91