MAR 19680130: NORTHERN ALBERTA

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Regional Surface Projects
Unit Representation
Geological Evaluation

Surface Geological Work
Prospects
Well-Site Supervison

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GEOLOGICAL

SULPHUR OCCURRENCE IN NORTHERN ALBERTA

The presence of surface sulphur accumulations in Northern Alberta has been known and mentioned by frequent geological surveys in the early part of this century. The local Indians of that area are said to have known of the yellow deposits.

Surface deposits of sulphur occur in a wide belt from Great Bear Lake, N.W.T. to the Clearwater River in Northern Alberta. These surface deposits are the result of highly sulphurous aqueous solutions which probably emmanate from underground springs, fault fissures and fracture patterns. The constant emmission of rich-sulphur-bearing-solutions from below has resulted in the precipitation of thick accumulations of sulphur bearing rocks, in certain areas. These surface deposits are often very pure, in some instances up to 98% sulphur, and are associated with limonite, sand, silt and limestones.

The source of the sulphur bearing solutions, which result in surface deposition of this element, are issuing from the truncated Upper Devonian, Woodbend Group which is exposed to the surface (see cross-section #1) or to the pre-Cretaceous unconformity, (see map #1). The staking of sulphur permits has taken place primarily along the wide band

of Woodbend subcrop; in areas where the Woodbend is exposed to the surface or where it is masked by Cretaceous erosional remnants.

The deposition of primary elemental sulphur can occur from the aqueous solution of sulphides and sulphates; according to the mineral solution equilibria. Thus, hydrogen sulphide coming from the Devonian formations dissolves in water and reacts with anhydrite and or Gypsum, depositing sulphur out of solution. Since calcium sulphate and hydrogen sulphide are more soluable in cold water than in hot, it could mean a high concentration of sulphur precipitation in areas of Karst topography where surface waters have been extremely active. Therefore two ingredients are needed for the formation of surface sulphur deposits (1) the presence of sulphates and sulphides, which could have come from iron pyrite concretions, gypsum or anhydrite. (2) The presence of intense water activity which generally occurs at unconformities and results in subterrainian caverns and sink hole type topography.

Iron pyrite concretions are abundant in the Cretaceous, Cariboo Mountains: the Woodbend group is known to contain thick beds of anhydrite in the subsurface. The area of study thus appears to have the necessary sulphates and sulphides for a chemical reaction. The needed water to bring about the solution and the later precipitation of sulphur, is evident by the amount of pre-Cretaceous and recent erosion in the area. The evidence of recent erosional action can be seen by the huge Cretaceous remnants and karst topography in the area. The

generally peneplained pre-Cretaceous unconformity indicates a long geologic period of erosion and exposure to surface waters. The present day erosional surface, which incises the peneplained pre-Cretaceous surface, is still vigourously envaded by surface solutions.

The said permits lie on the Cariboo Mountains, where Cretaceous beds are exposed to the surface. The Upper Devonian, in the area, lies from 0 to 800' unconformably below the surface. Some deeply incised river gorges, lake shores and sinkholes show outcrops of Woodbend where present day erosion has removed the Cretaceous cover. Surface sulphur deposits appear to occur on the Cretaceous, where the Cretaceous is underlain by the Upper Devonian Woodbend formation. The possibility of concentrated beds of sulphur occurring on top of the Woodbend, or at the pre-Cretaceous unconformity, is a distinct possibility not yet tested in Northern Alberta.

The presence of iron sulphides in the Cretaceous and sulphates in the form of anhydrite in the Woodbend, lend credibility to possible sulphur deposits at the surface and at the pre Cretaceous unconformity. The formation of transporting media for sulphur would be present day or pre-Cretaceous subsurface waters which penetrated the sulphates and sulphides present in the Woodbend and Muskeg Formation, via fractures and faults.

The geological formation in which sulphur occurs in the Woodbend (Upper Devonian) Group, is the Grosmont Formation. This formation consists of vuggy, petroliferous, reefoid dolomites, with varying amounts of thin bedded argillaceous limestones. The Grosmont is a

barrier-reef, equivalent in time to the Leduc. In the off-reef facies the Grosmont is equivalent to the Hay River limestones; in the back-reef areas thick evaporite sections (anhydrite) are known as the Hondo Formation. Native sulphur occurrences are known in the Grosmont, Windfall, Sundance, and Nevis, Leduc reefs. The Cretaceous Loon River shales overlie the unconformable Woodbend strata and contain abundant brown ironstone concretions, containing iron sulphide. The Woodbend is underlain by the Mikkwa Formation, which is equivalent to the Beaverhill Lake Formation, in Central Alberta. The Mikkwa Formation is composed primarily of dense, mottled, brown, limestones. Below the Mikkwa the Middle Devonian Muskeg, Keg River and Chinchaga formations are present. The entire Middle Devonian is composed of dolomite, anhydrite and salt. Salt water recoveries in drill-stem tests indicate high salenities and hydrogen sulphide.

The Grosmont and equivalent formations are exposed along river and creek valleys, certain lake shores and solution sink holes. It is here that native sulphur occurs at the surface as infill in large vugs and in thin beds covering relatively large areas. At Great Slave lake small lenticular pods of sulphur have been observed in Devonian rocks; to the east of the study area, thin beds of sulphur have been observed by Norris on the Peace River, in Middle Devonian strata.

The presence of gypsum and anhydrite in the Woodbend rocks, the ubiquitious occurrence of iron sulphides, the numerous rivers, creeks and sinkholes exposing the Woodbend may account for thick highly concentrated deposits of sulphur at the pre-Cretaceous unconformity, in the study area. These large concentrations of sulphur would have occurred prior to Cretaceous deposition and would have been sealed by them. Since sulphur, once precipitated out, is not exceptionally soluable in water, these deposits would not be succeptible to present day surface waters.

Arial photographs and mosiaics of the said area indicate the presence of considerable sulphur on the surface. The presence of many faults and fissure patterns, on the photographs, show possible channelways for the migration of surface waters to the Woodbend and Lower Devonian sources.

These permits, in the light of present knowledge, appear to be well situated for the exploration of surface and pre-Cretaceous sulphur deposits. Air photographs of the subject area indicate a similar pattern or analogy to those areas of extensive deposits of surface sulphur.

SULPHUR-BEARING FORMATIONS PRESENT

Practically all the sulphur recovered from sour gas in Alberta originates from the Paleozoic-Mississippian and Devonian systems.

Although in the subject area the Grosmont is the underlying formation and contains native sulphur, older Devonian formations such as the Beaverhill (Mikkwa) which underlie the northeastern portion of Alberta may also contain sulphur. Subsequently, younger Devonian and Mississippian formations (Winterburn, Wabamun, Banff, etc.) which subcrop successively as one proceeds west from the subject area, may also contain sulphur in situ. This is evident by the occurrence of sulphur at Great Slave Lake which is found in the Devonian Sulphur Point Formation (underlying the Beaverhill) and elsewhere in the Province, at depth.

The large Elk Point Salt Basin which parallels an area lying south of the Caribou Mountains, may have on its north flanks, thin salt sections. These salt sections by solution collapse may cause certain subsurface features favoring sulphur accumulation and deposition. Further detailed research and intensive studies of air photo mosaics may indicate certain patterns and alignments of surface features favoring sulphur deposition.

GEOLOGICAL MAP (refer to MAP #1)

The map shows the Upper and lower erosional edges of the Woodbend formation with the marked Grosmont outcrop along the Peace River, at Vermillion Chutes. The erosional edge of the Cretaceous, where it overlies the Woodbend is also shown.

RECOMMENDATIONS

It is recommended that an intensive detailed study of air mosaics be undertaken to establish favourable areas of sulphur accumulation. These areas should be evaluated on the ground as soon as weather and snow conditions permit. Once areas of favourable deposits are outlined by surface mapping a shallow test hole programme is recommended to delineate the depth and extend of the deposit.

The cost of such a programme is as follows:

1.	Photogeological study	2,500
2.	Surface inspection	3,500
3.	Shallow test drilling up to 1000'	7,000
4.	Sulphur assays @ $4.00 each	2,000
		$ 15,000

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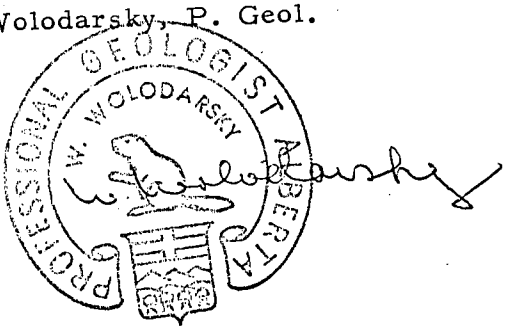

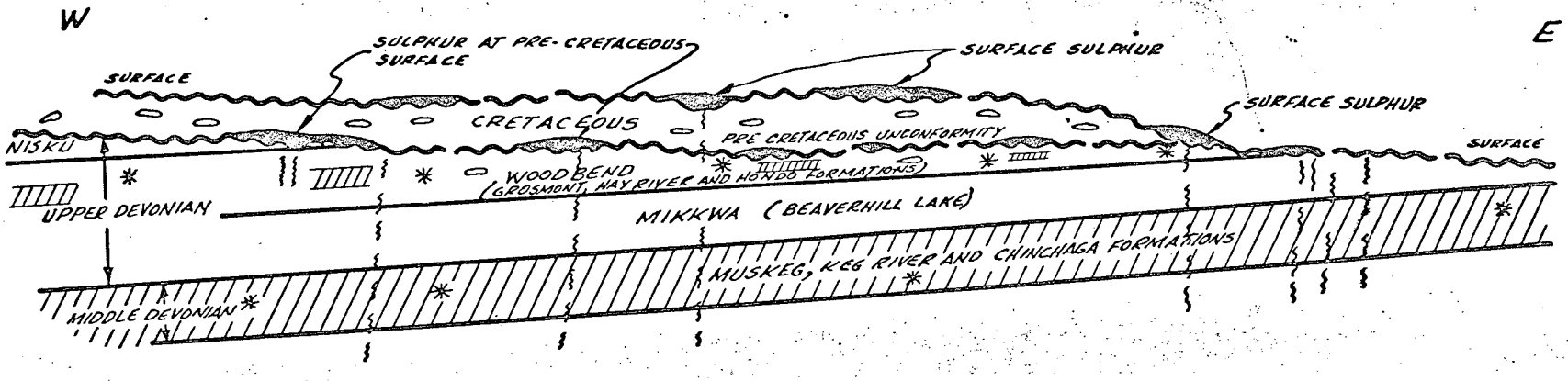

NOTE: 1. SULPHUR AT PRE-CRETACEOUS UNCONFORMITY REPRESENTS OLDER? PRE-CRETACEOUS DEPOSITION OF SULPHUR AT UNCONFORMITY.
2. SULPHUR ON TOP OF CRETACEOUS REPRESENTS YOUNGER GENERATION OF EROSION AND SULPHUR DEPOSITION.
3. SULPHUR ON SUBCROP OF WOODBEND. COULD BE PRE-CRETACEOUS OR YOUNGER IN AGE, OR A COMBINATION OF BOTH.

THE SULPHUR DEPOSITS IN ALL THREE LOCALS ARE PROBABLY THE RESULT OF SURFACE WATERS, BRINGING TO THE SURFACE AQUEOUS SOLUTIONS OF SULPHIDES AND SULPRATES FROM UNDERLYING BEDS.

LEGEND

- IRON SULPHIDE NODULES
- EVAPORITES (ANHYDRITE, DOLOMITE AND SALT)
- SULPHUR
- FISSURES - FAULTS PROVIDING CHANNEL WAYS FOR MOVEMENT OF SURFACE WATERS.
- MAJOR UNCONFORMITY
- TRACES OF KNOWN SULPHUR IN ROCKS.

DIAGRAMATIC EAST-WEST CROSS SECTION THROUGH CARIBOO MOUNTAINS

NO EXACT HORIZONTAL OR VERTICAL SCALE.

CROSS SECTION #1

By. W. WOLODARSKY

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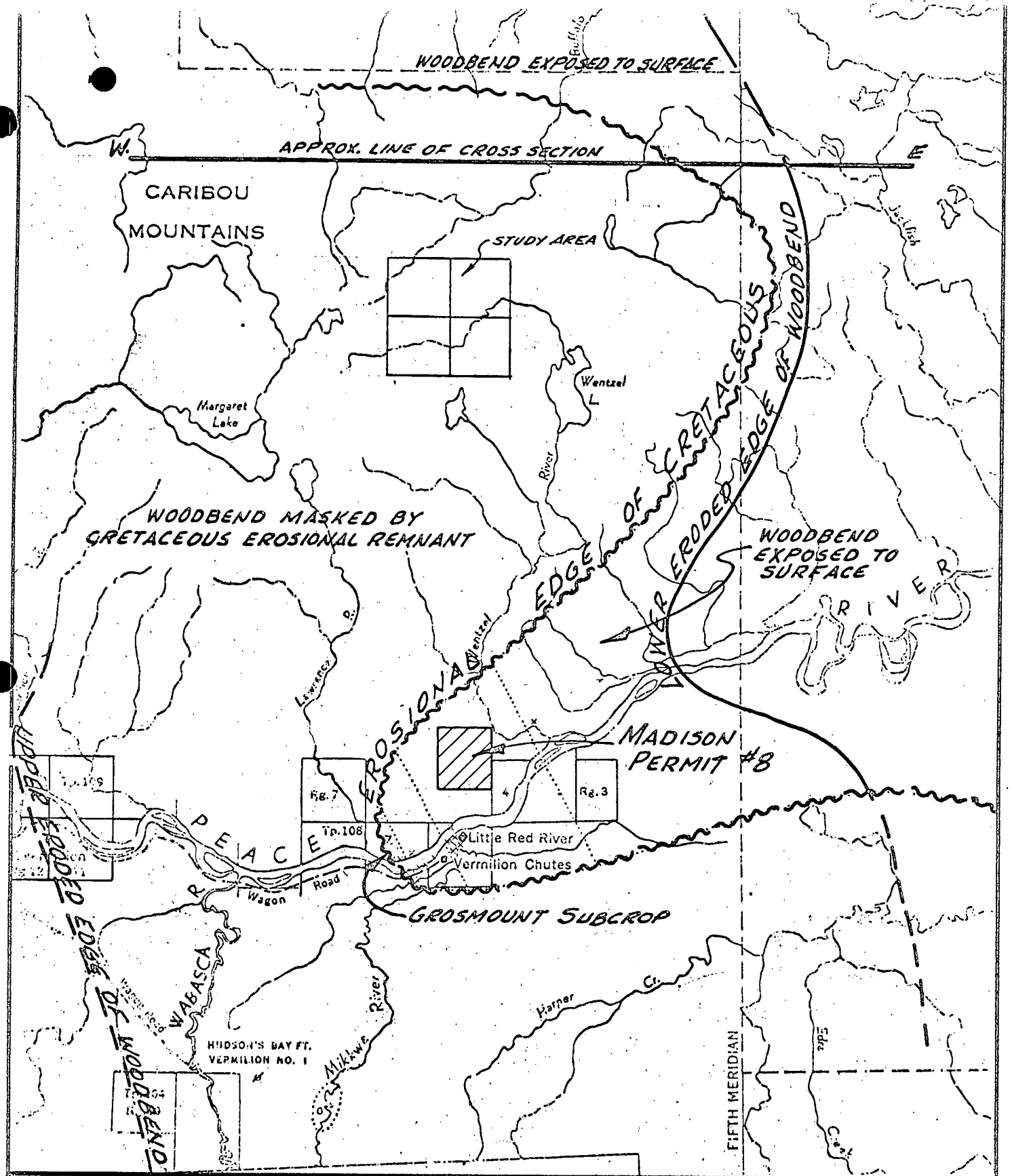
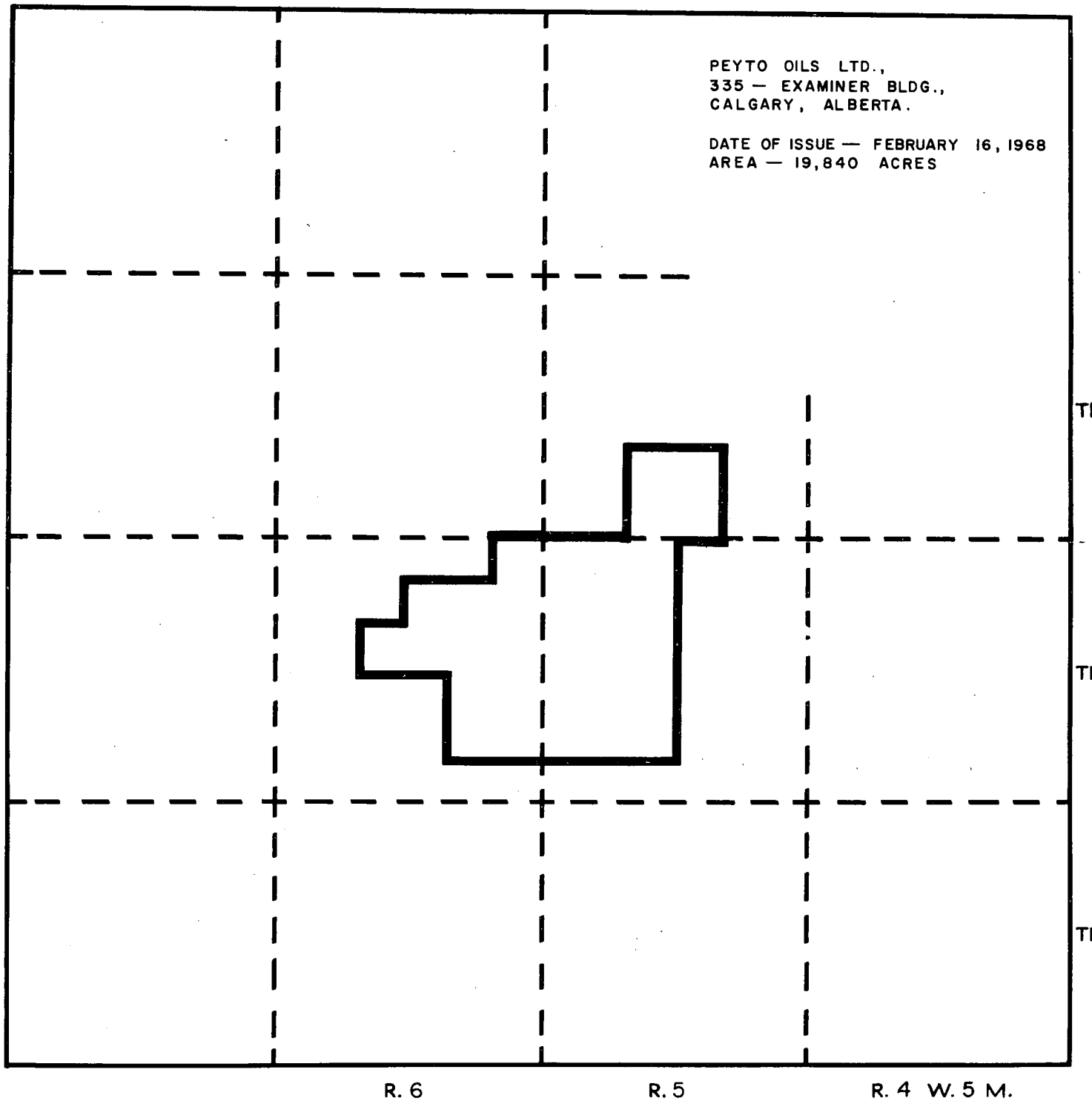


MAP #1

SULPHUR PROSPECTING PERMIT No. 165



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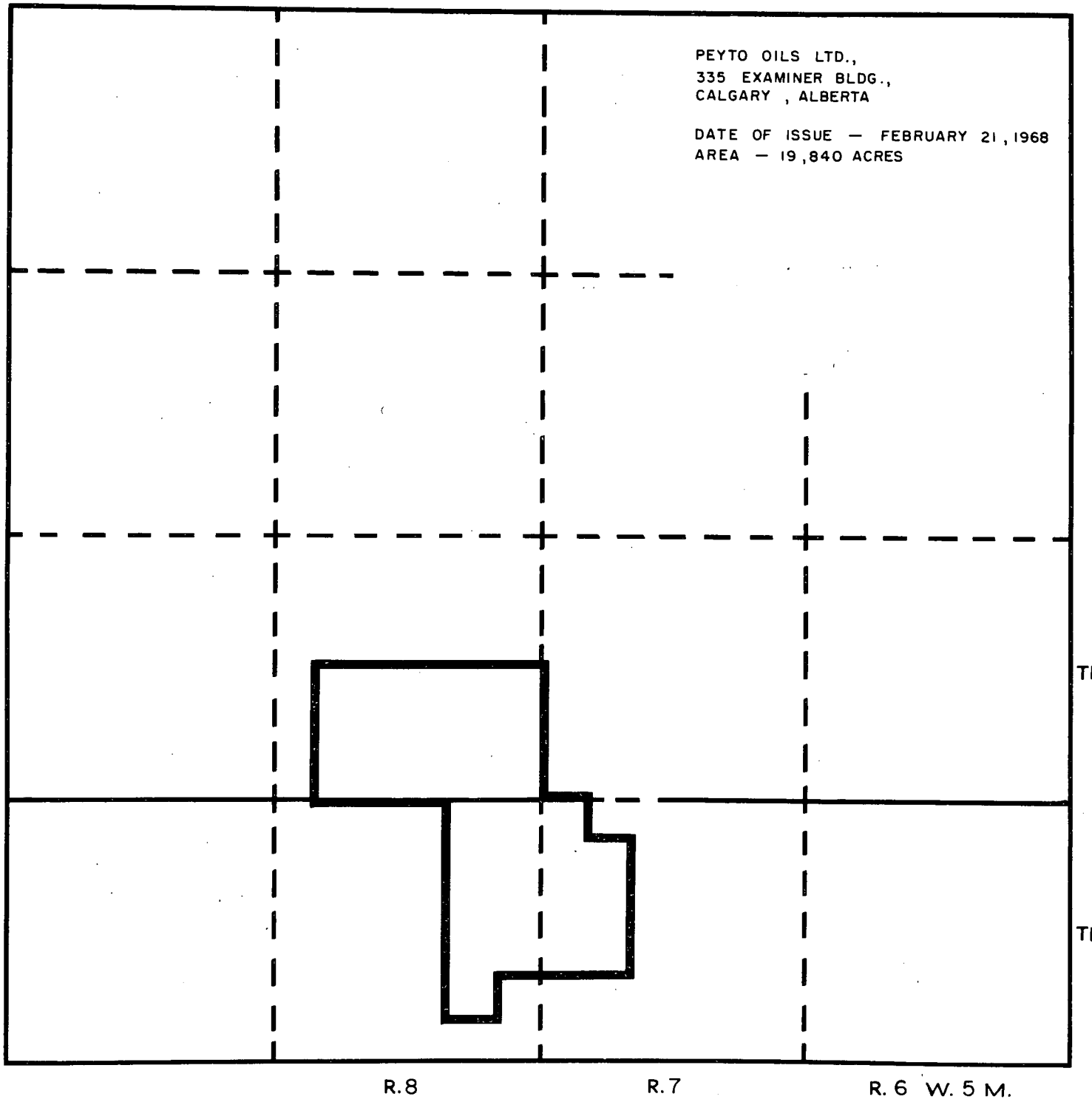

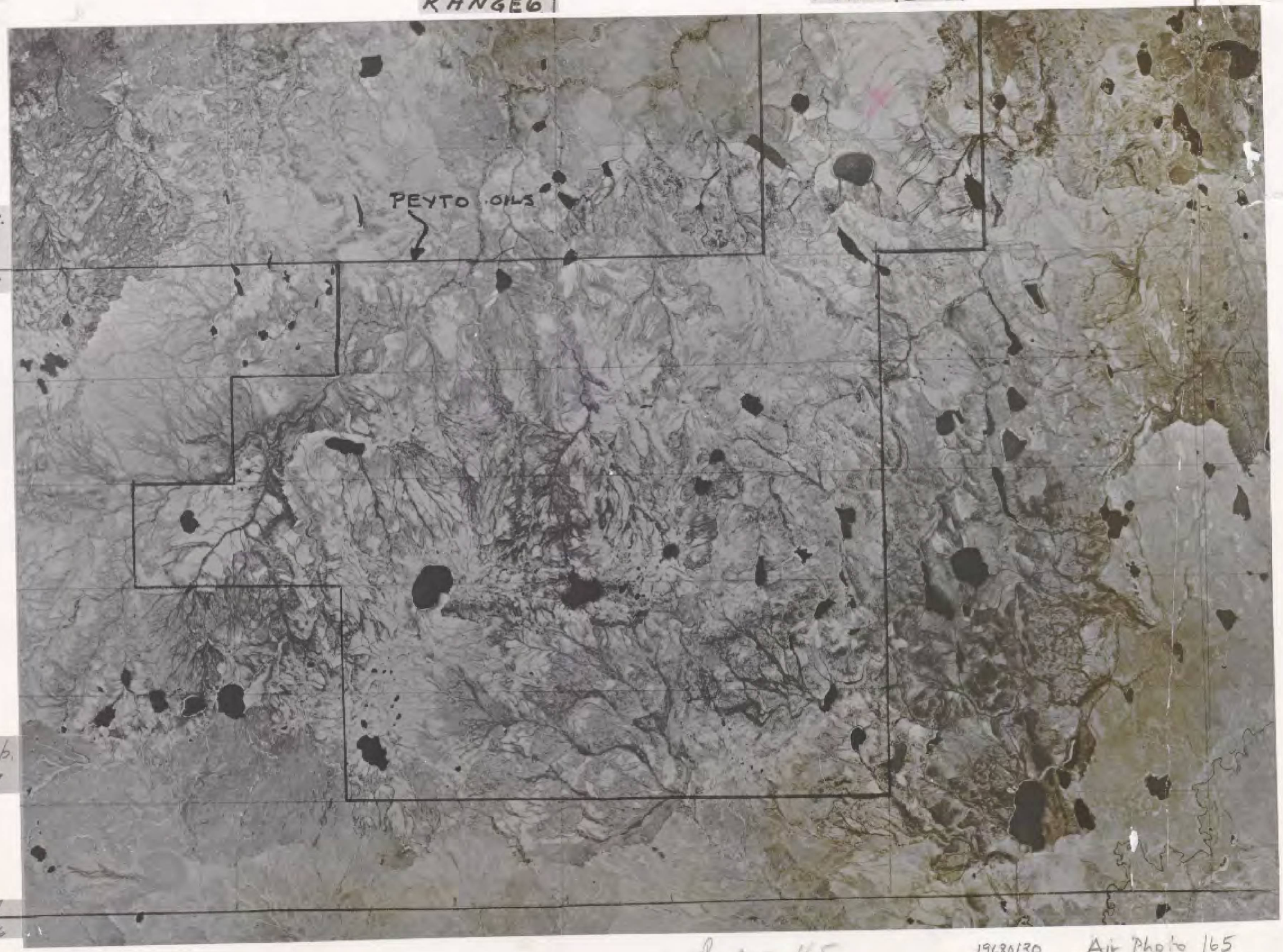

Peyto 165 19680130 Air Photo 165

Peyto 169 19680130 Air Photo 169