MAR 19680124: ALBERTA

Received date: Dec 31, 1968

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PRELIMINARY STUDY

OF

TWO ALBERTA SULPHUR PERMITS

IN

TWPS. 120 & 119, RANGE 2 W, 5th

AND

TWP. 119, RANGE 1 W, 5th

SHOWN ON THE ANNOTATED AIR PHOTO MOSAIC FRONTISPIECE

Geology by W. Wolodarsky, P. Geol.

February 12, 1968

PROFESSIONAL GEOLOGIST ALBERTA
W. WOLODARSKY

Engineering by Edward Lewis Jones, P. Eng.

February 12, 1968

[redacted]

EDWARD LEWIS JONES AND ASSOCIATES

CONSULTING ENGINEERS LTD.

PETROLEUM – GAS – CHEMICAL
PROCESS PLANTS & PIPELINES

244 Wildwood Drive
Calgary, Alberta
Telephone: 249-7956
February 14, 1968

SCHEDULE OF LANDS

1. All available sulphur rights owned by Duncan Campbell:

Sections 34 and 35 in township 119, range 2, west of the 5th meridian

AND

Sections 1 to 4 inclusive, 8 to 17 inclusive, 20 to 29 inclusive and 32 to 36 inclusive in township 120, range 2, west of the 5th meridian

(31 sections in one unit)

2. Owned by Nash & Nash

All available sulphur rights in:

Sections 1 to 22 inclusive and Sections 28 to 33 inclusive in Township 119 Range 1 W.5th

(31 sections in one unit)

3. Owned by Ray Thomas (ADDED LATER)

Sections 4 to 8 incl. Twp 120 R.1 W5 and Sections 23 to 27 incl. Twp. 119 R.1 W5 and 34 to 36 incl. Twp. 119 R.1 W5

(13 sections in one unit)

Regional Subsurface Projects
Unit Representation
Geological Evaluation

Surface Geological Work
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W. WOLODARSKY, P. GEOL.
PETROLEUM AND MINING
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CALGARY, ALBERTA

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 sulphourous 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.

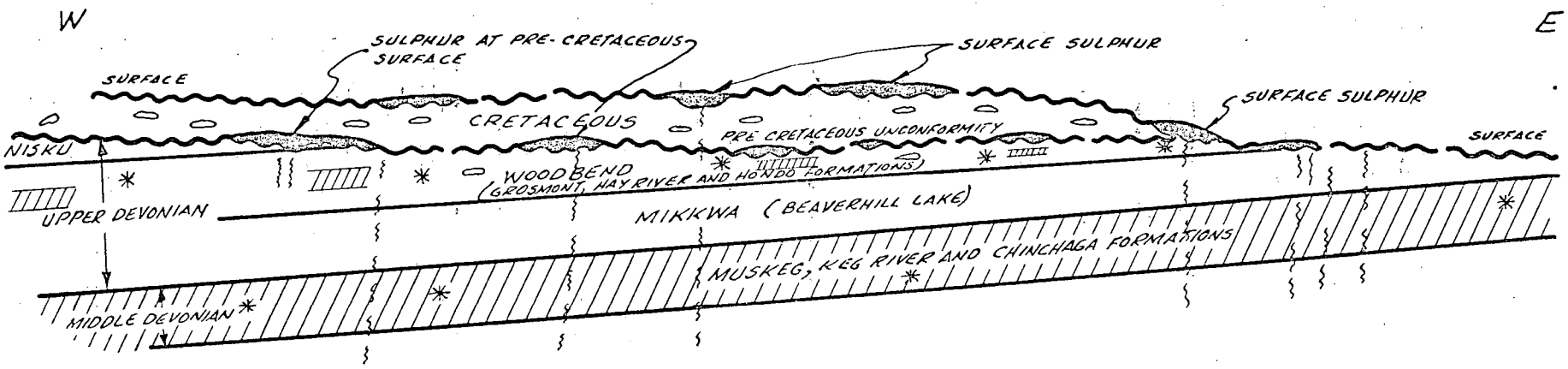
The deposition of primary elemental sulphur can occur from the aqueous solution of sulphides and sulphates; according to the mineral solution equilibria. Thus, hydrogen sulphide coming from the Devonian formations dissolves in water and reacts with anhydrite and or Gypsum, depositing sulphur out of solution. Since calcium sulphate and hydrogen sulphide are more soluble 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 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 subterrainan caverns and sink hole type topography.

Iron pyrite concretions are abundant in the Cretaceous, Cariboo Mountains: and 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 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 invaded by surface solutions.

The east limb of the Cretaceous, Cariboo Mountains intersects the permits here described, leaving at least half the permits on exposed Woodbend outcrop. The remainder of the permit lies on the Cretaceous Cariboo Mountains. The possibility of concentrated beds of sulphur below the Cretaceous; deposited prior to Cretaceous deposition, during the pre-Cretaceous time of erosion; as well as the present day deposition of sulphur on the exposed Woodbend subcrop is possible on these permits. The presence of sulphur on top of the Cretaceous mountains is also possible due to the presence of iron sulphides in the Cretaceous beds and the movement of subsurface waters from the anhydrite rich Woodbend formation, (see cross-section #1).

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



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 SULPHATES 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 FEB. 1968

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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 salinities 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 vuggy nature of the Grosmont, the presence of gypsum and anhydrite in equivalent rocks, the ubiquitous occurrence of iron sulphides, the numerous rivers, creeks and sinkholes exposing the Grosmont

may account for a thick highly concentrated deposit of sulphur in the study area. The possibility of sulphur concentrations at the pre-Cretaceous unconformity and on top of the Cretaceous could also be of considerable value. The concentration of large deposits of sulphur could have occurred before Cretaceous deposition, at the pre-Cretaceous unconformity. These deposits could have been sealed by the impervious Loon River shales. Since sulphur, once precipitated out, is not very soluble in water these deposits would not be susceptible to present day surface water. Faults and fissures from the Woodbend and Cretaceous could be responsible for sulphur accumulations observed on top of Cretaceous rocks.

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.

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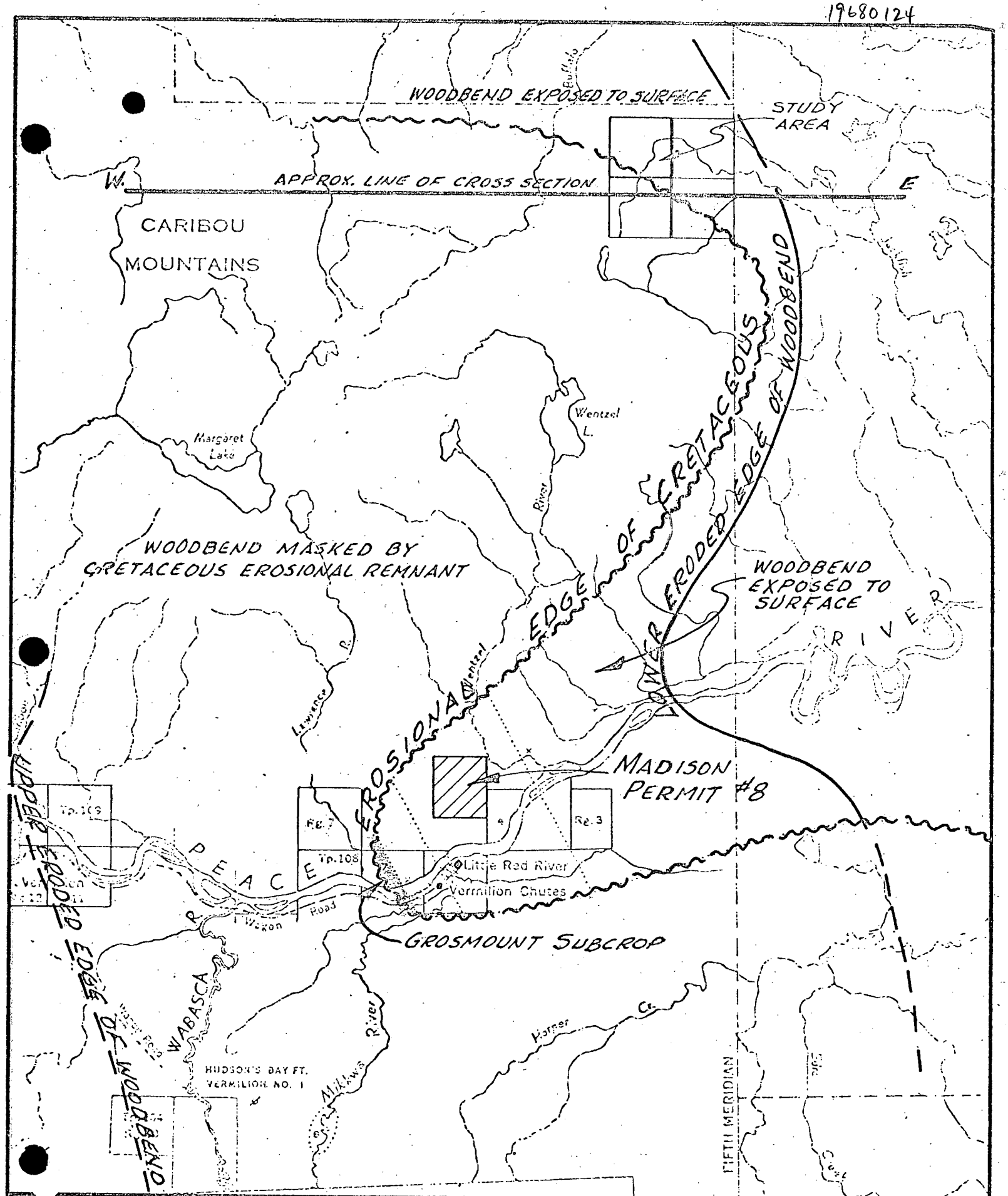


MAP #1

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.

[redacted]

W. Wolodarsky, P. Geol.

ENGINEERING

1. Transportation

The locations of the two Alberta Sulphur permits in Twps 119 & 120 Range 2, W.5th, and Twp 119 range 1 W5th are on the north side of the Peace River, as the Madison Permit No. 8, and about 36 miles downhill from the road running from Fort Vermilion to Fort Smith. Sulphur can be moved by truck direct to the Great Slave Railroad at High Level when the 36 miles of road have been constructed.

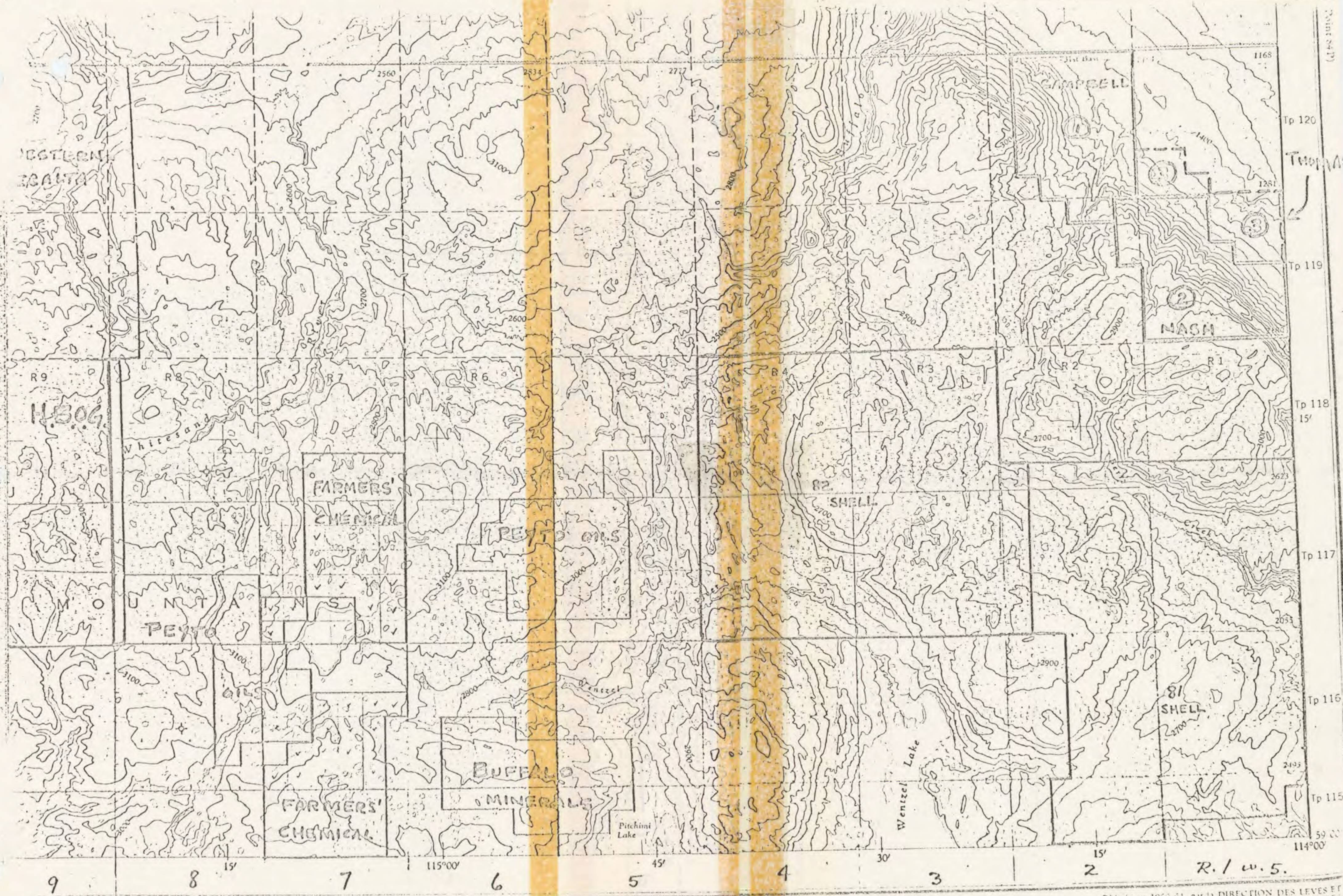
Barge transportation from west of the Vermilion Falls is possible in summer, up the navigable Peace River to the town of Peace River where the Railroad crosses it. About 50 miles of road transportation is first necessary to reach Vermilion Falls on the Peace River.

Tonnage products like sulphur cannot be portaged easily around the Vermilion Falls.

Another possibility is a pipeline for a slurry of sulphur ore which would require the cooperation of several permit holders.

Contour Map

A map (4 miles to the inch) showing the proximity of the two permits to the Madison No. 8 permit is included. The Vermilion Rapids and Vermilion Falls are also shown. No transportation problems that are abnormal are foreseen.



(Joins Vermilion Chutes 84J)

Projection Transverse de Mercator

Rédigée en 1960-61, par la DIRECTION DES LEVÉS ET D
LA CARTOGRAPHIE, MIN TÈRE DES MINES ET DES

19680124 MAP #2

EDWARD LEWIS JONES
PROFESSIONAL ENGINEER
REGISTERED
ALBERTA
BRITISH COLUMBIA
CALIFORNIA
TEXAS
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MONTANA
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ENGINEERING

2. Mining

Strip mining of surface sulphur ore may be performed economically if:

(a) A sufficient orebody near the surface is defined, the thicker the better

(b) Overburden is minimal or absent

(c) Volume production is maintained.

Strip mining of coal at a rate of 400,000 tons per year can be very reasonable, not more than $2.00 per ton. Lower costs for larger volumes.

Strip mining can be done on a long-term contract basis without owner's investment, provided long-term markets are available.

Since a section, one foot deep, of 60% sulphur contains 1,000,000 long tons of sulphur, worth $40,000,000, a deeper deposit can be quite attractive economically.

POSSIBLY FRASCH MINING

The cover of the Lower Cretaceous consists of Loon River Shales which form quite an impervious caprock perhaps suitable for Frasch mining (melting sulphur with hot water) of an underground deposit of sulphur if one is present. Deeper drilling should be done to determine this possibility as well as surface sulphur.

Frasch mining requires no process pla nt except perhaps a molten sulphur filter.

ENGINEERING

3. Processing

Several methods of recovery are available, but the one being used commercially in a California plant now, and that one experienced by the writer in Texas 15 years ago, consists of dissolving the sulphur in hot kerosene and filtering it from the gangue, and then cooling the solution so the sulphur precipitates.

This process has been written up in the attached article, along with others.

The cost of processing varies with the circumstances but is reliably reported to be not more than $15.00/long ton of sulphur, comparable to average Frasch costs.

4. Probable Costs

The cost of sulphur produced from a large deposit of 60% surface ore by strip mining and processing onsite is roughly estimated to be $20/long ton. To this must be added transportation costs to railhead, which probably range about $5.00 per long ton.

While sulphur sells for $50/long ton and up, a cost of $25/long ton is practical.

Basement and surface sulphur abounds in Northern Alberta

By Edward Lewis Jones
Consulting engineer, Calgary

The discovery of surface sulphur in the Northwest Territories and Alberta may be the first step in the subsequent discovery of substantial subsurface deposits which may be amenable to Frasch mining, following developments in Texas.

Surface sulphur in Canada

A wide belt of quite pure surface sulphur from springs exists from Great Bear Lake and Great Slave Lake in the Northwest Territories to the Clearwater River in Alberta.

Largely these springs are on Devonian outcrops and they may well have been the origin of the surface sulphur deposits which have recently been discovered on the Peace River near Little Red River in Alberta.

The springs occur near faulted zones and it is also possible that the faults allow the circulation of waters to the surface, carrying up sulphur which may be broken out by permafrost, since sulphur is so friable.

Analysis of the surface sulphur in the Northwest Territories shows:

(1) No catalyst poisons such as arsenic, selenium and tellurium, which are very destructive to the life of the vanadium catalyst used in the sulphuric acid plants — the major use for sulphur.

(2) Up to 98 percent sulphur, with no metallic ions or hydrogen sulphide which might be associated with the sulphur in metallic sulphide deposits.

(3) The complete absence of sulphate reducing bacteria.

(4) A gangue material which is mostly calcium, carbonate, sand and silt.

The problem with the deposits around the surface springs in the Northwest Territories is that they are not extensive enough at any one location to support a mine, although some are within three miles of the railway.

The recent discovery of more extensive sulphur deposits on the surface near Little Red River in Alberta, however, followed by an extensive land play amounting to more than three million acres since October, suggests that much more be afoot. A comparison with the West Texas situation may be pertinent.

Comparison with West Texas

Fifteen years ago the writer was engaged on a plant project to process sulphur from surface ores (10 percent sulphur) from West Texas, in Pecos County (Oilweek, Nov. 20/67, page 72).

Today, the interest in West Texas sulphur is at its peak, and for the subsurface sulphur deposits.

Leases are drawing high prices. A 555-acre sulphur lease in Culberson County in West Texas (the county adjacent to Pecos County) drew a high bid of $1,056,323. A second 480-acre sulphur lease was bid at $526,469.

Subsurface sulphur is the great attraction in this area (Wall Street Journal, Oct. 29/67).

Apparently in Pecos County there is a 300-foot thick layer of elemental sulphur about 800 feet deep which is amenable to Frasch mining (Barons, August 1966).

The significance of surface sulphur deposits, in view of the thick deposit of elemental sulphur below the surface manifestations in West Texas, should not be overlooked in the exploration for sulphur in Alberta. Drilling to basement rock is the only sure way of determining the presence of sulphur, especially since the surface deposits appear to occur where there are faulted zones.

Recognition of sulphur

The surface deposits may easily be confused with clay, as well as with limonite, or yellow ochre. The burning of dry sulphur samples (ignition point, 475° F.) in air is well known, and is a sure test for sulphur with the characteristic royal blue flame and the pungent odor of sulphur dioxide.

However, sulphur may be red, brown and green, as well as yellow.

The deeper sulphur deposits at Ankerton, Alberta, have plastic sulphur which is dark green. A recognition problem exists.

Logs will show the presence of sulphur in well bores. A combination of three logs is required: This procedure was developed first, to the writer's knowledge, at Ankerton, and interested parties should contact Fred Halkow or E. E. Brownless, geologists and owners of the Ankerton deposit, for details on the detection of sulphur in downhole logs.

Requirements for mining sulphur

(1) SURFACE SULPHUR

Surface deposits of sulphur require sufficient sulphur for strip mining operations, both laterally and at depth, and preferably with a very low ratio of waste to ore, including overburden.

The thinner the overburden the better for low cost per ton of sulphur recovered.

The higher ratio of sulphur to gangue, the better. For strip mining coal, the figures are well worked out and well known. For a large-scale operation where ore mined costs $2 per ton, the recovery of a 50 percent ore at that price would result in a sulphur cost of $4 per ton. To this must be added the several costs of processing and transportation to market. Surface sulphur usually requires an extraction plant, which is not cheap.

(2) SUBSURFACE SULPHUR

The Frasch method of melting the sulphur downhole (as on the salt domes of the Gulf of Mexico area) requires fuel for hot water at 330° F., plus compressed air to lift the recovered pure brimestone in molten form.

The fuel requirements are not small. No less than 10,000 gallons of water per long ton of sulphur is sometimes required, although the better mines may require only 4,000 gallons per long ton.

Well costs are high, since some domes require wells as close as 100 feet. Also bleed wells are required down-dip to remove cold water and improve circulation of heat to melt the sulphur. The reservoir heat balance must be right.

Lost water circulation down faults can also be a problem, which may be solved by mudding.

Conclusion

The sulphur play in Alberta has tremendous possibilities for both surface and for subsurface deposits which may be showing on the surface. Owners of exploration permits for sulphur should consider deeper drilling to basement as well as exploring the surface deposits.

Texas Sulphur Lease Of 555 Acres Draws High of $1,056,323 Bid

Lone Investor Beats United Gas Unit by Wide Margin for Plots Located Near New Mexico Line

Special to THE WALL STREET JOURNAL

AUSTIN—A 555-acre sulphur lease in West Texas brought a high bid of $1,056,323 in sales by the Texas School Land Board.

The lease is located about 13 miles west of Orla, a small town in Culberson County, near the New Mexico border.

The bid was submitted by W. C. Tillett, but Land Board officials couldn't furnish further indentification of him.

Mr. Tillett also successfully bid $526,469 for a 480-acre sulphur lease in Culberson County, the second highest bid of the sale.

A total of 3,095 acres of sulphur leases were offered by the board, with high bids totaling $1,645,193.

Duval Corp., Houston, a subsidiary of United Gas Corp., was the unsuccessful second bidder on those tracts purchased by Mr. Tillett. Duval bid $263,200 on the tract which brought more than $1,000,000, and $231,800 on the other tract.

Duval paid $17,203 each for two 640-acre tracts in the same area of Culberson County, however.

Potential sulphur deposits in West Texas have generated a flurry of leasing activity in the area in recent months. Rising sulphur prices have made once economically undesirable deposits attractive to mining companies.

The Land Board, which handles leasing for Texas' submerged areas and for lands which are owned by the state's public schools, also took bids on 54,650 acres, mostly offshore oil and gas leases in the Gulf of Mexico. Bonuses for the land, averaging $45.27 an acre, totaled $2,467,502.

Cities Service Oil Co., subsidiary of Cities Service Co., paid $23,787 for a 1,440-acre lease in the Gulf near Nueces County, while Humble Oil & Refining Co., subsidiary of Standard Oil Co. (New Jersey), paid $20,107 for a 1,419-acre offshore lease at Calhoun County.

Sulphur recovery from surface ores

Discovery of apparently large reserves of native sulphur ore body in northern Alberta could result in the first substantial Canadian sulphur production other than from sour natural gas. Four Alberta sulphur prospecting permits covering nearly 80,000 acres have been issued in the Fort Vermilion area, and an undisclosed major company has entered into an agreement with Madison Oils and a private Calgary syndicate to explore and develop three of these permits. The following paper outlines some of the aspects involved in recovering sulphur from ore bodies.

By Edward Lewis Jones, P.Eng.
Consulting engineer

Fifteen years ago the writer engineered and constructed a small plant to recover sulphur of 99.5 percent purity from low-grade (10 percent) ores in Pecos County, West Texas.

The use of solvents to recover sulphur is well known. Sulphur will dissolve in a variety of solvents, usually best at its melting point of 246° F., such as: carbon disulphide, benezene, carbon tetrachloride, and aromatic petroleum solvents.

The process employs a number of steps which are common to all methods, no matter which solvent is used:

(1) Strip mining of the sulphur ore.

(2) Crushing, grinding and screening to −20 mesh.

(3) Mixing with the lean solvent which is hot enough to heat the mixture to 250° F. (above the melting point of sulphur).

(4) Gangue separation to remove the solids from the sulphur-rich solvent.

(5) Solvent recovery from the gangue. The efficiency of this step frequently determines the economics of the process. The lower grades of ore increase solvent losses. Thus there is a lower sulphur limit, in any set of circumstances, which is the limit of economics corresponding to a given price for sulphur. Steaming is sometimes used to recover solvent from the gangue.

(6) Solvent distillation and sulphur recovery. Molten sulphur may be recovered by distillation of the solvent from it. The condensed solvent is re-used, after heating, to pick up more sulphur from the ore.

Points to watch in such a process include:

(a) Solvent losses (to avoid drain of dollars).

(b) Suitable solvent selection to avoid the hazards of flammability and toxicity. Both are present with carbon disulphide. Carbon tetrachloride is highly toxic but not flammable. Both are expensive. A suitable aromatic petroleum fraction can be handled well without expensive losses and without serious contamination of the molten sulphur with hydrocarbons, yet with a reduced toxicity and flammability.

(c) Circulation rates. The science of extraction solids is well known, as are its disadvantages listed above. The range of sulphur solubility is from 10 percent to 15 percent in suitable petroleum fractions, depending upon the U.S. Bureau of Mines correlation index. About 0.5 percent to 2.0 percent residual sulphur remains in the recovered solvent for re-circulation in the process.

The solubility of the sulphur in the solvent crucially affects the circulation rate. It is evident that the circulation rates vary inversely with the solubility.

(d) Moisture. Any moisture in the ore requires a water draw tray in the distillation column, and a preliminary drying step may be necessary if the moisture percentage is too high.

Other processes

VAPORIZING

Sicilian surface deposits have been refined by heating, vaporizing the sulphur and condensing it to a solid. Usually part of the sulphur is burnt to provide heat, a very wasteful process.

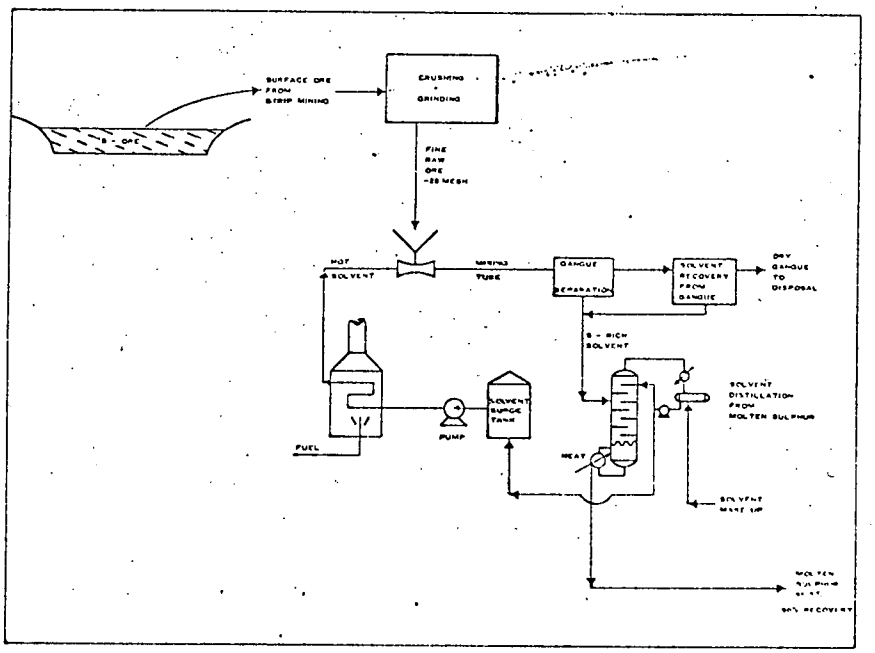
FLOTATION

Certain flotation agents have been developed to recover sulphur from the surface ores. Then the process of autoclaving the flotation product to produce an acceptable product of suitable purity.

DIRECT OXIDATION

Surface ores in Nevada are burned with air to give sulphur dioxide in

(Continued on page 74)



BOW VALLEY INDUSTRIES LTD. APPOINTMENT

Mr. Daryl K. Seaman, President, Bow Valley Industries Ltd. announces the appointment of Mr. Gordon B. Darling as General Manager of Alcon Petroleums Ltd., a wholly owned subsidiary of Bow Valley Industries Ltd.

Mr. Darling is a Petroleum Geologist and a graduate of the University of Alberta. He has a background of 21 years of major company technical and management experience in the Canadian oil industry.

TEXAS GULF SULPHUR APPOINTMENT

James W. Estep

James W. Estep of Calgary was recently elected a vice-president of Texas Gulf Sulphur Company.

Mr. Estep has been general manager of the Gas Division since it moved its headquarters from Worland, Wyoming to Calgary in 1963. He was responsible for the construction of the two TGS sulphur recovery plants at Okotoks and Whitecourt, Alberta.

SULPHUR RECOVERY

(Continued from page 72)

a special burner which is then converted to sulphuric acid for use in mining operations.

It is of interest to note this possibility for increasing the loading on the under-loaded H_2S conversion plants in the sour gas industry in western Canada:

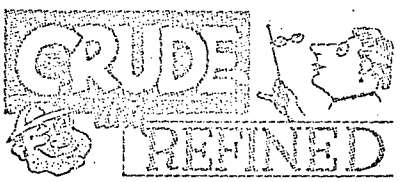
$$2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

Problems of proper heat balance and avoidance of dust carry-over must be solved.

FERTILIZER

Recovery of sulphur dioxide from burning of surface ores may be done in ammonia solution. This can be performed to provide ammonium sulphate by well proven processes. Sulphate is 21-0-0, a well known fertilizer acceptable in international trade.

The greatest demand is for sulphur — elemental brimstone — for acid plants and for pulp and paper plants. Surface ores may be refined by solvents to yield acceptable brimstone in molten form. Each situation requires a detailed engineering study before the economics can be defined.



When I'm wearing strapless things
Instead of buttons and bows,
I notice that my boy friends
Are always on their toes.

◊ ◊ ◊

"If a lady preacher got married could you say that one man's mate is another man's parson?"

◊ ◊ ◊

Marriage is a process for finding out what sort of guy your wife preferred.

Bulletin Board

MEETINGS

Nov. 20 — Engineering Institute of Canada, Calgary Branch to hear D. C. Fleming, director of Southern Alberta Institute of Technology, Carolina Restaurant, Calgary, 12 noon.

Nov. 20 — Alberta Association of Petroleum Landmen monthly meeting, Palliser Hotel, Calgary, 8:30 p.m.

Nov. 21 — Canadian Petroleum Tax Society to hear D. Mook regional director of excise tax, Palliser Hotel, Calgary, 5 p.m.

Nov. 22 — Alberta Society of Petroleum Geologists to hear Dr. R. G. McCrossan on aspects of geo-chemical prospecting of oil and gas reserves of western Canada, Parker's Calgary, 12 noon.

Nov. 22 — Calgary Branch, CIMM to hear A. R. Smith discuss potential for Canadian participation in industrial and mineral resources development in SE Asia and export opportunities, Palliser Hotel, Calgary, 5:30 p.m.

Nov. 24 — Engineering Institute of Canada, Calgary Branch, to hear report on USSR by J. F. Langston, J. Hanna, E. G. Price, Al San Circle, Calgary, 8 p.m.

Nov. 29 — Sulphur symposium, Highlander Hotel, Calgary, 9 a.m.

LAND SALES

Nov. 21 — DMR sale of 22 permits, Alberta.

Nov. 23 — Indian Affairs Branch sale of permits and leases on three Alberta reserves, Calgary.

Nov. 28 — DMR sale of 12 drilling reservations, Edmonton.

Nov. 29 — CMR sale of 48 Block A leases, Calgary.

Dec. 12 — Saskatchewan Department of Mineral Resources sale of 11 permits, 10 drilling reservations and 40 leases, Regina.

Dec. 12 — DMR sale of 14 P & NG reservations, Edmonton.

Dec. 13 — CMR sale of 44 Block A leases, Calgary.

Dec. 19 — DMR sale of 13 leases, Edmonton.

ADVERTISERS' INDEX

Brimstone in a Bind

Texas Gulf Again Cuts Sulphur Allocations, To 65% of '65 Deliveries, as Shortage Grows

By ALAN ADELSON
Staff Reporter of THE WALL STREET JOURNAL

NEW YORK—Texas Gulf Sulphur Co., which only last September cut sulphur deliveries to 75% of their 1965 level, has notified its customers that they would be limited to as little as 65% of their 1965 purchases.

A company spokesman said new delivery levels will be effective Jan. 1 for the duration of the first quarter.

The decision to further ration allocations of sulphur—coming as it did from one of the world's biggest brimstone producers—served to underline the critical world shortage of the vital element. It also reinforced the belief among industry observers that it won't be long before sulphur prices resume their upward march.

Indeed, U.S. sulphur producers have been announcing price increases almost as regularly as they have published quarterly earnings reports. There have been no less than three such boosts since December 1966, culminating in a $5.50-a-ton increase initiated by Freeport Sulphur Co. last September. Sulphur now sells for $30 a ton in the U.S.; only the fear that customers might turn to other chemicals with similar properties has deterred U.S. producers from charging even higher prices.

Economists are convinced that sulphur will remain in short supply at least until 1970. The sulphur industry is nonetheless hopeful that the very shortage of sulphur may make possible a solution to the problem: If huge quantities of the element in its natural form aren't found soon, they say, higher prices resulting from the shortage will make it feasible for companies to extract sulphur from other minerals.

Bonded With Metal Ores

An abundance of sulphur now lies trapped in "pyrite" and "pyrrhotite" ores in which it is chemically bonded with metals like iron, zinc and tin. Sulphur companies and many of their customers have been buying up such deposits—from Maine to California—for years in anticipation of the rising value of sulphur. Texas Gulf Sulphur, for example, says it has a sizable amount of sulphur in pyrite deposits at the company's Timmins, Ontario, mineral claim.

The heavy start-up expenses involved in extracting sulphur from pyrite have so far discouraged such a move. Nevertheless, says an official for Allied Chemical Co., a big producer of sulphuric acid that owns 30,000 acres of pyrite land in northern Maine: "Every time we see sulphur prices going up again, we take another long look at possible extraction operations up there."

Freeport Sulphur, which owns the mineral rights on 7,500 acres of pyrite-rich land in Virginia, says it is pending $1 million on metallurgical research to see if, and at what prices, the pyrite can be economically processed for its sulphur content.

Likewise, Stauffer Chemical Co. says that a subsidiary, Mountain Copper Co., owns "one of the major pyrite deposits in the U.S.," located in Shasta County, Calif., with a sulphur content of about 45%. The ore would yield about 7 million tons of sulphur and is "economically operable at today's prices," Stauffer says. But the company is holding back until it can arrange a reliable group of customers and "some guarantee that over the life of the plant sulphur will remain at least at today's prices."

Supplies Being Depleted

No major finds of pure sulphur have been made recently, with the result that reserves are gradually being depleted. In 1952, aided by discoveries of deposits in underground salt domes along the Gulf Coast, the sulphur industry boosted inventories sufficient to supply their customers for a year. They now report that they have only 16 weeks of inventories on hand at a time.

Aggravating the supply and demand situation is the fact that an estimated 150,000 tons of sulphur annually, or 10 times the normal amount, now are being used for military purposes as a result of the war in Vietnam.

The high price of sulphur is particularly worrisome to users of sulphuric acid, a chemical agent that's essential to the production of literally thousands of products from plastics to fertilizers. The steel industry, for example, has for years employed sulphuric acid as a "pickling" agent to cleanse steel of its impurities; in the production of rayon, sulphuric acid is used to make the material "coagulate" into fibers.

U.S. miners of sulphur have deliberately kept the price of brimstone below the prevailing rate on world markets in an effort to retain the good graces of their far-ranging customers. Sulphur consumers in Europe are said to be paying up to $60 a ton, compared with contract prices of about $28-$30 a ton in the U.S., and sulphur produced in Mexico sells here for about $30 a ton.

Protesting the Market

Sulphur producers reason that an overly drastic increase in sulphur prices might scare users—especially fertilizer manufacturers—into building expensive new plants that would produce nitric acid. Several big chemical companies, as noted, are already considering production of sulphur from pyrite. A move to nitric acid would be an even more serious blow to sulphur producers, since it would simply obviate the need for sulphur.

American farmers are expressing increased interest in European reports that nitric acid is a satisfactory base for fertilizer; with record demand for fertilizer expected again next year, sulphur producers fear their hold on the market may begin to slip. At least one chemical company, Chemical Construction Co., a subsidiary of Electric Bond & Share Co., has already announced it has developed a system to produce "nitrophos" fertilizers which combine nitrogen and phosphorous.

Meany Cites Record Of Past Two Years As Reply to Critics

President of AFL-CIO Says Gains In Negotiating and Membership Unparalleled in Recent History

By The WALL STREET JOURNAL *Staff Reporter*

MIAMI BEACH—AFL-CIO President George Meany replied to his critics, including United Auto Workers President Walter Reuther, by citing a record of two years of "solid trade union achievement" for the labor federation.

"The gains made by the affiliates of the AFL-CIO in organizing and in negotiations are without parallel in recent history," Mr. Meany ... ing efforts, which Mr. Reuther has criticized as insufficient.

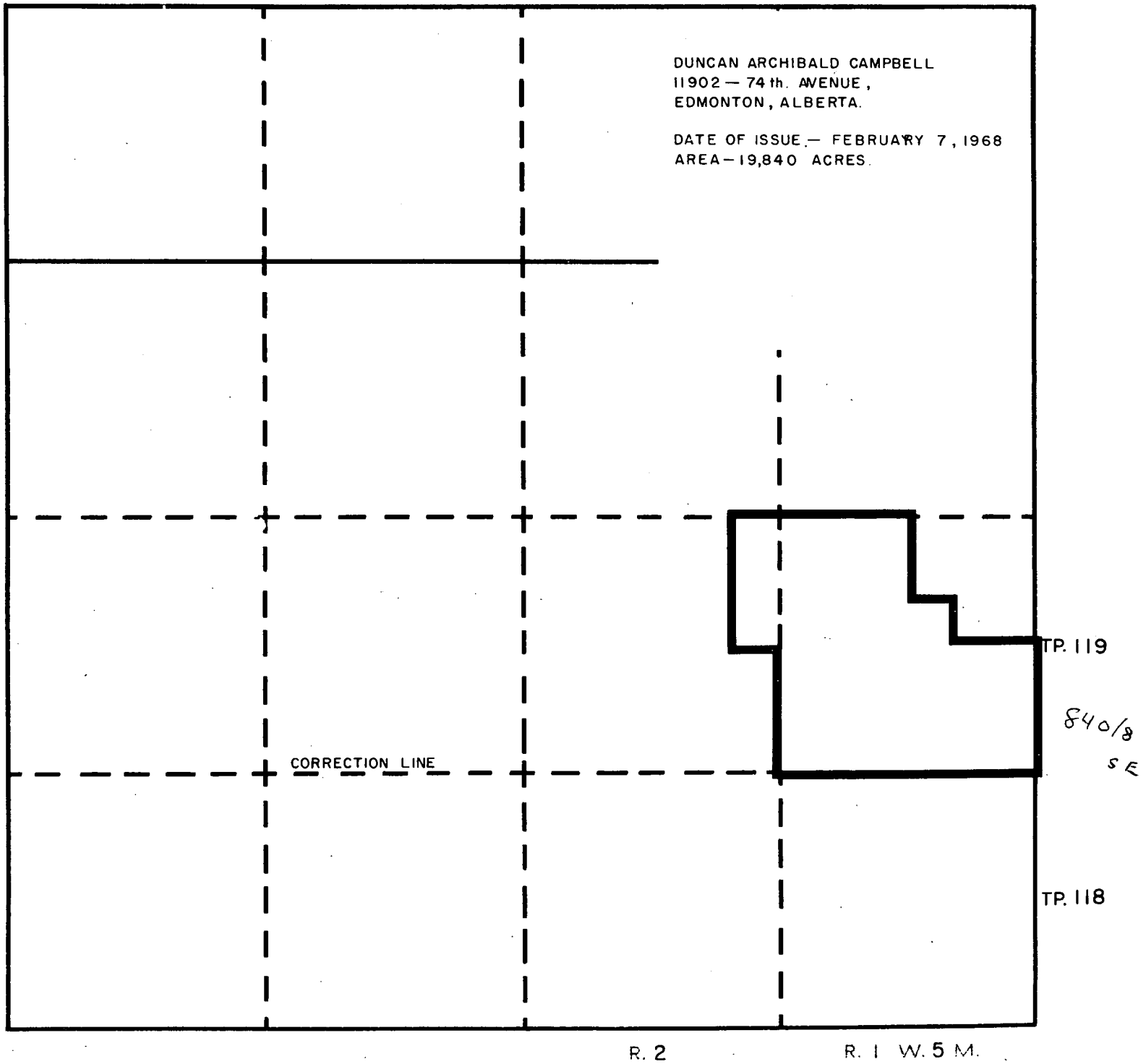
The UAW chief, who has been publicly feuding with the AFL-CIO leadership for more than a year over AFL-CIO policies, announced Friday that he wouldn't attend the convention, because of the press of national contract negotiations with General Motors Corp. The decision is seen as another sign that Mr. Reuther will pull his 1.4-million-member union from the AFL-CIO next year.

U.S. Will Send to India 3.5 Million Tons of Grain In First Half of 1968

WASHINGTON—(AP)—The U.S. will send 3.5 million tons of grain to India in the first half of next year, Agriculture Secretary Freeman said.

The total would equal shipments in the first six months of 1967.

SULPHUR PROSPECTING PERMIT No. 148



SULPHUR PROSPECTING PERMIT No. 170