MAR 19670008: PONTON RIVER & WENTZEL RIVER

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PRELIMINARY GEOLOGICAL REPORTS

PONTON RIVER & WENTZEL RIVER SULPHUR PROSPECTING PERMITS

NORTH-CENTRAL ALBERTA

INTRODUCTION

This report has been prepared at the request of Mr. H. A. Pearson, acting for Sturdy Mines Limited, Multi-Minerals Limited, Ortega Minerals Ltd., and Kamalta Explorations Ltd. These four companies share equally (25 percent each) in the two Sulphur Prospecting Permits described below under the heading of "Property."

The report presents the results of an investigation of published literature covering the area surrounding the Company's two Permits and a preliminary field examination of Alberta Sulphur Prospecting Permit No. 13 (Ponton River Permit) on November 13 and 15, 1967. Due to the presence of low cloud cover which impeded helicopter flying, it did not prove possible to examine the Company's second Permit area on the Wentzel River at that time. Significant information regarding these and adjacent areas is available from our files or from published literature and has been utilized in this report.

The field work was undertaken by Mr. V. A. Farley, one of the senior field geologists of J. C. Sproule and Associates Ltd., Consulting Geologists and Engineers of Calgary, Alberta. The presence of widespread, but moderate, snow cover in the area during the November field study was an important factor in determining the extent to which field examination was feasible. The field work was carried out from a base at High Level, and transportation in the field was by means of helicopters supplied by Alpine Helicopters Ltd. of Calgary, and Associated Helicopters Ltd. of Edmonton, from bases at High Level and Rainbow Lake.

Property

Sulphur Prospecting Permit No. 13 (also referred to as the Ponton River Permit), includes a total of 19,840 acres and is described as follows:

Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, 26, 35 and 36, Township 112, Range 14, W.5 M.
Sections 4, 5, 6, 7, 8, 9, 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, and 33, Township 112, Range 13, W.5 M.
Section 36, Township 111, Range 14, W.5 M.

This Permit was formally issued on November 8, 1967 in the name of Colin Hugh Kerr, but it is beneficially owned in equal shares by the four companies listed above. This ownership has been confirmed to us verbally by officers of all four companies, and it was announced in the December 6, 1967 issue of Nickle's Daily Oil Bulletin.

The second Sulphur Prospecting Permit, which was applied for in mid-November, has not as yet been assigned a number so that it will hereinafter be referred to as the "Wentzel River Permit" (after the principal river in the area). This Permit includes the same number of sections of Permit No. 13 and is described as follows:

Sections 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17 and 18, Township 113, Range 3, W.5 M.
Sections 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, and 35, Township 112, Range 3, W.5 M.

It is understood that the Permit application has been accepted by the Alberta Government authorities but due to the number of applications outstanding in this fast-moving "play", there is currently a delay of several weeks in the completion of the paper work prior to formal issue. The application for this Permit was recorded in the December 6, 1967 issue of Nickle's Daily Oil Bulletin, where it was reported as the "general Waldo Creek area." Waldo Creek is a small stream whose headwaters are within the Permit area.

The two Permit areas described above have not been previously under permit for the purpose of prospecting for sulphur.

No detailed investigation has been made by the undersigned as to the ownership or percentage interests held by the above-mentioned Group of Companies.

Location and Access

The Ponton River Permit (Permit No. 13) is located 26 miles northeast of the town of High Level (Figures 1 and 2), Highway 58, an all-weather gravel road which runs in an easterly direction from High Level, passes within 12 miles of the southern boundary of the property. Seismic and secondary roads are plentiful in the general area and it is believed that the Permit area could be reached by a four-wheel drive vehicle with a small amount of road repair.

The Wentzel River Permit is located 95 miles east of High Level. Highway 58, now under construction, passes within four miles of the southeastern corner of the Permit. This highway is in some stage of completion at least to the Wentzel River, since it is currently being used to service an oil well being drilled in the north half of Township 111, Range 4, W.5 M., approximately six miles southwest of the subject Permit.

The mainline of the Great Slave Lake Railway, operated by Canadian National Railways from Roma, Alberta, near the town of Peace River, to Hay River and Pine Point in the Northwest Territories, passes through the town of High Level. The Mackenzie Highway follows the same route from Peace River to Hay River. Edmonton may be reached from High Level by either road, rail, or scheduled airlines, via Peace River (a distance of approximately 460 miles).

The Peace River itself, which flows less than 20 miles to the south of the Permits, is navigable to moderate size vessels and it might be of commercial significance for some types of traffic, but only for about five and one-half months annually.

Topography

The Ponton River Permit area slopes gently from north to south, dropping in elevation above sea-level from approximately 1,700 feet to 1,400 feet. The Ponton River flows southward through the centre of the area, locally exposing cliffs up to 150 feet in height of bedrock and slumped material. Surface cover in the area consists of lake-deposited sediments overlying glacial till. These lacustrine deposits appear to be quite thin where they were observed along the Ponton River.

The surface of the Wentzel River Permit is level to gently rolling and the area as a whole is gently inclined to the southeast at approximately 65 feet per mile. The Wentzel River cuts through the extreme northwest corner of the Permit and flows to the southwest. The major portion of the Permit is drained by the headwaters of small southeastward-flowing tributaries of the Peace River, Waldo Creek and Fitz Creek. Lake deposited sediments cover the southeastern half of the property.

HISTORY OF NORTHERN ALBERTA SULPHUR PLAY AND ITS RELATIONSHIP TO REGIONAL GEOLOGY

Sulphur, in various manifestations, has been reported from many points in northern Alberta and the adjacent parts of the Northwest Territories over a period of at least a century. Such sulphur shows have taken the form of small deposits around springs and around gas seeps, (including "smoke" or "steam" escapes), of thin stringers, beds and cavity infillings in various types of beds, of nodules of marcasite (a form of pyrites, or iron sulphide), as well as of finely disseminated sulphur which is present as an appreciable minor constituent in many shale deposits and in the well known Athabasca Oil Sands. Furthermore, vast deposits of calcium sulphate in various forms have been known for many years from surface deposits in Northeastern Alberta and neighbouring areas, and similar deposits are now known to be widespread in the subsurface.

Until the last few years, it was virtually universally assumed that such sulphur deposits were uneconomic. Even in the early years of the present decade, vast unsold stockpiles of high quality sulphur were still accumulating at many of the sour gas-producing plants scattered throughout southwestern Alberta. The limited quantities of sulphur sold at that time were priced at about $11.00 per ton. During the mid-sixties, the worldwide sulphur supply-and-demand picture has changed dramatically as demand, stimulated particularly by the worldwide fertilizer industry, has outstripped supply, stockpiles have been depleted, new discoveries have failed to replace exhausted reserves, and major producers have been obliged to ration long-standing customers. In these changed circumstances, sulphur prices have increased to $40.00 to $50.00 range for large long-term contracts, and to much greater prices for individual "spot" sales.

Under the new conditions, the earlier scattered reports of sulphur shows in northern Alberta have suddenly become of possible economic significance. During recent months, mainly as the result of reports by local inhabitants of a large area of north-central Alberta on both sides of Peace River, principally in the general vicinity of the Caribou Mountains and the Buffalo Head Hills, a considerable number of Sulphur Prospecting Permits have been issued to a number of persons and companies, and many other Permit applications are presently being processed by the Alberta authorities. The early reports by laymen have, in many cases, been confirmed and elaborated by geologists and other specialists, and their findings have been checked by assays by several reputable laboratories. The serious nature of the present sulphur play has been further confirmed in recent weeks by the active entry of Shell Canada Limited, Canada's largest sulphur producer, which is also one of the largest major international oil companies. Within the last three weeks, two other large companies have taken out new Sulphur Prospecting Permits in this same play, one being Inland Chemical Canada Ltd., the largest sulphur users in Canada, and the other is Hudson's Bay Oil & Gas Limited, one of the principal oil producing companies in Alberta, which is backed by very large international oil and trading interests. Still another substantial interest, Bow Valley Industries Ltd., have recently acquired options to purchase the first three Permits within the area of the present play (Nos. 8, 9 and 10), whose filing precipitated the present flurry of land acquisition and exploration. More recently British American Oil Company, Canada's second largest integrated oil company has made application for Sulphur Prospecting Permits, and several other large oil companies have been reported

unofficially to have made similar applications (Daily Oil Bulletin December 1, 1967). In addition, a considerable number of other Permits have been acquired or applied for by smaller companies or by individuals acting either for themselves or for undisclosed interests. Further details of these Permits and applications are shown on Figures 1 and 2 and in the Appendix.

The geological environment in which these sulphur prospects occur may be summarized as follows. The present filing is concentrated in a rectangle covering more than 10,000 square miles of north-central Alberta, entirely to the east of and largely to the south of the Peace River. This rectangle extends from Township 95 in the south to Township 113 in the north, and from the Fifth Meridian in the east to Range 15 in the west (Figures 1 and 2). There are no well defined geological boundaries to the present play and it may well become extended further in any direction. Within the rectangle described above, the principal outcropping bedrocks in the area are of Cretaceous age, but in the northeastern portion of the rectangle, particularly in the valleys of the Peace and Mikkwa rivers, erosion has stripped off the Cretaceous beds and has exposed much older Devonian rocks.

The Devonian rocks exposed in this northeastern corner of the region belong to a series of Paleozoic rocks, which extends from the margin of the ancient mass of crystalline and metamorphic rocks of the Precambrian Shield exposed to the north and east in the country around Lake Athabasca. These Paleozoic rocks are generally inclined gently to the west or southwest so that progressively younger rocks are exposed in those directions. The Paleozoic rocks exposed within the rectangle discussed above are of Late Devonian age, whereas Middle Devonian rocks are exposed not far to the eastward in Wood Buffalo National Park and elsewhere. Long after the Devonian rocks were deposited, but prior to Cretaceous times, the whole Paleozoic series of rocks was severely eroded and then, still later, the whole erosion surface was tilted westward both prior to and subsequent to the deposition of the Cretaceous sediments. This westward dipping Mesozoic sedimentary sequence forms part of the eastern limb of the Alberta Syncline. The affect of these events and of post-Cretaceous erosion has been to expose the Devonian rocks in the northeast of the area, and to leave them buried by a progressively thicker series of Cretaceous beds to the westward (Figure 1). In the extreme southwestern part of the area of interest, the Upper Devonian rocks beneath the pre-Cretaceous erosion surface are themselves overlain by a wedge of younger Paleozoic sediments of Mississippian age, which wedge generally thickens to the west. The Cretaceous overburden above the Paleozoic ranges in thickness from zero in the northeast around Vermilion Chutes and along the Mikkwa River, to some 2,000 feet in the western part of the area under discussion. Although the general thickening is to the westward and southwestward, the local topographic relief in the area also has a pronounced affect, so that Cretaceous thicknesses are markedly less beneath the major river valleys than beneath the principal hill areas, such as the Buffalo Head Hills (Figure 2).

For the purposes of this report, which is principally concerned with sulphur prospects, it is not necessary to describe the details of the stratigraphy of the area. Although, at the present stage of research in connection with this very new sulphur play, no definite evidence as to the origin of the sulphur is available, there are excellent grounds for considering that the principal source for the sulphur manifestations is essentially within the extensive Elk Point evaporite deposits of Middle Devonian age. These Elk Point beds, which contain

large quantities of calcium sulphate (anhydrite and gypsum principally), are exposed in Wood Buffalo National Park to the northeast and occur extensively in the subsurface in a vast belt of Alberta extending from the area around the prolific Rainbow Lake oilfields immediately to the westward near the British Columbia border, southeastward across neighbouring Saskatchewan into North Dakota.

Various complex mechanisms for the transformation of calcium sulphate into sulphur are known to exist but it is not the purpose of this report to delve into the chemistry of such changes. Generally speaking, sulphur appears to be derived from calcium sulphate which has been in the presence of suitably circulating subterranean waters, of hydrocarbons and of certain bacteria which are associated with the hydrocarbons.

Within the rectangle under discussion, sulphur in various manifestations and quantities has been reported from many different locations and geological environments. Little information has been formally released by the various companies and individuals in the area and our ideas must necessarily be based largely on our own observations supplemented to a limited degree by the more reliable reports which are generally current in the industry. Some of the phenomena, which first drew attention to the region's sulphur prospects, are associated with various types of combustion, some of which may have been induced spontaneously by chemical reaction and others which probably have been started by lightning or some other external agency. Burning phenomena of various types have been reported. These include burning pits, where the ground surface together with varying amounts of underlying material burn actively. The area now covered by Sulphur Prospecting Permit No. 8 (O'Connor Syndicate - Madison Oils Ltd., now under option to Bow Valley Industries Ltd.) is one of the best known examples characterized by such burning. Indeed, it was the efforts of local Indians and others working in conjunction with the Forestry authorities to eradicate such burning that drew attention to the presence of high percentages of sulphur (in the 60 to 90 percent range in a number of cases) in near surface deposits. Other sporadically burning areas appear to be at least partially associated with gas seeps with the gas apparently consisting largely of methane and hydrogen sulphide in varying combinations. Burning gases may be associated with steam and/or smoke in many instances.

Another combination phenomenon which is widespread in the region under discussion consists of "smokes" (or "bocannes") and "fires" associated with burning shales and slump features. These features closely resemble those which gave the name to the Smoky River, some hundred miles to the south-southwest, and which have been described in a number of publications (for example, Selwyn, 1877, pp. 56-58 and 73; Dawson 1881, pp. 57B and 123; and Rutherford 1930, pp. 51-53). Features of the "Smoky River type" are particularly common in the western portion of the region under discussion in this report stretching from the Ponton River in the northwest, around the northern and eastern edges of the Buffalo Head Hills, particularly in the vicinity of the Wabasca River in its segment between Wadlin Lake and the lower reaches of the Muddy River. That there is some relationship between such phenomena and the presence of sulphur in some form seems evident, but it is clear that at least some of the "Smoky River type" features, particularly as described by Rutherford, need not necessarily be associated with appreciable quantities of sulphur. These phenomena appear to be associated in almost all instances with recent slumps within shales (which invariably contain minor amounts

of sulphur, iron sulphide and other non-clay minerals). The slumping apparently triggers the mechanism which leads to ignition by bringing air and/or moisture into contact with fresh shales and combustion usually is short-lived, leaving brightly coloured patches of burnt shales. Both before and after the combustion phase, the surrounding terrain is characterized by abnormally high temperatures, which may maintain it free of snow during winter. Although this type of combustion in the region under consideration has not yet been demonstrated to be related directly to known major sulphur deposits, several of the reported lesser sulphur occurrences, especially in the Cretaceous shales of the Wabasca-Muddy area, are situated in close juxtaposition with slumped, steaming, smoking or burning shales.

Some of the combustion phenomena discussed in the preceding paragraph have been reported to have springs in the vicinity, but no analyses of such spring waters are available. Outside the limits of the present study area, there are many reports of both cold and warm sulphur springs within the area of Devonian outcrop stretching from south of Wood Buffalo Park to Great Slave Lake, but these have not been considered to be of commercial importance up to date. Such spring deposits appear to be mainly quite limited in size and are scattered over a wide area. In order for sulphur formed by chemical change from the underlying Elk Point evaporites to have become concentrated in potentially commercial deposits, some mechanism for channelling migrating sulphur into specific local accumulations is required. Two factors that might influence the migration and concentration of sulphur in this area are briefly discussed in the following paragraph.

It is assumed that sulphur deposited at or near the surface has been brought from depth by means of flowing sulphur springs along fissures following major fractures and faults within the overlying rocks. Most of the Upper Devonian sequence above the main evaporites is formed of rigid carbonates as well as of indurated and brittle shales and other sediments. Such older sediments are normally well jointed, and any major fractures and faults developed within them tend to remain as open fissures that form semi-continuous channels for migrating fluids. In contrast to these Paleozoic rocks, the overlying Cretaceous sediments in the region under discussion mainly consist of relatively plastic shales that tend to seal up the majority of fissures that have been formed within them during their geological history. For these reasons, sulphur springs and similar phenomena of deep-seated origin are more common in the areas of Devonian outcrop to the north and northeast of the region than in the areas of Cretaceous cover. The prospects of encountering large quantities of sulphur concentrated at the surface in local areas would appear to be relatively poor over the broad expanse of Devonian areas with abundant open fissures, as sulphur will tend to be dispersed at many scattered points over a large area. Prospects within the areas of thick Cretaceous cover are probably even poorer. In either of these major areas, the principal prospects should be best in the vicinity of major faults and fractures, especially where such features intersect. On the basis of our present knowledge, we assume that the principal surface concentrations are likely to be close to the surface trace of the Devonian-Cretaceous unconformity, since it seems likely that sulphurous waters migrating upward through open fissures within the Devonian carbonates would commonly encounter the barrier of impermeable overlying Cretaceous shales and would then tend to continue to migrate upward beneath the base of the gently inclined Cretaceous beds toward the present erosion surface. As the "outcropping" Devonian beds of this region mainly occupy low-lying areas and the Cretaceous beds tend to

rise up above them, sulphur from springs near the unconformity is most likely to be deposited on the Devonian side of the contact. In some cases sulphur may not have been able to migrate freely beneath the unconformable Cretaceous cover, and some may have been deposited in porous zones close below the unconformity, either in ancient weathered deposits related to the pre-Cretaceous land surface or in porous beds within the Devonian sequence. The substantial Devil's Elbow-Ankerton sulphur deposit southeast of Edmonton in the subsurface, some eighty feet beneath the top of the Devonian and below the Cretaceous unconformity, may perhaps be of this latter type, although little detailed information has yet been released (see Nickle's Daily Oil Bulletin listed under References with May-June 1967 dates).

Within the region under consideration the largest reported sulphur deposits, on the Madison et al Permit No. 8 (Northern Miner, November 30, 1967, page 97), are situated immediately on the Devonian side of the surface trace of the Devonian-Cretaceous unconformity in just the type of location which fits the theory which we have propounded. A further point of interest regarding this deposit is that it appears to be at least partly within post-glacial fluvio-lacustrine clays and gravels which form a thin cover over the Devonian beds. It would seem that sulphur springs must have been very active in the immediate post-glacial period when meltwater lakes fringed the retreating glaciers and ice-caps. At such a time, the removal of the ice-load would have permitted escape of pent-up migrating fluids previously trapped beneath the ice. Furthermore, the release of pressure in the earth's crust during the relaxational phase of diminishing ice-loading with the associated upward isostatic adjustment of the land surface probably was accompanied by the opening up of many fractures, which may have further increased a spring activity. It cannot be wholly discounted that the glacial activity, which resulted in the movements of materials southwestward from the evaporite exposures of Wood Buffalo National Park and elsewhere, might have resulted in the transport of calcium sulphate materials into the region under consideration including the post-glacial lakes, but we doubt whether such mechanisms would have given rise to the sulphur phenomena observed in the region.

Although we have assumed that the bulk of the sulphur of the region emanates by means of chemical reactions and migration from evaporite deposits, some of the sulphur may have been deposited around seeps of sour gas. Both at the surface and in the subsurface, sour gas may deposit elemental sulphur under suitable conditions of temperature, pressure and hydrogen sulphide concentration.

LOCAL GEOLOGY

The following descriptions of local geology are brief due to the nature of the outcrop and because the field reconnaissance was carried out under conditions of partial snow cover, which precluded comprehensive mapping. At this stage of exploration, we consider that the position of these Permits within the regional geological setting is of much greater significance than the presence or absence of any particular local features.

Ponton River Area (Sulphur Prospecting Permit No. 13)

Sulphur Prospecting Permit No. 13 was examined in the field to check a reported "burning area" on the property and attempt to evaluate its significance. On arriving at High Level, and prior to visiting the Permit area, a check was made with the nearby Forestry District Office. Because if its role in fire control, this office was aware of several shale outcrops that had recently been "burning" and these had been located on a wall map. One of these locations was on the Ponton River at the extreme eastern edge of Section 19, Township 112, Range 13, W. 5 M., near the centre of Sulphur Prospecting Permit No. 13. When the above location was visited in the field later that day, no smoke or steam was observed and any evidence of previous burning was difficult to ascertain because of snow cover.

No detailed geological maps are available of the area. The following geological observations are based on a reconnaissance of the Permit by helicopter and a surface examination of outcrops along the Ponton River at the extreme eastern edge of Section 19, Township 112, Range 13, W. 5 M.

Discontinuous outcrops of dark grey Cretaceous shales and thin ironstone beds form high angle slopes along the meandering course of the Ponton River. These cliffs rise approximately 150 feet above the river in the north half of the Permit, but are much lower in the south portion. The beds appear to be essentially horizontal; slumping is common, however, on the steeper slopes, and makes it difficult to determine the true bedding position.

A common feature is the yellow weathering characteristic of some of these shales, which is due largely to a thin limonite coating. Locally, this material is also seen filling numerous fractures in the shales, especially in the slumped areas. As these shales weather, irregular concentrations of limonite, sometimes several feet across, collect at the base of the slopes.

Five samples were collected on a somewhat arbitrary basis from the outcrop examined on the Ponton River and assayed for sulphur content by Crest Laboratories Ltd., Edmonton, Alberta.

These are described as follows:

Sample No.	Description	Sulphur %
1 and 2	Yellow limonite	.30
3	Black Shale	.77
4	Zone encrusted with secondary deposits.	.56
5	Grey shale with abundant yellow material (mostly limonite). This sample was near the base of the surface deposits and quite weathered.	3.92

It should be noted that within the region as a whole, samples of almost identical appearance, in each case of bright yellow powdery material, have shown sulphur to vary from zero to 30 percent while limonite content has correspondingly varied from quite low percentages to almost 100 percent. A detailed collecting and assaying program would be required to adequately check the nature of such widespread yellowish deposits, but such a study might not be warranted on account of the generally small proportions of such materials compared to the total amount of sediments.

Wentzel River Area

In the introduction to this report it was explained that, on account of weather conditions, this Permit was not mapped nor examined in the field so that the nature of the bedrock geology can only be interpreted from regional maps and from air photographs.

Surface cover in the Permit area consists of glacial till which in the southeast is overlain by relatively thin lake deposits. Additional information on surficial deposits of the area is presented in Preliminary Soil Survey Report 60-1, which is available from the Research Council of Alberta.

As previously described, under Regional Geology, the Cretaceous-Devonian contact is known to be present near Vermilion Chutes (on map 1161A, Geological Survey of Canada - 1965), this contact is shown extending in a northeasterly direction to a point in Township 111, Range 5, W. 5 M. where it intersects, and locally parallels, the Wentzel River. If this should be correct, then the subject Permit would be located in a similar geological position, with respect to this contact, as Sulphur Prospecting Permit No. 8 where extensive sulphur deposits are known to be present (Figures 1 and 2). These figures show the contact to pass through the northwest corner of this Permit, but it must be emphasized that no certain control for this contact position is present within the actual Permit area or in its immediate vicinity, since bedrock outcrops are rare, especially in the Devonian rocks. The contact position shown is based on generalized regional extrapolation between control points at Vermilion Chutes and distant points in the Northwest Territories.

It should further be noted that in this Permit, as in the whole strip to its southwestward, including the Madison et al Sulphur No. 8, conventional field geological mapping cannot be expected to yield much information due to the almost complete absence of outcrops. For this reason in our recommendations for further work at the end of this report, emphasis is laid on augering and core-hole drilling.

Sulphur Occurrences on Permit No. 8

Sulphur assays from the Madison et al Permit No. 8 have not been made public, but it is reliably reported that they range between 40 and 90 percent. Approximately 160 shallow power auger holes have defined a sulphur body measuring 1,400 feet by 1,400 feet (Northern Miner - November 20, 1967) and several pits have been dug. The thickness and final outline of this deposit is yet to be determined.

RECOMMENDED EVALUATION PROGRAM

The work program set out below consists of several stages. The continuation and intensity of any given stage would be commensurate with the results obtained and can be readily adjusted to fit the available budget.

1. A stereoscopic study of the aerial photographs should be made. The location of structural and surface features would form the necessary background to determine the pattern of locations and the density of the test holes.

2. A brief field examination, under snow-free conditions, would further influence the positioning of the test hole grid.

3. The initial test hole program should be confined to the Wentzel River Permit and should be limited to shallow depths. This would include the uppermost part of the Devonian bedrock and could be accomplished by means of a small portable power auger. In this manner a dense drilling pattern could be used at relatively low cost.

4. If the results obtained in the auger program on the Wentzel River Permit are encouraging, a similar program could be extended to the Ponton River Permit, but should initially be carried out using a widely spaced reconnaissance-type drilling pattern.

5. Following stage 3 above, and possibly concurrently with stage 4, areas in which the uppermost Devonian beds are too deep for testing by an auger-drill, could be evaluated by use of a light portable core-drilling rig of adequate capacity to penetrate the Cretaceous overburden. Such a step would only be undertaken if the previous results should provide sufficient encouragement.

6. Following the above program, and possibly concurrently with its latter stages, other evaluation methods might be introduced in the light of the initial results. Such methods might include the use of infra-red photography, if a relationship between present sulphur deposits and thermal activity should be apparent.

SUMMARY OF THE SULPHUR PROSPECTS

1. The Sturdy, Multi-Minerals, Ortega, Kamalta Group have under Sulphur Prospecting Permit (on application) two areas, each of 19,840 acres which are located within the region of North-Central Alberta which is currently under most active exploration and within which several sulphur shows of considerable interest have been reported. The serious interest of the sulphur, mining, petroleum and natural gas industries in the region in which the subject permits are located is clearly demonstrated by the fact that sixteen Permits covering well over 300,000 acres were issued during the two-month period from September 29 to November 30, 1967 and that further applications covering a further area of some 2,000,000 acres have been announced during the first week of December. The majority of such Permits granted and applied for have been on behalf of very large national and international corporations, including some of the principal sulphur producers and users. No definitely commercial bodies of sulphur have yet been proven but one of the reported deposits is of considerable size and several show high sulphur value.

2. The Wentzel River Permit (under application) is located in a geological situation which appears to be analogous to that of the largest currently reported sulphur body in the region (on Sulphur Prospecting Permit No. 8) from which it is some fourteen miles distant. Further evaluation of this Permit should be possible at limited cost as the principal sulphur prospects are expected to be near the surface.

3. The Ponton River Permit is located in a general zone of similar geological characteristics stretching from the northwest corner to the south-central portions of the main region of present sulphur prospecting activity in which several sulphur shows have been reported. The same zone is marked by the presence of distinctive combustion and related phenomena which appear to have a relationship with the presence of sulphur.

4. At the present early stage of exploration, hampered by the presence of snow cover and preceding a drilling program, these regional factors are considered to be of much more significance than the relatively sparse local information on the Permits themselves.

5. The Permits are located within a few miles of an all-weather road, near navigable waters and within limited distance of a major highway, a railroad and a scheduled airline airport. If commercial deposits of sulphur are located, transportation should therefore not constitute a major problem.

6. The area is surrounded by some of the most prolific fuel sources in Canada, including Rainbow, North Zama and Red Earth oil fields, as well as sources of natural gas and the Athabasca Oil Sands development, so that low cost fuel should be readily available.

7. The future price and market position for any sulphur produced appears to be excellent in view of the continuing world shortage of this mineral and the increasing demand for its use.

8. Evaluation of the subject Permits should be carried out in several stages with the continuation and the intensity of any given stage to be commensurate with the results obtained during the previous stages. We would recommend the following steps:

a) A stereoscopic study of the aerial photographs to provide background knowledge of the structure and surface features on which to base planning of a pattern of test-hole drilling. Estimated cost $750.

b) A brief field examination under snow-free conditions to provide further background for planning a test-hole program. Estimated cost $2,000 - $3,000.

c) A test-hole program on the Wentzel River Permit with a portable power auger. Extent of program to depend on initial results.
Estimated cost $10,000 - $20,000.

d) A similar program on the Ponton River Permit initially on a limited reconnaissance basis only for possible near-surface objectives, if Wentzel results good.
Estimated cost of this reconnaissance phase $3,000 - $5,000.

e) A core-hole program on the Wentzel River Permit for objectives beyond the reach of power-auger drilling (program expected to be of limited scope due to anticipated shallow depths of objectives).
Estimated cost range $10,000 - $15,000.

f) A core-hole program on the Ponton River Permit for objectives near the Devonian-Cretaceous unconformity (depths in 600 to 1,000-foot range), only if previous results on subject Permits and in the region as a whole justify this more costly step.
Estimated cost range $20,000 - $50,000, for minimum to moderate program but higher if an exhaustive evaluation program is to be conducted.

Finally, it should again be emphasized that plans and budgets for each new step of the evaluation program should be adapted in the light of the results of the preceding stages. The more expensive later stages need only be undertaken if early results offer tangible encouragement.

This report has been prepared for the use of the four companies holding the subject Permits and it is not to be sold or otherwise disposed of without the written permission of J.C. Sproule and Associates Ltd.

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December 9, 1967
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SULPHUR PROSPECTING PERMITS

Permit Nos. 1 to 7 are located outside the area of interest and are not included.

Permit No.	Date of Issue	Acres	Holder
8	29-9-67	19,840	J.J. O'Connor, Madison Oils (Option to Bow Valley Ind.)
9	4-10-67	19,840	" "
10	6-10-67	19,840	" "
11	6-11-67	19,840	Kamalta Exploration Ltd.
12	8-11-67	19,200	Pearce, L. A.
13	8-11-67	19,840	Sturdy, Multi-Minerals, Ortega, Kamalta Group.
14	8-11-67	19,840	Undisclosed Interests
15	9-11-67	19,840	Shell Canada Limited
16	9-11-67	19,840	" "
17	10-11-67	19,840	" "
18	10-11-67	19,840	Clark, C. B. (Undisclosed Interests)
19	21-11-67	19,200	Inland Chemicals Canada Ltd.
20	23-11-67	39,680	Gt. Plains Dev. Co. of Cda.
21	30-11-67	19,840	Alaska-Canadian Corporation
22	30-11-67	19,840	" "
23	30-11-67	19,840	" "

CERTIFICATE

I, Gordon Harris Jones, consulting geologist, of [redacted] Calgary, Alberta, do declare:

1. That I graduated as a geologist from the University of Birmingham, England, with the degree of Bachelor of Science (Honours) in the year 1948; I obtained the degree of Doctor of Philosophy in Geology from the same university in the year 1955, and that I have practised my profession as a Geologist over the past nineteen years.

2. That I am a Fellow of the Geological Society of London, a Member of the Alberta Society of Petroleum Geologists, the Arctic Institute of North America, the American Polar Society, and the American Geographical Society, and that I am a registered Professional Geologist of the Association of Professional Engineers of Alberta.

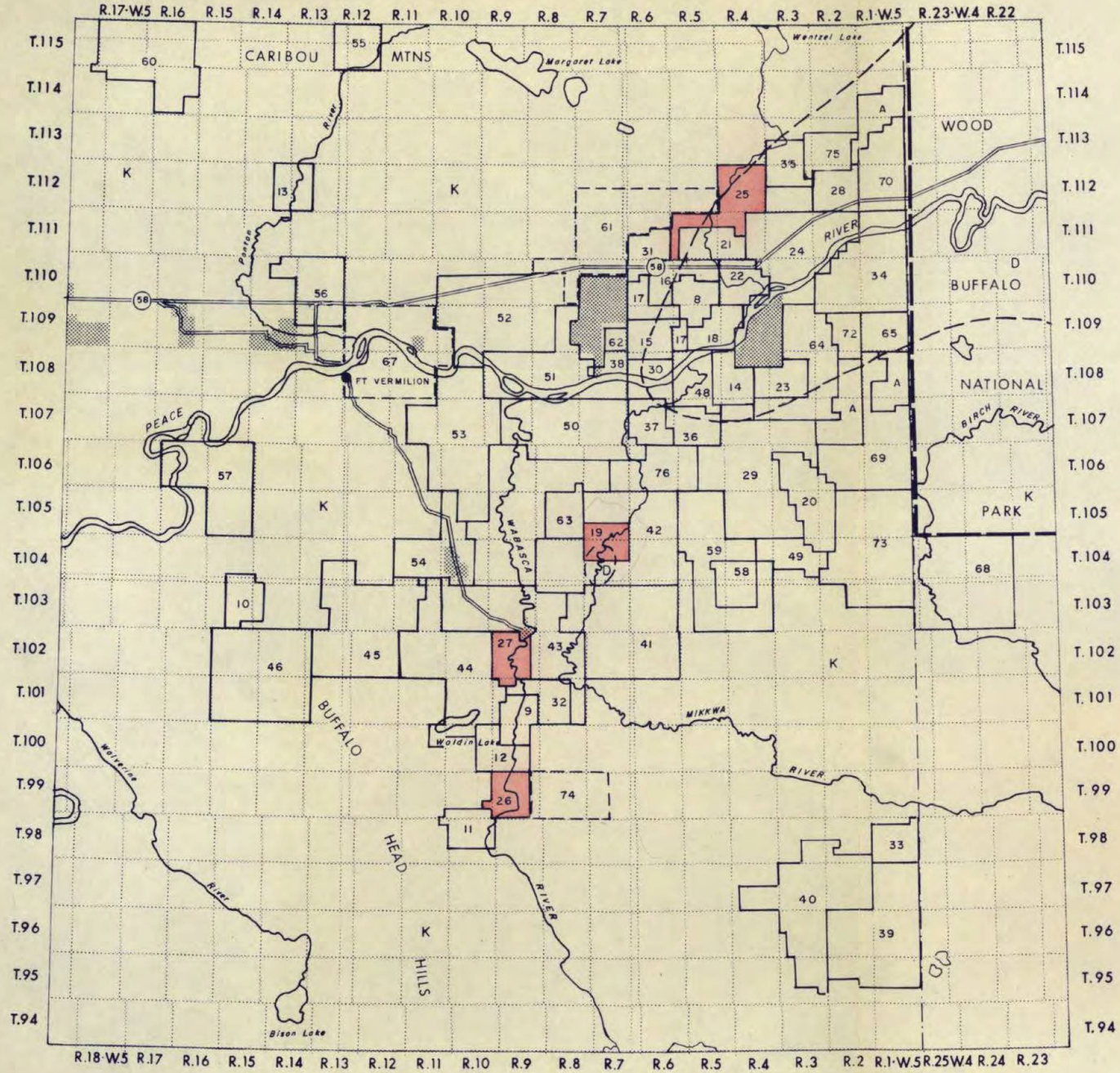
3. That I have no interest, direct or indirect, nor do I expect to receive any interest, direct or indirect, in the properties described in the attached report entitled, "Preliminary Geological Reports, Ponton River & Wentzel River Sulphur Prospecting Permits, North-Central Alberta," nor have I any interest, present or expected, in the securities of the companies from whom this report is prepared.

4. The above report is based on my geological knowledge of the areas described above, and that of my associates in the firm of J.C. Sproule and Associates Ltd., Calgary, Alberta, and upon a consideration of available data on wells drilled in adjacent areas as well as field and other pertinent data. I have not personally been on the properties described. The report sets forth sources of reference and the results of the field examination made by Mr. V.A. Farley.

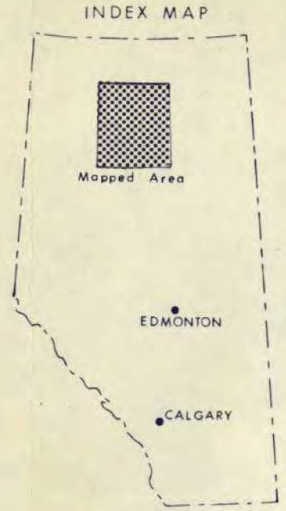
[redacted]

Gordon H. Jones, P. Geol.

1009 Fourth Avenue S.W.,
Calgary, Alberta.
December 9, 1967



INDEX MAP



K Cretaceous Formations

D Devonian Formations

Approximate Position of Eroded Edge of Devonian Outcrop

8 Sulphur Prospecting Permit (Approx as of Jan. 5, 1968)

74 Assumed Boundary of Sulphur Prospecting Permit

A Permit Applied For

27 Inland Chemicals Canada Ltd. Sulphur Prospecting Permit

Indian Reserve

SULPHUR PROSPECTING PERMITS IN NORTH-CENTRAL ALBERTA

PREPARED FOR

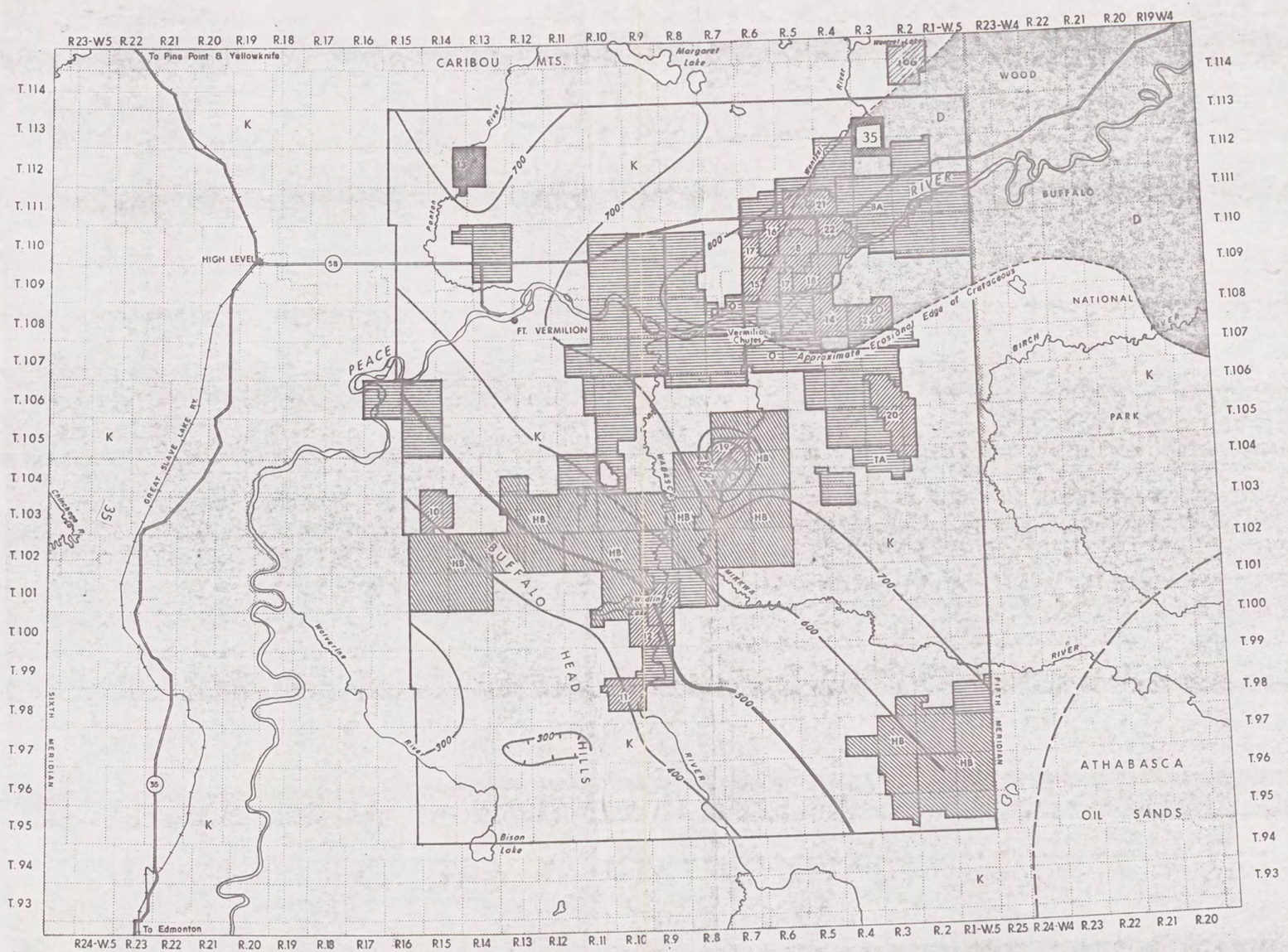
INLAND CHEMICALS CANADA LTD.

JANUARY 1968

16 0 16 32

SCALE: 1" = 16 MILES

To accompany Report to Sturdy—Multi-Minerals—Ortega—Kamalta Group, December 1967



INDEX MAP

LEGEND

- K — Cretaceous Formations
- D — Devonion Formations
- Contours on the Paleozoic Surface Contour Interval: 100 Feet Datum: Sea Level
- Sulphur Prospecting Permit (with Number)
- Sturdy—Multi-Minerals—Ortega—Kamalta Group
- HB — Permit Applied For (Hudson's Bay O. & G. Co. Ltd.)
- Permit Applied For — BA British American, O Omega, TA Trans-Alta (Unlettered Block Indicates Applicant Unknown)
- Outline of Current Sulphur Exploration Area

NORTH - CENTRAL ALBERTA

showing

REGIONAL SETTING OF SULPHUR PROSPECTING AREAS

PREPARED FOR

STURDY—MULTI-MINERALS - ORTEGA—KAMALTA GROUP

0 16 32 64

SCALE: 1" to 16 MILES

J.C. SPROULE AND ASSOCIATES LTD, CALGARY