CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN MCLEISH, DIRECTOR

# INVESTIGATIONS OF MINERAL RESOURCES AND THE MINING INDUSTRY, 1923





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MINES BRANCH INVESTIGATIONS OF

# MINERAL RESOURCES AND THE MINING INDUSTRY, 1923

The investigations described herein have been carried out under the direction of A. W. G. Wilson, Chief of Division of Mineral Resources.

## I

## BENTONITE

**Hugh S. Spence**

In continuation of the work on this material, a number of deposits in Saskatchewan, Alberta, and British Columbia were visited and samples taken for testing. During the past few years, numerous samples of bentonite have been received by the Mines Branch from persons desirous of ascertaining whether the material had any value, and several of the deposits from which these samples were taken were examined with a view to determining their extent and economic possibilities, should a market for bentonite develop. The field work shows that at several points in western Canada deposits of bentonite exist that have workable dimensions and are located sufficiently close to railway transportation to permit of exploitation. Several important beds exist near Princeton, B.C.; one of these, a 14-foot bed outcropping in the railway cut close to the town, being particularly well situated for development. A deposit about half a mile from the railway at Knollys, Saskatchewan, also possesses workable dimensions.

None of the Canadian occurrences are yet being exploited, owing to lack of a market for the clay; but should such a market develop, the deposits at Princeton, B.C., would be in a good position to supply the demand, owing to their proximity to Vancouver and the consequent advantage of being able to ship to eastern markets via Panama. The heavy expense of all-rail freight from the deposits in the Prairie Provinces must prove a serious drawback to their profitable development.

In addition to the examination of Canadian bentonite occurrences, visits were also made to a number of deposits in the United States, in order to determine how the Canadian deposits compare with the latter, some of which have been worked more or less actively. An attempt was also made to gather data, both in the United States and Canada, as to the immediate commercial possibilities for bentonite and the various uses to which it has been put. The results of this survey show that, while the present demand for bentonite is small, increasing interest is being taken in the material by numerous industries, its peculiar physical character suggesting a wide field of usefulness in industry and the arts.

A report has been prepared that contains the results of the writer's field work on bentonite to date, as well as a summary of laboratory work carried out by the Chemical Division of the Mines Branch upon various samples of bentonite and an outline of the uses to which the material has been put, or which a study of its properties suggests it may serve. This report will appear as a separate publication of the Mines Branch.

## II

## FELDSPAR

Visits were also made to the feldspar mines in the Lièvre River district, Quebec, and to properties recently opened up in the Sudbury area, Ontario.

*Lièvre River district.*—A number of deposits were worked more or less actively following the opening of the large Derry mine by O'Brien and Fowler, in 1921. Many of these mines were closed down during 1923, the O'Brien mine remaining the only important producer in the district.

Practically all of the feldspar from the Lièvre River deposits is light coloured, ranging from white to cream and buff, as contrasted with the predominantly pink or red spar from the Templeton district, a few miles to the west. The O'Brien deposit carries also a proportion of translucent and very brittle, glassy spar that conforms to the requirements of the dental trade. A second deposit, carrying an almost pure white feldspar, has lately been acquired by the O'Brien company; this body lies on lot 15 in range II of Derry township, about two miles distant from the present mine, and it is the intention of the company to proceed with its development during 1924.

A deposit of good, pink feldspar was operated late in the year on lot 24, range V of West Portland township, west of the Lièvre river, by B. Winning. This property, known as the Skead mine, was worked years ago for muscovite mica, which occurs with the feldspar.

*Sudbury district.*—Interest in feldspar in this district first commenced some years ago, when the Donnen Feldspar Company was formed to develop a property at Callum siding, on lot 6, concession V of Dryden township, 4 miles west of Markstay. Very little work has been done here and no shipments have been made. There are several leads on the property, the largest being about 60 feet wide. Most of the visible dike material consists of pink graphic granite carrying considerable black mica in plates up to 6" across. The company also owns a deposit on lot 9, concession IV of Hagar township, from which a trial car was shipped in 1918. The dike here is stated to be 30 feet wide. The property lies $2\frac{1}{2}$ miles from Markstay station.

On lot 9, concession II of Dryden township, a body of fine, pink feldspar was worked actively during 1923, by Messrs. McQuillin, Anderson and Harrison. The property lies $1\frac{1}{2}$ miles from Wanapitei station, to which the spar is hauled in two-ton cars, over a narrow gauge tramway. About 600 tons of spar was shipped between May and September, some of it going to Toronto and some to Rochester, N.Y. Several cars of quartz, also, were shipped to Hamilton.

The dike here measures 125 feet in width and consists of a series of well-defined zones of feldspar and quartz. Both minerals are segregated into parallel, vein-like bands, and no indications of graphic granite intergrowth were seen in the bands exposed in the pit. The latter was (Sept. 1923) 50 feet across by 15 feet deep, and sinking was being proceeded with by means of steam drills. The potash content of the feldspar is stated by the operators to run 13·16 per cent.

The alternate banding of clean feldspar and quartz as displayed by this deposit is a striking and unusual feature. Over a width of 45 feet in the west face of the pit, six distinct, vertical and alternating bands of feldspar and quartz are exposed, the spar bands ranging from 3 to 14 feet in width, and the quartz bands from 5 to 11 feet. The broken spar requires no cobbing, and the only mineral noted, other than quartz, is black mica, which, however, is confined to a single narrow seam in one of the quartz bands.

Lots 11 and 12, concession IV, township of Cleland. Work was commenced here early in 1923 by the Weisman Feldspar Company, of Sudbury. The mine is situated one mile north of St. Cloud station, on the Sudbury-Toronto line of the Canadian National railway. An open-cut 25 feet wide has been carried 50 feet into a dike of pink feldspar and quartz. A tramway of 350 feet connects the pit with a loading chute on the railroad siding. Shipments up to September were reported as about 600 tons, all of which was consigned to Toronto.

# III

## BITUMINOUS SANDS OF NORTHERN ALBERTA

S. C. Ells

The "Preliminary Report on the Bituminous Sands of Northern Alberta", No. 281, was issued by the Department of Mines in 1914. This report was based on observations made in 1913, during a period of eight weeks field work. The edition was exhausted some years ago.

Subsequent and more detailed field work has furnished much additional information regarding the Alberta deposits. It has not, however, necessitated any change in views expressed, or conclusions arrived at in the original report.

The work completed by the Mines Branch, Department of Mines, in October 1923, may be briefly summarized.

(*a*) Surveys.—Topographic maps of considerable areas adjacent to the Athabaska river and tributary streams have been prepared. These maps are drawn on a scale of one inch equals one thousand feet, and contours of twenty-foot intervals have been indicated. The manuscript maps already completed include the following areas and comprise an aggregate of 1,260 square miles lying between the 4th and 5th meridians.

| | |
|---|---|
| Tp. 87 R. 6 | N.E. ¼ of tp. |
| Tp. 87 R. 7 | N½ of tp. |
| Tp. 88 | W½ R. 6, and Rs. 7, 8, 9, and 10. |
| Tp. 89 | S ⅔ W½ R. 6; S. ⅔ Rs. 7 and 8. Rs. 9 and 10. |
| Tps. 90, 91 and 92 | Rs. 9 and 10. |
| Tp. 93 | Rs. 9, 10 and E. ½ R. 11. |
| Tps. 94, 95, 96 and 97 | Rs. 10 and 11. |
| Tp. 98 | Rs. 9, 10 and 11. |
| Tps. 99 and 100 | Rs. 8, 9, and 10. |

A traverse of Firebag river, together with a stratigraphic section, has also been completed for a distance of 60 miles from the junction with Athabaska river.

(*b*) Examination of outcrops.—Outcrops within the area indicated have been measured and examined. Extensive sampling of many of the outcrops, by means of asphalt augers, has been completed, and the cores analysed for bitumen content and grading of sand aggregate. A provisional classification of the outcrops has been made and is based on their probable importance from the viewpoint of commercial development.

(*c*) Trial shipments.—Approximately 150 tons of bituminous sand has been mined, sacked and shipped as required in connexion with a variety of experimental work.

(*d*) Paving.—Areas of sheet asphalt, bitulithic and bituminous concrete wearing surface, have been constructed in order to demonstrate the merits of Alberta bituminous sand.

(*e*) Recovery of bitumen from bituminous sands, either as semi-solid bitumen or as liquid hydrocarbons, has been studied in the laboratory. In certain instances, information relative to research undertaken by private individuals along similar lines has been secured.

*General Description of Area Underlaid by Bituminous Sand.*

The Athabaska and Clearwater valleys constitute the chief topographic features of the area under discussion. Principal tributary streams include Christina river, Hangingstone river, Horse river, Poplar creek, Steepbank river, Beaver river, Muskeg river, McKay river, Ells river[1], Tar river, Wolf creek, Calumet river, and Firebag river. Along each of these streams, valley walls are abrupt, and zones in which drainage has become effective are usually limited in extent. Throughout these narrow zones there is usually a fair growth of poplar, jack pine or spruce, although a considerable percentage of such growth has been destroyed by fire. As the result of a series of fires, large areas at a distance from the principal valleys are now covered by dense second growth poplar and jack pine.

On leaving the valleys, elevations gradually increase. Toward the east, large areas of country are covered by sand derived from disintegration of Precambrian rocks. In passing westward, the sand gradually disappears and clay soil predominates.

In the following table an attempt has been made to provisionally classify soil and forest growth. This classification is based on notes on some 3,000 miles of traverse lines. In many instances it has been difficult to differentiate poplar, spruce, and jack pine areas, since this growth is frequently intermixed. Spruce is usually found on bottom lands, along the smaller valleys and in certain swamps. Owing to the irregular nature of such areas, it has been difficult to definitely estimate the total acreage of this growth.

Although the total acreage of merchantable timber constitutes a considerable area, stands of poplar, spruce and jack pine are, as a rule, scattered and, individually, of limited extent. A somewhat extensive area of jack pine in townships 96 and 97, ranges 10 and 11, east of the Athabaska river, constitutes a notable exception. It is also unfortunate that many areas of clay soil are marked by the presence of numerous irregular muskegs and swamps.

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[1]Not Moose, Namur nor Dover.

| — | | Character of forest growth | | | | | Character of soil | | River bottom lands | Water area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Muskeg, slough and swamp | Poplar | Spruce | Jack pine | 2nd growth (brulé) | Clay soil | Sandy soil | | |
| Tp. | Range | % | % | % | % | % | % | % | % | % |
| 88— | 8 | 35·2 | 6·7 | 3·5 | ..... | 44·7 | 40·0 | 60·0 | 10·3 | 2·5 |
| | 9 | 30·2 | 11·5 | 11·7 | ..... | 37·5 | 89·9 | 10·1 | – | 0·8 |
| | 10 | 31·0 | 17·7 | 19·8 | ..... | 39·5 | 95·0 | 5·0 | – | 5·0 |
| 89—S. ⅔ | 8 | 40·7 | 15·9 | 11·1 | 6·9 | 24·4 | 19·5 | 80·5 | 1·0 | 0·2 |
| | 9 | 19·0 | 36·3 | 13·1 | ..... | 27·6 | 84·2 | 15·5 | 4·0 | 10·4 |
| | 10 | 38·5 | 21·2 | 11·4 | ..... | 28·6 | 67·5 | 32·5 | 0·3 | 2·5 |
| 90— | 9 | 37·4 | 20·8 | 13·5 | ..... | 17·9 | 25·8 | 74·2 | 10·4 | 7·2 |
| | 10 | 22·2 | 38·1 | 17·3 | ..... | 22·4 | 80·0 | 20·0 | ..... | ..... |
| 91— | 9 | 48·4 | 12·2 | 13·2 | ..... | 19·8 | 30·0 | 70·0 | 6·4 | 7·7 |
| | 10 | 38·9 | 10·6 | 21·6 | ..... | 28·9 | 60·0 | 40·0 | ..... | ..... |
| 92— | 9 | 48·7 | 13·7 | 7·9 | 7·8 | 19·9 | 20·0 | 80·0 | 2·0 | 5·4 |
| | 10 | 52·0 | 13·9 | 15·7 | ..... | 17·4 | 20·0 | 80·0 | 1·0 | 4·9 |
| | E. ½ 11 | 49·9 | 16·9 | 13·0 | ..... | 20·2 | 40·0 | 60·0 | ..... | ..... |
| 93— | 9 | 59·9 | 5·6 | 4·3 | ..... | 40·5 | 19·3 | 80·7 | ..... | ..... |
| | 10 | 47·8 | 9·9 | 0·8 | 13·7 | 15·8 | 19·7 | 80·3 | 11·3 | 10·1 |
| | E. ½ 11 | 28·0 | 12·1 | 0·7 | 24·7 | 34·5 | ..... | 100·0 | ..... | 1·0 |
| 94— | 9 | 57·0 | 9·3 | 12·8 | ..... | 20·9 | 20·0 | 80·0 | ..... | 2·7 |
| | 10 | 41·9 | 19·4 | 11·4 | ..... | 23·0 | 30·0 | 70·0 | 0·2 | 4·2 |
| 95— | 10 | 55·5 | 5·1 | 6·9 | ..... | 30·7 | ..... | 100·0 | 4·2 | 1·8 |
| | 11 | 47·6 | 11·7 | 10·1 | 0·3 | 28·5 | 16·0 | 84·0 | 1·8 | 7·6 |
| 96— | 10 | 34·9 | 6·9 | 3·2 | 2·9 | 32·2 | 0·9 | 99·1 | ..... | 0·1 |
| | 11 | 48·0 | 15·2 | 16·3 | 10·4 | 18·4 | 2·8 | 97·2 | 0·6 | 8·8 |
| 97— | 10 | 27·9 | 5·7 | ..... | 12·6 | 53·6 | 1·0 | 99·0 | 0·2 | 2·2 |
| | 11 | 42·6 | 16·7 | 3·3 | 16·4 | 20·4 | 1·0 | 99·0 | 0·6 | 6·1 |
| 98— | 9 | 3·4 | ..... | ..... | 2·2 | 94·4 | ..... | 100·0 | ..... | 11·1 |
| | 10 | 31·2 | 3·9 | 0·4 | 8·4 | 55·4 | ..... | 100·0 | 0·7 | 8·2 |
| | 11 | 48·6 | 1·4 | ..... | 2·4 | 48·6 | 2·8 | 97·2 | ..... | ..... |
| 99— | 8 | ..... | ..... | ..... | 0·4 | 99·2 | ..... | 100·0 | 0·1 | 0·3 |
| | 9 | 36·9 | 3·5 | ..... | 8·6 | 49·7 | ..... | 100·0 | 1·3 | 4·6 |
| | 10 | 44·0 | 6·1 | ..... | 7·2 | 40·4 | ..... | 100·0 | 2·3 | 6·3 |
| 100— | 8 | 11·2 | 1·5 | 0·8 | 0·8 | 82·6 | 0·4 | 99·6 | ..... | 1·5 |
| | 9 | 16·4 | 8·9 | 8·0 | 8·5 | 36·6 | 5·0 | 95·0 | 21·6 | 8·8 |
| | 10 | 61·2 | 6·5 | ..... | 15·5 | 16·8 | 1·5 | 98·5 | ..... | |

*General Description of Alberta Deposits.*

(*a*) Extent of deposit.—It appears unnecessary, nor is it indeed at present possible, to attempt an accurate estimate of the area underlaid by bituminous sand. The writer has examined upwards of 270 individual outcrops, all of which represent portions of a more or less continuous deposit. These outcrops extend along the Athabaska river and its principal tributaries, through a total distance of more than 220 miles. On the Athabaska river, the most northerly exposure of apparent commercial

importance occurs in Sec. 16, Tp. 98, R. 10. Other minor exposures are, however, seen along the Athabaska as far as the northern boundary of township 105. The direct distance in a north and south direction, through which outcrops have been noted, is approximately 115 miles, and that from east to west approximately 55 miles. Extensions of the deposit under heavy overburden, particularly toward the south, will materially increase the above estimate. Having due regard to methods at present recognized for mining bituminous sand, and considering other controlling factors, such as variation in quality, the area actually available for commercial development at the present time probably does not exceed one per cent of the above estimate. Apart from occurrences indicated, other exposures of bituminous sand occur at points many miles to the east and west, notably on Wabiskaw river, on headwaters of Reid creek, on Muskeg river, on Buckton creek and on Firebag river, Alberta; and on Buffalo lake, Sask. Certain of these have been examined by the writer. If, however, commercial development of the various outcrops, already recognized in the McMurray district, is found to be impracticable, it is evident that deposits in the outlying areas noted cannot be considered as of economic importance.

In view of the above considerations it will be seen that, in considering possible commercial development of bituminous sand areas, thickness of overburden and ground available for disposal thereof, freedom from impure partings, uniformity and degree of enrichment, and conditions affecting transportation, fuel supply and labour, may be considered as among the principal controlling factors.

In passing northward, from the 22nd base line, elevations, and consequently depths of overburden through the zone drained by the Athabaska river, gradually decrease to a point near the north boundary of Tp. 94. Between this point and Sec. 16, Tp. 98, R. 10, evidence as indicated by actual outcrops is incomplete. It appears, however, that, although the surface elevations become progressively lower, elevations of the upper horizon of bituminous sand also decrease. This may be due either to extensive erosion of the bituminous sand, or to a more marked dip of the strata. In townships 93 and 94 this is particularly true, owing to marked irregularity of the surface of underlying Devonian limestone.

For many years the occurrence of so-called tar springs, or seepages of bitumen, has been recognized throughout the area under discussion. The writer is familiar with upwards of 40 such springs, but in no instance are they in themselves of commercial value as a source of bitumen, although they have, at times, been regarded by some observers as a definite indication of the presence of petroleum pools. Instead of coming from below, however, the bitumen merely seeps laterally from slightly inclined beds of particularly rich, coarse-grained sand. An underlying impervious clay parting, together with a small local depression, makes possible the formation of a small pool of bitumen.

At various times sections of many of the more important outcrops have been measured. In so doing, an attempt was made to determine the thickness of bituminous sand of commercial grade, thickness of what may be referred to as low-grade material, and of which probably the greater part must be classed as overburden, and finally, the probable thickness

and character of surface drift and other overburden. In many instances, earth slides, the encroachment of the timber line along the upper part of an exposure, and the presence of a more or less extensive talus pile along its foot, has partially obscured the outcrop. In such cases, the securing of accurate measurements would have necessitated extensive excavation work, and approximations were, therefore, made. For similar reasons it was found somewhat difficult to accurately indicate the length of many of the outcrops. Such data, even if available, would frequently have little significance, since the numerous outcrops merely represent small portions of one continuous deposit. Indeed it is quite possible that certain parts of the deposit, which are at present partially obscured by timber or drift, may, on examination, prove to be more advantageously situated for development purposes than are many of the sections which happen to be well exposed at the present time.

(*b*) Character of overburden.—A brief reference to the geologic section along the Athabaska river will furnish some indication of the general character of the overburden. Between Athabaska and the Cascade rapids, La Biche shales, Pelican sandstones and shales, Grand Rapids sandstones, and Clearwater shales are, at various points, well exposed; but northward and eastward from the Cascade rapids the Clearwater series and surface drift appear to constitute the entire overburden above the bituminous sand. Thus, in undertaking stripping operations, the class of material to be excavated should present no serious difficulty, since shales and soft sandstones, with occasional thin bedded quartzites, apparently represent the bulk of the strata to be removed. The surface drift consists chiefly of boulder clays and sand. Obviously, other things being equal, areas lying within triangles at the junction of two streams, present material advantages from the standpoint of removal and disposal of overburden.

*Recovery of Hydrocarbons from Bituminous Sand.*

In 1913 the writer indicated that, in any attempt to ship crude bituminous sand, freight charges would seriously handicap large commercial development in the McMurray district.[1] This view is now generally accepted and requires no comment. For many years prior to 1913, however, the desirability of developing a successful process for the commercial recovery of hydrocarbons associated with bituminous sand and bituminous limestones had been recognized in foreign countries, and no little study had been given to the problem. Active interest in the matter ceased about the year 1900, owing largely to rapidly increasing production of well petroleum in the United States, together with marked modification in refinery practice. More recently, changing conditions have again appeared to warrant further investigation of the recovery problem.

Prior to 1900, treatment of bituminous sands and bituminous limestones was directed primarily toward the production of a bitumen more or less unaltered from its original consistency. During more recent years, effort has also been directed toward recovery of the original bitumen, either in the form of crude petroleum, or of various petroleum fractions.

[1]On the basis of quantity of imported asphalts entered for consumption in Canada during the fiscal year 1913–14, ten acres of bituminous sand, 50 feet in thickness, would supply the paving requirement of the provinces of Alberta, Saskatchewan, and Manitoba for a period of approximately 24 years.

At the present time, it appears that the market for solid or semi-solid bitumens in western Canada is somewhat limited.[1]

This market should be susceptible to material expansion, when various applications for what is admittedly a high-grade bitumen become more fully recognized. Among such applications already recognized, and to some extent demonstrated, are its use as asphalt cement in construction of city streets, highways, and sidewalks; as binder for briquetting fuels; as a basis for paints and varnishes; as an ingredient of roofing preparations; and as a constituent of synthetic mastic which has a wide application in connexion with building construction. Among the many uses to which mastic has been successfully applied are the construction of various types of flooring (as in public buildings, breweries, courtyards, laboratories, armouries, powder magazines and explosives factories, railway and freight sheds), footways, roofing, damp courses, foundations for high speed machinery, engine beds and heavy hammers, waterproofing courses for arches of bridges and viaducts, fireproofing, lining of acid proof tanks, and compressed slabs or blocks.

The probable commercial value of spent sand, particularly in the manufacture of certain glasses, appears to be slight under present market conditions, and in the face of present competition.

The production of crude petroleum[2] or petroleum fractions from bituminous sand is a many sided question which can merely be touched upon in a brief paper. The importance of such production, if commercially feasible, requires no emphasis. Petroleum has become a fundamental basis in the industrial and military life of a nation. Fuel oil is necessary for a navy, a mercantile marine, and for large industrial plants. Lubricating oil is essential for all machinery.

At the present time Canada depends largely on the United States for her supplies of petroleum products. Yet in the United States, with a production of crude petroleum during 1923 of 725,702,000 barrels, the public, the government, and the companies already appreciate the gravity of the

[1]Statement showing quantity of undermentioned hydrocarbons entered for consumption in Canada at Winnipeg, Calgary, Edmonton, Regina, Saskatoon, New Westminster, and Vancouver.

Asphalt, solid

| 1911-12 | | 1912-13 | | 1913-14 | | 1921-22 | | 1922-23 | |
|---|---|---|---|---|---|---|---|---|---|
| tons | value | tons | value | tons | value | tons | value | tons | value |
| 7,857 | $ 139,586 | 17,814 | $ 276,431 | 7,563 | $ 127,446 | ..... | $ 64,506 | 3,367 | $72,197 |

Asphalt, not solid

| | 1913-14 | | 1921-22 | | 1922-23 | |
|---|---|---|---|---|---|---|
| | tons | value | tons | value | tons | value |
| | ..... | $ 24,412 | ..... | $ 339 | ..... | $ 11,336 |

[2]Total quantities and value of petroleum products other than solid and semi-solid asphalts entered for consumption in the provinces of Manitoba, Saskatchewan, Alberta, and British Columbia.

| 1921-22 | | 1922-23 | |
|---|---|---|---|
| Gal. | Value | Gal. | Value |
| 168,057,671 | $ 13,111,167 | 167,705,479 | $ 11,998,088 |

situation that will result when the domestic supply becomes so depleted as to fail to meet demands. Those who look beyond periods of temporary over-production realize that the problem of furnishing sufficient oil to meet the inevitable and rapidly increasing demands is indeed of high importance. In February, 1922, the United States Geological Survey estimated that there still remained underground in that country 9,150,000,000 barrels of petroleum recoverable by current production methods. Present production in the United States exceeds 500,000,000 barrels per year, at which rate known reserves amount to less than 20 years' supply. Even should reserves be twice as large as estimated, the petroleum supply in the United States cannot possibly be adequate to meet future demands. The peak of production is apparently not distant, and new sources of petroleum products or substitutes for them must be found.

It is evident that production of petroleum products from Alberta bituminous sands is a question that should be given careful consideration. Such production would apparently be relatively free from certain well-recognized hazards which attach to the present production of well petroleum. Among these may be mentioned the uncertainty of locating oil pools, the uncertainty respecting amortization, the fluctuating price hazard, due largely to uncertainty of uniform production, and the danger of new discoveries more advantageously situated with respect to markets.

In a short paper it is impossible to outline various attempts which have been made to recover the hydrocarbon content from bituminous sand. The writer's investigation has included a determination of relative efficiency of chemical solvents, and various petroleum distillates; separation of bitumen by heated water at temperatures up to 320°F; separation by flotation methods and final purification of partially refined bitumen, by means of filter presses and centrifuging. The possible use of crude bituminous sand as fuel has also been considered, and the value of spent sand as a basis for the manufacture of glass. Distillation of the crude bituminous sand has been attempted. The crude petroleum recovered in this manner has been fractioned, the various fractions refined by the use of sulphuric acid and aluminium chloride. Results of this work are inconclusive.

In the following summarized statement, reference is made to certain companies and individuals who have been interested at various times in the development of processes for recovery of hydrocarbons from bituminous sand. At the plant of the Uvalde Asphalt Company, Texas, bituminous limestone was treated. The dates given indicate approximate period during which experimental work or actual production has been carried on. This list furnishes an interesting comment on the interest that has been aroused in the problem.

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American-Canadian Oil Products Co., 530 Spreckles Bldg., San Diego, Cal., Can. Pat. 234272, 1923.
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Ash, H. W., Cambridge, Mass., U.S. Pats. 757387, 779198, 1903-05.

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Kelsey, A. F., U.S. Pat. No. 485484.
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# IV

## NATURAL ABRASIVE MATERIALS IN CANADA.

V. L. Eardley-Wilmot

The field work carried on during the season of 1923 consisted in the investigation of natural abrasive materials in Canada. The areas visited were mainly confined to the Maritime Provinces and British Columbia.

These natural abrasives include:—

Corundum for abrasive papers and wheels; diatomaceous earth for metal polishes; garnet for abrasive papers and cloths; sandstones and certain slates for making grindstones, scythestones and honestones; fine siliceous sands and silts for abrasive papers and as ingredients for scouring and cleaning compounds; pumice and volcanic ash also for scouring, cleaning and polishing.

A considerable portion of the time was spent in the investigation of deposits of diatomaceous earth, because this material has been applied to a great number and to varied uses other than for polishing purposes, and the only way of successfully working any deposit would be to find an output in these different markets. The pure earth when dry, is an extremely light, snow white, porous material which is almost entirely composed of microscopic siliceous skeleton diatoms formed by the agency of aquatic plants and it occurs in Canada in beds of varying thickness on the bottom of existent, or ancient lakes.

### MARITIME PROVINCES

With the able assistance of Mr. J. C. Dawson, of Halifax, about 3,000 miles were covered by automobile in Nova Scotia and New Brunswick.

Approximately sixty different deposits of diatomaceous earth were visited and sampled with an auger that could be extended up to 24 feet in length. It was found that the purest grade deposits occur at the higher altitudes or near the sources of rivers and streams, since they are not liable to be contaminated and disturbed by spring freshets.

In Nova Scotia these deposits are well scattered throughout the province, with the exception of the southeastern portion, but the majority, and those of the highest grade, occur in the Cobequid mountains in Cumberland, Colchester and Pictou counties. In fact nearly every lake in these regions has at least a trace of diatomaceous earth, but owing to inaccessibility, the difficulty of drainage, and smallness of deposits, those of any possible commercial value are at present extremely limited. In this northern territory, of the half dozen deposits worthy of consideration, those of Brora lake, southwest of New Glasgow, and Trout lake, near Folleigh station, are among the most promising so far discovered. What appears to be the largest deposit occurs at Little River on Digby neck, on the west coast, which in many places was found to be over 25 feet of diatomaceous ooze. The top 4 or 5 feet might be termed a self-calcining diatomaceous peat, for when dry, it will readily ignite and smoulder away, leaving a pure white fluffy material almost entirely composed of siliceous diatoms.

There are a number of deposits in Cape Breton but none are at present being operated. The only company producing this material is the Oxford Tripoli Company, who are now working a 4-foot bed of good grade, overlain by 6 feet of peat. They dry, calcine and grade their product in a mill on the deposit, which is situated on Silica lake southeast of Oxford, N.S.

In New Brunswick these deposits appear to be confined to the southern portion of the province, particularly in Albert and Kings counties, the most promising of which is in Pollet lake south of Penobsquis.

Deposits of sandstone suitable for the manufacture of grindstones and scythestones occur in northern Nova Scotia and in eastern and southeastern New Brunswick.

In the former province the majority of the recent stones have been made from the Mic Mac quarry on Merigomish harbour, and a few from Quarry island, one mile to the north. A few hand made stones are also turned out annually from Waugh river. The sandstone deposits at River John, Malagash, Wallace and Joggins, have not been worked for grindstones for many years. The latter, at Lower Cove, Chignecto bay, are within the large area of these grits found in the southeast corner of New Brunswick and which include a number of deposits in the vicinity of Sackville, Woodpoint, Rockport, Grindstone island, Dorchester, Beamont, etc.

The Read Stone Company own several pulp and building stone quarries in these localities, but now confine their grindstone output to their Chaleur Bay property in the north, but a quarry has recently been opened at Lower Rockport and managed by F. L. Dobson, from which grindstones are being taken out.

A number of grindstones were at one time made from the quarries at Newcastle and Quarryville in Northumberland county, but recently the only shippers are the Miramichi Company from the latter place. The Read Stone Company who own a quarry on the same ledge have temporarily abandoned it and are contemplating shipping their machinery to Lower Rockport.

By far the largest output of Canadian grindstones comes from the Read quarry at Stonehaven on the bay of Chaleur. The company has extensive machinery, and the beds, which are covered by high tide, are enclosed by a sea-wall and the excavations kept dry by means of pumps. There are several other now abandoned grindstone quarries in the immediate vicinity of Stonehaven.

The finer grits from many of these maritime quarries are suitable for scythestones, but the market appears to be limited. The largest number, however, are made from the Stonehaven grit.

Canadian grindstones, which are only produced in the Maritime Provinces, are made in three grades of grits, and are said by users to be of good quality. The production has declined in recent years, mainly due to high freight rates and competition from artificial abrasive wheels. The advent of the latter also tends to eliminate the use of the smaller stones in the factories, the material for which is unavoidably made in cutting out the larger blocks. This also limits operations to the thickest beds, so that in many quarries these smaller blocks and narrower seams have now to be discarded and thrown on the waste pile.

Hone or whetstones are not now produced commercially, but pieces of suitable material are picked up and used locally. Some exceptionally fine honestone occurs at Whetstone lake, northeast of New Germany, N.S., but the zone is only 3 feet wide, though it has been traced for several miles in length. There are about a dozen showings in eastern and northern Nova Scotia.

Garnets, which should be hard and break into sharp fragments suitable for making abrasive papers, are not, so far, mined in the Maritime Provinces. The only deposit which might be of commercial importance occurs at Chegoggin point near Yarmouth, N.S. The belt, some 40 feet wide and of high garnet content, outcrops on the seashore and has been traced for several miles inland. Garnet sands are found on its line of strike on lake George, 12 miles to the northeast. There are several deposits of fine white sands and silts, some of which are occasionally used locally in the manufacture of cleansers and scouring soaps.

## BRITISH COLUMBIA

Diatomaceous earth is known to occur on Vancouver island and in several localities in the Ashcroft, Clinton, Quesnel and Cariboo mining divisions. The half dozen occurrences on Vancouver island are too small, or too impure to be of commercial importance, but the small deposit at the head of Prospect lake, near Victoria, is the best grade and might be used locally.

The largest, as well as the purest deposit so far found in the Dominion, occurs in the immediate vicinity of Quesnel, the present terminus of the Pacific Great Eastern railway. At least a dozen different showings are exposed over an area of 30 square miles within the Fraser and Quesnel River valleys. These horizontal and inclined beds are exposed on the faces of steep bluffs caused by slides and the cutting away of the river valleys. The deposits occur from 100 to 800 feet above the present rivers, but were probably originally formed at the higher levels, where the beds are more uniform and attain a thickness in some places of 40 feet, whereas the exposures just above the present river are much broken up, twisted and faulted. This movement is well illustrated at the big bend, 10 miles north of Quesnel, where the diatomaceous earth, together with highly coloured clays, are exposed at various elevations for three-fourths of a mile along the west bank. The earth is in most cases overlain by a bed of porous basalt. All these deposits occur as an almost pure white, dry, compact material, and in many places can be cut into blocks up to 3 feet in diameter, the size varying according to the thickness of the bedding planes. Microscopic examination of samples taken from six of these different exposures show each of them to be almost entirely composed of the same species of diatoms, which are in the form of curved porous cylinders. No work has yet been done, but several places were tested by auger a few hundred feet from the exposures, and the material was found under a few feet of soil, so that these beds must cover large areas and contain very considerable tonnages of diatomaceous earth.

Other deposits occur in Tsacha lake; on the Blackwater river; farther south, near Alexandria; Loon lake; and several other places in which the deposits are of only minor importance.

The material, reported as diatomaceous earth, occurring near Deadman lake 30 miles north of Savona, was found to be a fine white volcanic ash, which is exposed on the face of the steep bluffs as three or four horizontal beds within the soft yellow volcanic tuffs of that region.

These beds, which are 8 to 10 feet thick, are separated by 40 to 50 feet of the tuffs, and can be traced for some miles on both sides of the river and chain of lakes. Between two of these lakes a deposit of marl was found which contains a large number of siliceous diatoms. The material in this region is of excellent quality but at present is too far from rail transportation to be of economic value.

Along the Thompson river, between Ashcroft and Kamloops, and at many places along the Fraser, there are great quantities of silts and fine sands that would probably be suitable for ingredients in scouring compounds. A good grade of volcanic ash occurs near Burton on the east shore of Arrow lake. Near Hope, a yellow volcanic ash deposit of small extent was worked during the year, and the material made into a cleaning compound by a firm in Calgary.

Although there are numerous occurrences of garnet in British Columbia none have yet been found in sufficient quantities and of a quality suitable for abrasive papers, though samples of good garnet have been obtained east of the Columbia river, 50 miles north of Revelstoke, but the transportation distances would be at present too great.

The Western Abrasive Company has a plant at Victoria for making garnet papers. They get their supply partly from the United States and partly from a deposit north of Wrangel, seven miles above the mouth of the Stikine river, Alaska.

Pumice, or lava ash, in the form of lumps up to two inches in diameter, is found on the Bridge river, 40 miles west of Lillooet. This material covers an area of at least 40 square miles, and is evenly spread all over the surface of the country. On account of the evenness of its distribution (which averages one foot to a maximum of three feet) and its present distance from rail transportation, it is of doubtful commercial value, except locally.

A deposit of volcanic ash east of Swift Current, Sask., has recently been worked by the Van Kel Company, who are putting up the material in tins for polishing and cleaning purposes.

# V

# NATURAL GAS IN ALBERTA

R. T. Elworthy

CONTENTS



## INTRODUCTION

Although natural gas occurs in many parts of the world it has been found in great amounts only in the United States and Canada. Since the first natural gas wells were drilled in the United States in the early part of the nineteenth century, the annual consumption in that country has grown to the enormous figure of over seven hundred thousand million cubic feet, valued at over one hundred and seventy-five million dollars.

The annual production in Canada is only about one-fortieth of this amount, valued approximately at five million dollars, but even with this quantity Canada stands second in the list of the world's producers.

The petroleum and natural gas resources of Canada were the subject of a thorough survey in 1912 and 1913, and an exhaustive report covering the results was issued in two volumes by the Mines Branch in 1914. The first volume of the report covered the technology and exploitation of oil and natural gas in a very complete manner; the second volume included the results of the investigation of the Canadian fields at that time. The report dealt with the individual fields, province by province, and gave a detailed account of the oil and gas industry in Canada up to 1914.

This investigation showed that, though natural gas occurs in many parts of Canada, Ontario and Alberta are the only provinces in which extensive resources have so far been found.

The Ontario fields have shown signs of exhaustion during the last few years and the provincial government has thought it necessary to take steps to regulate the distribution and use of the gas in order to conserve this valuable natural product in the best interests of the public. In Alberta the situation is different. In the search for oil, during the last decade, many large flows of natural gas have been struck, and the existence of extensive fields in several areas which were indicated in the earlier report has been confirmed.

Very little reliable information has been collected on these gas fields, however, especially as to the volume of the gases available, and their character. The product of some of the fields may not be required for domestic consumption for many years to come; but, in view of the development of the natural gas gasoline and carbon black industries in the United States, it was thought desirable to obtain data regarding the volume, pressure, composition and gasoline content of gases from representative wells in the various fields.

This information should be of value to those who are interested in the establishment of the natural gas industry and in making regulations for the conservation of the natural gas resources.

The following report gives the results of this investigation. The situation of the chief fields is described with brief reference to the geological formations underlying them and the manner in which the gases may be used to the best advantage. The character of the field work is referred to, followed by a description of the chief gas fields. The possibilities of natural gas gasoline production, the manufacture of carbon black and the extraction of helium are also considered.

Brief mention only is made of subject matter which is treated more fully in other government publications to which full references are given.

## THE LOCATION OF THE GAS FIELDS IN ALBERTA

The settled portion of Alberta, that is southern and central Alberta, roughly forms an irregular rectangle, bounded on the east by the fourth meridian (W longitude 110), on the west by the Rocky mountains, on the south by the International Boundary and on the north by latitude 54. This area is about two hundred miles wide at the south and four hundred at latitude 54, which is four hundred miles north of the United States boundary, and includes about 120,000 square miles.

Eight railways, approximately thirty to forty miles apart, cross this area from east to west, from Saskatchewan to the line running north and south from Calgary to Edmonton. The topography, geography, climate, and means of transportation are well described in a bulletin published by the Natural Resources Intelligence Branch in 1920 on "Oil and Gas in Western Canada".

The known gas fields lie to the east of the Calgary Edmonton line, with one exception—the Turner Valley field, forty miles southwest of Calgary—and the four chief fields are situated near the main railway lines; the Medicine Hat and Bow Island fields on the main line of the Canadian Pacific railway, and the Wainwright and Viking fields near the Canadian National railway.

The gas from these fields, with the exception of Wainwright, is used for domestic and industrial heating and lighting; Medicine Hat gas for the city of Medicine Hat, and Bow Island gas for Lethbridge, McLeod, Calgary, and the smaller towns in their vicinity. Edmonton has used its first gas this winter, supplied from the Viking field.

The new fields, Many Islands Lake, and Foremost, although within forty miles of Medicine Hat and Bow Island respectively are treated separately in this report.

Besides these fields many isolated wells have been drilled in various parts of Alberta, almost all in a search for oil, in which gas has been found and which give indications of large reservoirs in the neighbourhood.

Natural gas is also known to exist in great quantity in northern Alberta; the main areas, where wells have been drilled, being along Athabaska and Peace rivers, between latitudes 56 and 57.

These fields were not included in this year's investigation but the information now available is given in the report.

## FIELD WORK

Although the main object of the field work was to make examinations of gas from representative wells in the newer fields, most of the older fields also were visited. A motor truck carrying the necessary apparatus and equipment was used for transport.

At the various wells, determinations were usually made of the open flow, rock pressure, gasoline content and specific gravity of the gas. Samples for analysis were also collected and information was obtained of the depth drilled, history of drilling, difficulties encountered, and of any other matters that seemed of interest and importance.

## METHODS USED

For the measurement of the gasoline content, the Oberfell gas testing apparatus was used. In this apparatus a measured volume of the gas was passed through activated charcoal which took up the gasoline hydrocarbons. The charcoal was afterwards heated in glycerine and the absorbed gasoline distilled off, condensed, and the volume measured.

The results obtained by this method were compared on one occasion with those given by the older oil-absorption apparatus. Satisfactory agreement was shown. Although the gasoline content of a natural gas found by the charcoal method is probably a little greater than the result obtained with the usual type of oil-absorption apparatus and certainly higher than would be obtained in commercial operations, this method is far more convenient for itinerant testing and gives comparable results for the different fields, which is the main consideration.

The open flow, pressure, specific gravity, etc., were measured by the standard methods. Duplicate samples for analysis were collected in one gallon glass bottles, usually by water displacement, though for comparison some samples were taken by air displacement, allowing the gas to pass through the bottle for at least ten minutes. Subsequent analysis of the samples collected by the air displacement method showed that this method did not give a pure sample.

Where larger quantities of gas were required, as for helium determinations, the samples were collected in small steel cylinders.

The cylinders were previously washed out five times by alternate filling with gas and blowing off, and were finally filled at well pressure, which was usually over 500 lbs. per square inch.

The gases were analysed in an improved type of Burrell gas analysis apparatus. Helium was determined by the usual method of first liquefying the hydrocarbons and then absorbing all other gases not liquefied by activated charcoal, cooled to the temperature of liquid air. Helium, the only gas not absorbed, was pumped into a burette and the volume measured.

## Medicine Hat field[1]

*Extent.* The proved gas area at Medicine Hat covers about forty or fifty square miles and future drilling may open up new wells outside the borders of that area.

*History.* The first gas well was drilled in 1890 to a depth of 650 feet but it was not until 1905 that the main gas sand was located at a depth of about 1000 feet. By 1913, sixteen wells had been drilled by the city authorities and gas was supplied to 1,900 domestic consumers and sixteen industrial plants. The Canada Cement Company, in 1914, drilled several wells, the gas from which not being required by the company, is sold to the city. In 1919 the consumption was over 2,500,000,000 cubic feet, while in 1922 it amounted to nearly 3,200,000,000 cubic feet. There are today more than 68 miles of pipe of 4-inch and 6-inch diameters conveying the gas from the wells to the consumers.

There are two gas horizons in this field, one at 600 - 800 feet and the other, the larger reservoir, at 1000 - 1200 feet depth.

The gas pressure when these wells were first drilled was about 500 lbs. per square inch with open flows of up to 500,000 cubic feet a day. In 1914 the closed pressure had fallen to an average of 470 lbs. per square inch. In 1923 the only measurements obtainable were the gas pressures registered while gas was passing into the high pressure mains reduced from well pressure to 60 - 70 lbs. per square inch. Under these conditions the average pressure at 17 wells ranged from 300 - 400 lbs. per square inch.

*Use.* Medicine Hat early sought to attract industries to locate in its neighbourhood by offers of cheap gas, and the city undoubtedly owes its present development in great part to the establishment of several such plants.

The largest industrial consumers are three flour mills, the city power house, in which gas is used in boiler plants, the Alberta Clay Products Ltd., the largest manufacturer of sewer pipe and building tile in the west, and the Medalta Potteries, manufacturers of domestic stoneware. In the clay working plants, natural gas is used in large amount for firing the kilns. Several foundries and other smaller plants also use considerable quantities of gas.

Besides the supply that is obtained from their own wells, these plants consume about 1,500,000,000 cubic feet a year from the city's wells. The rate to the domestic consumer is 25 cents per thousand cubic feet. The total consumption reported to the Dominion Bureau of Statistics from the city's wells and from the privately owned wells of ten companies was 3,157,932,000 cubic feet in 1922.

*Redcliff.* There are six gas wells, giving a good flow of gas, in the town of Redcliff, two miles west of Medicine Hat. These wells are privately owned, and the gas is used in the glass melting furnaces of the Dominion Glass Company and in two or three brick plants. The gas comes from the same sands as the Medicine Hat gas.

The rock pressure of these wells was reported to be 450 lbs. per square inch in 1923. Over 300,000,000 cubic feet was used in 1922.

[1]Geol. Surv. Sum. Rep. 1916, pages 124–130.

*Character of the Medicine Hat gas.* When examined in October 1923, tests showed the gas to be a dry gas of specific gravity 0·565. This result was confirmed by the analyses given below. Previous results are also given for comparison.

| | Gas from city main Mines Branch October 17, 1923 | City gas* | Smith well* |
|---|---|---|---|
| Methane $CH_4$ | 97·8 | 99·5 | 76·6 |
| Ethane $C_2H_6$ | 0·3 | – | 4·4 |
| Carbon dioxide $CO_2$ | 0·4 | – | 2·0 |
| Oxygen $O_2$ | Nil | – | 6·0 |
| Nitrogen $N_2$ | 1·5 | – | 11·0 |
| Sulphuretted hydrogen | — | 0·5 | — |

*Mines Branch Bull. No. 31, p. 21.

The calorific value of the gas, calculated from the recent analysis, is 1046 B.T.U. showing it to have a high fuel value.

The gas would be a valuable source of methane for future chemical manufacturing processes using natural gas as a raw material. Examples of such processes are the manufacture of methyl chloride by the regulated action of chlorine on methane, and the production of formaldehyde by partial oxidation of methane.

## The Many Islands Lake field

Although this field is only 40 miles east of Medicine Hat and might be considered as within the Medicine Hat field, for the purpose of discussion it will be regarded as a separate area.

Six wells have been drilled or are being drilled in township 14, ranges 1 and 2, west of the fourth meridian. A considerable flow of gas has been discovered in the well of the Medicine Hat Development Co., but the other holes had not reached the gas sands (Sept. 1923), which are at a depth of 1300 to 1500 feet, except in the Community Oil well, in which the gas had been mudded off, and the Canadian American Oil Co's well.

The companies drilling wells are:—

| Name | Location | Depth drilled in 1923 |
|---|---|---|
| | | feet |
| The Community Oil Wells, Ltd | LSD 7, Sec.19, Tp.14, Rg. 1, W.4th.M. | 2471 |
| The Medicine Hat Development Co | LSD 7, Sec.19, Tp.14, Rg. 1, W.4th.M. | 1200 |
| | LSD 7, Sec.20, Tp.14, Rg.1, W.4th.M. | 70 |
| The Many Islands Oil and Gas Co. Ltd | LSD 13, Sec.26, Tp.13, Rg.2, W.4th.M. | 1400 |
| The Canadian American Oil and Gas Co., Ltd. | LSD 12, Sec.31, Tp.13, Rg.1, W.4th.M. | 1350 |
| Alberta Gas and Oil Co | LSD 1, Sec.12, Tp.14, Rg.2, W.4th.M. | |

Most geologists agree that there exists in this neighbourhood a favourable structure for the presence of oil and gas. The area was explored by an officer of the Geological Survey in 1923, and his report is awaited with interest.

*The character of the gas.* Two gases were examined in this field, from the wells of the Medicine Hat Development Co. and of the Canadian American Oil Co.

*Medicine Hat Development Co.* Owing to a defective casing in the Medicine Hat Development Co's well the gas could not be entirely closed off for a test of the rock pressure nor for a satisfactory open flow measurement. It was calculated, however, at 800,000 cubic feet a day. The specific gravity of the gas was 0·578.

Two tests for gasoline hydrocarbons were made, using the Oberfell apparatus. The tests were negative. This result is confirmed by the analysis, and by the low specific gravity of the gas.

*Canadian American Oil Co's well.* This well was reported to be 1350 feet deep. An hour after being blown off, the rock pressure was 350 lbs. per square inch. The flow was about half a million cubic feet per day.

The gas was a dry gas, of specific gravity 0·587. Two tests gave no evidence of the presence of gasoline hydrocarbons in the gas, a result confirmed by the analysis.

*The Community Oil Well, Ltd.* This is the deepest well in the field, but it has never been thoroughly tested. It was drilled to its present depth with a rotary drill, but the mud has never been entirely pumped off for a test. The driller believed that a heavy flow of wet gas was thus kept back.

Owing to an accident with the casing, the well could not be tested when it was visited in October 1923.

*Analyses.* The following are the results of analyses of the samples collected:—

| | Medicine Hat Development Company | Canadian American Oil Company |
|---|---|---|
| | Per cent | Per cent |
| Methane $CH_4$ | 95·6 | 96·3 |
| Ethane $C_2H_6$ | Nil | 0·5 |
| Carbon dioxide $CO_2$ | 0·2 | 0·5 |
| Oxygen $O_2$ | 0·1 | 0·3 |
| Nitrogen $N_2$ | 4·1 | 2·4 |
| Sp. Gr. | 0·574 | 0·578 |
| Calorific value B.T.U., at 0°C. and 760 mm. | 1017 | 1074 |
| Gasoline content | Nil | Nil |
| Helium | Not examined | 0·07 |

Although it is probable that large supplies of gas will be ultimately available, none of the wells yet drilled are in a position to supply large amounts to Medicine Hat or to any industrial plants in the neighbourhood. The erection of a gasoline extraction plant is not warranted as there is little gas and it is dry. Nor is the gas of the most suitable composition for a carbon black plant, as the ethane content is too low to give desirable yields of black.

## Bow Island field[1]

The Bow Island field covers townships 10 and 11, ranges 11 and 12, west of 4th meridian, an area of about 20 square miles. The chief wells are situated along the south bank of the Saskatchewan river, ten miles north of Burdett station on the Medicine Hat—Lethbridge branch of the Canadian Pacific railway.

*History.* The first well was drilled in 1908 by the Canadian Pacific Railway Company, 12 miles from the present centre of production. The development of the field was subsequently carried out by the Canadian Western Natural Gas, Light, Heat and Power Co., Ltd., and in 1913, 16 wells producing 75,000,000 cubic feet per day were drilled. The present pipe line to Calgary, 160 miles long, was laid at that time. To date, twenty-five wells have been drilled in this field, several of which are now abandoned owing to the encroachment of water.

*Present condition.* The original rock pressures in this field were about 750 lbs. per square inch and open flows of seven and eight million cubic feet a day were common. The principal supply of gas comes from the Dakota sands at about 1900 feet, though a small amount is obtained at 800 - 1000 feet in the Belly River shales.

Unfortunately the field is showing signs of exhaustion and Calgary has suffered from a shortage of gas at times in the past few years. During the summer of 1923 many of the wells were cleaned out and the field was not drawn upon. A recent report based on an examination of the field in October 1923, made by engineers appointed by the Public Utilities Commission of Alberta, shows that this treatment has checked the decline of the field and the average rock pressure has increased slightly, to 210 lbs. per square inch. The open flow of all the wells was found by the Canadian Western Natural Gas Co's engineers to be about 17,000,000 cubic feet per day in September.

The minimum field pressure that will transmit gas through the pipe line to Calgary is 60 lbs. per square inch.

*Character of the gas.* The gas from the Bow Island field is of low specific gravity and is a dry gas, as the following analyses show:—

| Analysis by | Mines Branch | G. A. Burrell, Pittsburgh | | |
|---|---|---|---|---|
| | 1914 | 1915 | 1916 | 1919 |
| | p.c. | p.c. | p.c. | p.c. |
| Methane $CH_4$ / Ethane $C_2H_6$ | 91·6 | 92·3 | 91·1 | 90·3 |
| Oxygen $O_2$ | 0·2 | trace | 0·1 | 0·0 |
| Carbon dioxide $CO_2$ | – | – | 0·1 | 0·0 |
| Nitrogen $N_2$ | 8·2 | 7·7 | 8·7 | 9·7 |
| Specific gravity | 0·59 | 0·58 | 0·59 | 0·60 |
| Calorific value B.T.U. at 0°C., 760 mm | 946 | 983 | 970 | 962 |

[1]Geol. Surv. Sum. Rep. 1916, pp. 130-134.

Further analyses, reported[1] in 1917 by Mr. Patterson when examining the Bow Island gas for its helium content, were:—

| | Barnwell | | | Bow Island | | |
|---|---|---|---|---|---|---|
| | Well No. 25 | | | Wells 1,2,3, 4,5,6,7,8, 12,13 and 23 | No. 22 | No. 9 and 10 |
| | (I) | (II) | (III) | (I) | (I) | (I) |
| | | p.c. | | p.c. | p.c. | p.c. |
| Methane | 86·2 | 91·6 | 87·0 | 87·6 | 90·1 | 89·2 |
| Ethane | 4·3 | 1·9 | 5·0 | 0·9 | 2·6 | 0·9 |
| Nitrogen (including helium) | 9·5 | 6·5 | 8·0 | 11·5 | 7·3 | 9·6 |
| Helium | – | 0·36 | – | 0·30 | 0·33 | 0·30 |

Other wells were drilled to the east of the Bow Island field, in township 12, range 13, at Taber, and near Lethbridge but no gas was found.

A number of wells have been drilled at various points on the Canadian Pacific Railway branch line from Medicine Hat to Suffield and Lomond. At Suffield, Alderson, Brooks, and Bassano small flows of gas were encountered, and are supplied to these towns for domestic use and for running gas engines and pumps at railway stations.

The supply from wells of this kind is usually less than five hundred thousand cubic feet a day and is of little importance from a domestic or industrial point of view except to the towns where the wells have been drilled.

## The Foremost field

This area is eight miles south of Foremost station, on the Canadian Pacific Railway branch line from Lethbridge to Manyberries. A well drilled to a depth of 3705 feet by the United Oil Wells Ltd., on sec. 31, township 5, range 10, west of the 4th meridian, on the south bank of the Etzikom coulee first showed the possibilities of this region. Unfortunately a heavy flow of salt water drowned out this well.

Recently the Canadian Western Natural Gas, Light, Heat and Power Co., Ltd. put down a well on sec. 1, tp.6, range 11, west of 4th meridian. At a depth of 2180 to 2190 feet a strong flow of gas, reported to amount to 20 million cubic feet a day, was struck. The company is now drilling two other wells a mile to the south, and if, as is expected, equally good flows of gas are struck, a pipe line 40 miles long will be laid to connect this supply with the main pipe line of the company from the Bow Island field to Calgary.

This gas is found in the Dakota formation.

*Character of gas.* No measurements of the open flow were made when the well was visited. The rock pressure was 650 lbs. per square inch and cylinders were filled at this pressure. No gasoline hydrocarbons would be expected in a gas at this high pressure and no tests for them were made.

[1]Mines Branch Bulletin No. 31, p. 55.

The report of the engineers appointed by the Public Utilities Commission of Alberta gives the rock pressure as 660 lbs. per square inch and the open flow 15,703,000 cubic feet per 24 hours. At 150 lbs. line pressure the well could flow at the rate of 12,660,000 cubic feet per day. This well is therefore the biggest gasser in Canada so far opened up.

The result of the analysis of the sample collected on October 20th, 1923, was:—

| | Per cent |
|---|---|
| Methane $CH_4$ | 94·2 |
| Ethane $C_2H_6$ | 0·8 |
| Carbon dioxide $CO_2$ | 0·3 |
| Oxygen $O_2$ | 0·3 |
| Nitrogen $N_2$ | 4·4 |
| Helium content | 0·20 |
| Specific gravity | 0·610 |
| Calorific value B.T.U. at 0°C and 760 mm | 1018· |

The gas is free from odorous sulphur compounds and on account of its high calorific value is a very suitable gas for domestic use.

The Foremost area is undoubtedly a promising field and will be of great value in increasing the supply for Calgary and other towns fed by the Bow Island pipe line.

## The Sweet Grass field[1]

Since the discovery of a new oil field in northern Montana, the Kevin Sunburst field, in which many producing oil wells have been drilled, 12 to 18 miles south of Coutts on the International Boundary, there has been great drilling activity in township 1, ranges 14 and 15 west of the 4th meridian. Many companies have commenced drilling during the last two years in the hope that the Kevin Sunburst field may be found to extend into Canada.

The following is a list of the chief companies operating:—

| | L.S.D. | Sec. | Tp. | Rg. | Depth drilled up to Oct. 1923 |
|---|---|---|---|---|---|
| | | | | | feet |
| Boundary Oils, Ltd. | 1 | 3 | 1 | 15 | |
| Lethbridge Oils, Ltd. | 1 | 12 | 1 | 15 | 2040 |
| Border Oil Co. | 1 | 6 | 1 | 14 | 2015 |
| Wm. Livingstone | 1 | 4, 11, 24 | 1 | 15 | |
| Coutts Sweetgrass Oils, Ltd. | 1 | 2 | 1 | 15 | 2900 |
| Oil Lands Exploration Co., Ltd. | 1 | 2 | 1 | 15 | 200 |
| Stokes Stephens | | 22 | 2 | 14 | |
| Anglo Indian Oil Co. | | 14 | 1 | 15 | Commencing |
| Snake River Oils | 4 | 20 | 1 | 14 | |
| Canadian Oil and Gas Co. | | 29 | 1 | 11 | 1360 |

[1]The Geological Survey has commenced a detailed geological investigation in this field. See oil prospects in Southern Alberta. M. Y. Williams, Canadian Mining Journal, Nov. 30, 1923, p. 949.

Two slight showings of oil have been reported but very little gas has been struck, and lately, following the decline of activity in the Sunburst field, many of the companies have suspended operations.

Other wells in the neighbourhood drilled by The North West Co., Ltd., on L.S.D. 6, sec. 5, tp. 1, range 16, west of 4th meridian, have furnished valuable geological information but, so far, have yielded no oil and little gas.

## The Turner Valley field

This field, situated in the foothills, in townships 19, 20 and 21, range 2, west of 5th meridian, is the only one in western Canada where oil is being produced commercially at the present time. The Black Diamond field, the Sheep River district, the Dingman field and the Okotoks field, are other names by which this field is known. It lies to the southwest of Calgary and is reached by a good road through Okotoks, a distance of forty miles.

The formations in this neighbourhood are greatly disturbed and faulted and the difficulties of drilling are great. The geology and structural conditions are fully described in Geological Survey Memoir No. 122, Sheep River Gas and Oil Field, by S. E. Slipper.

*History.* Oil was first discovered in quantity in May 1914 at 2718 feet, in No. 1 Well of the Calgary Petroleum Products, Ltd., and at once a boom started in Calgary which is a vivid memory with many people. The failure to open up a large oil pool and the formation of worthless companies, coincident with the outbreak of war, led to much disappointment and loss of money.

A few companies, the Southern Alberta Oil Co., the Alberta Southern Oil and Refining Co., the Alberta Petroleum Consolidated Oil Co., and the Canada Southern Oil and Refining Co., produced some oil but only the first of these is in commercial operation today. The present production, about twenty barrels a day, is lower than the initial yield and the oil is heavier in character. An analysis is given below.

The chief wells producing gas in this field are:—

| | L.S.D. | W. 5th Mer. | | | Depth | Gas volume cubic feet per day |
|---|---|---|---|---|---|---|
| | | Sec. | Tp. | Rg. | | |
| Southern Alberta | 18 | 18 | 20 | 2 | 3575 | 1,000,000 |
| Illinois-Alberta | 14 | 12 | 20 | 3 | 3038 | 2,000,000 |
| Royalite No. 1 | 6 | 20 | 20 | 2 | 3910 | |
| Royalite No. 3 | 14—6 | | 20 | 2 | 2830 | 3,000,000 |
| Royalite No. 4 | 12—7 | | 20 | 2 | 2890* | 7,000,000 |

A list of wells drilled in this field and to the east, west, and south of Sheep river, giving the location, structure, depth, quantity of gas and oil found, is given on pp. 31, 32, and 33 of Memoir 122.

*Sept. 12, 1923, still being drilled.

*Tests made.* The field was visited on two occasions when samples for analysis were collected and tests made for the gasoline content of gas from five wells. The results are tabulated in the following columns:—

| Constituents | Royalite Oil Company | | | Illinois-Alberta | | Southern Alberta |
|---|---|---|---|---|---|---|
| | Well No. 1 | Well No. 3 | Well No. 4 | Well No. 1 | | Well No. 2 |
| | % | % | % | % | % | % |
| Methane ($CH_4$) | 71·8 | 67·2 | 65·9 | 67·4 | 74·8* | 52·0 |
| Ethane ($C_2H_6$) | 25·9 | 30·3 | 24·4 | 30·0 | 22·1 | 45·1 |
| Carbon dioxide ($CO_2$) | 2·1 | 1·7 | 1·2 | 1·0 | 2·1 | 1·4 |
| Oxygen ($O_2$) | 0·3 | Nil | 2·0 | 0·2 | Nil | 0·8 |
| Nitrogen ($N_2$) | 0·9 | 0·8 | 6·5 | 1·4 | 1·0 | 0·7 |
| Helium (He) | | 0·06 | | | | |
| Specific gravity | 0·70 | 0·71 | 0·73 | 0·72 | 0·77 | 0·86 |
| Calorific value B.T.U. at 0°C and 760 mm | 1274 | 1280 | 1156 | 1276 | 1201 | 1392 |
| Gasoline hydrocarbons pints per 1000 cu. ft. | | 2·2 | 2·1 | 1·4 | | 4·0 |
| Open flow 1000 cu. ft | 2,000 | 3,000 | 8,000 | 2,000 | | 800 |

*The production of gasoline in the Turner Valley field.* The Royalite Oil Co., in 1921 established a plant for the extraction of gasoline from the gas from wells of the Calgary Petroleum Products Ltd., which they had taken over.

The method used is an absorption process, operated under patents owned by the Hope Natural Gas Co. of Pittsburgh. The absorbing medium is a mineral oil, specific gravity 0·88 - 0·82, through which the gas is passed under pressure, first in spray absorbers and then through cylindrical absorbers. The oil, slightly lowered in gravity by taking up the gasoline hydrocarbons, is then distilled and the gasoline fraction separated. The oil is passed through heat exchangers, and then recirculated. The gas, after being stripped of the gasoline hydrocarbons, is piped through a 6-inch pipe to Okotoks, into the main Bow Island line, to supply Calgary.

The production from No. 4 well lately drilled, will increase the quantity of gas being treated in this plant and augment the Calgary supply. Recently six additional compressors, making twelve in all, have been installed. The pressure of delivery has been raised to about 300 lbs. per square inch at the intake end of the pipe line and the maximum volume that the line will convey at this pressure is about 8,000,000 cubic feet a day.

The production in 1922 was about 400,000 gallons gasoline and 1,250,000,000 cubic feet of gas. The plant is well arranged and efficiently managed.

*The Jennings Refining Co., Ltd.* This company has recently installed a plant to separate gasoline from gas from the Illinois-Alberta well. A small amount of oil in this well and the oil spray carried by the gas has undoubtedly accounted for the difficulty in getting concordant analyses of its gasoline content. The gas flow, according to recent reports, has increased to three million cubic feet since the measurements were made in September 1923, when it was only about one million. The method

*Analysis of sample collected April 1923.

employed for the recovery of gasoline is the usual absorption process; the gas passes up a tower, packed with special tiles affording a large surface over which the absorbing oil flows. The oil is then distilled and afterwards recirculated through the absorber. The plant had not commenced commercial production when visited, though trial runs were in progress. No arrangements had then been made for the utilization of the gas after the gasoline had been removed.

*Analysis of gasoline obtained.* A sample of the product obtained in this plant was examined in the oil laboratories of the Fuel Testing Division.

The specifications for aviation gasoline are included for comparison.

| | Aviation gasoline | Lab. No. 2595 |
|---|---|---|
| Specific gravity at 60°F | Less than 0·725 | 0·692 |
| Colour | Water white | Water white |
| Water | None | None |
| Iodine number | Less than 7 | 4 |
| Acidity | None | None |
| Sulphur content | Less than 0·01% | Less than 0·01% |
| Distillation range | | |
| 10 per cent must distill between | 60–75°C | 40% below 75°C |
| 65 per cent must distill below | 100°C | 79% below 100 |
| End point | 150°C | 178°C |

Analysis by H.McD. Chantler, Jr. Chemist.

The comparison shows that the product contains too great a quantity of the more volatile hydrocarbons and would have to be blended with less volatile naphtha to produce a good fuel.

The gasoline would also require a purification treatment to remove the unpleasant smelling constituents.

*The Alberta Southern Oil and Refining Co.* This company has a small plant in which the oil obtained each day from the Southern Alberta Oil Co's well No. 1 is distilled. About 20 barrels a day of this oil is blown off into a 60-barrel tank and from there is pumped into a still.

The products obtained are gasoline, which forms about 65 per cent of the crude oil, kerosene about 15 per cent, and fuel oil which makes up the balance.

The following is a report of an analysis made on a sample of the crude oil collected in September:—

FUEL TESTING LABORATORIES

Ottawa, Feb. 29, 1924

REPORT OF ANALYSIS

| Crude Oil from Southern Alberta Oil Company's Well, | | Laboratory No. 2594 Black Diamond Field. |
|---|---|---|
| *Specific Gravity* of oil at 60°F | | 0·765 |
| *Distillation of oil.* | | Specific gravity *at 60°F.* |
| *Fraction* | *% Volume* | |
| Light (gasoline) fraction up to 150°C | 52·5 | 0·723 |
| Medium (illuminating) oil 150°—300°C | 35·3 | 0·790 |
| Heavy (lubricating) oil 300°C. up | 10·0 | 0·864 |

Distillation range 49°C. to 391°C.

R. E. Gilmore (Sgd.)
Superintendent

Analysis by:
H. McD. Chantler, Jr. Chemist.

## The Viking field

The Viking field covers townships 48 and 49, ranges 12 and 13, west of 4th meridian. The ten wells so far drilled are near the range line, six miles north of the town of Viking, which is on the main track of the Canadian National railway. The gas field probably extends to the north of Birch lake and leases have been taken up all over this area and for fifty miles to the west along the railway line to Wainwright.

The wells were drilled in 1914 by the Northern Alberta Natural Gas Development Co. but negotiations between this company and the city of Edmonton failed to reach any agreement. In 1923 a new company, the North Western Utilities, was formed and a contract to supply gas to the city was made.

*Particulars of wells drilled.* The following measurements were made by the company's engineer in 1923:—

| No. | Location | | | | Depth feet | Rock pres. lbs. per sq. in. | Open flow M. cu ft. per day. |
|---|---|---|---|---|---|---|---|
| | L.S.D. | Sec. | Tp. | Rg. | | | |
| 1 | 13 | 24 | 48 | 13 | 2435 | | 9,000 |
| 2 | 5 | 19 | 48 | 12 | 2373 | All | 2,700 |
| 3 | 10 | 25 | 48 | 13 | 2365 | | 5,000 |
| 4 | 3 | 30 | 48 | 12 | 2343 | wells | 1,350 |
| 5 | 8 | 36 | 48 | 13 | 2220 | | 6,286 |
| 6 | 5 | 6 | 49 | 12 | 2203 | | 7,617 |
| 7 | 1 | 6 | 49 | 12 | 2215 | about | 7,000 |
| 8 | 2 | 18 | 48 | 12 | 2430 | | 2,000 |
| 9 | 8 | 24 | 49 | 13 | 2340 | 800 | 3,250 |
| 10 | 16 | 29 | 48 | 12 | 2220 | | 3,000 |

The available supply in the immediate field is calculated to be over sixty billion cubic feet of gas and should be sufficient for many years if it is properly conserved and efficiently used.

*Character of gas.* The gas is a dry gas, with methane as the chief constituent as the following analyses show. It contains no sulphur compounds and therefore has little or no smell. It has a high calorific value and is of excellent quality for domestic heating and lighting.

| Constituents | Mines Branch *1923 | Provincial analyst 1919 |
|---|---|---|
| | Per cent | Per cent |
| Methane $CH_4$ | 92·5 | 93·3 |
| Ethane $C_2H_6$ | 3·5 | – |
| Carbon dioxide $CO_2$ | 0·5 | 0·6 |
| Carbon monoxide CO | – | 0·6 |
| Oxygen $O_2$ | 0·1 | 0·4 |
| Nitrogen $N_2$ | 3·4 | 5·0 |
| Sulphuretted hydrogen $H_2S$ | Nil | Nil |
| Helium He | 0·006 | |
| Specific gravity | 0·64 | |
| Calorific value B.T.U. at 0°C and 760 mm | 1051 | |

*Sample taken from well No. 6.

*The Edmonton gas supply.* The pipe line from the Viking field to Edmonton is eighty miles long. Gas from the wells is piped to a central pressure reducing station, where it passes into the main 10-inch pipe line at about 300 lbs. pressure. At Clover Bar, just outside Edmonton, the pressure is again reduced to 20 lbs. per sq. in. and the gas passed into the high pressure belts in the city, from which it enters the supply line at a few ounces pressure.

The cost to consumers will be 46½ cents per thousand cubic feet for the first 60 thousand cubic feet with a reduction to 40 cents for the next 20 thousand cubic feet and a third reduction of 5 cents per thousand cubic feet for each additional 20 thousand cubic feet used, down to a minimum rate of 30 cents.

## The Wainwright field

This field, sometimes known as the Irma field, lies between Irma and Wainwright along the Battle river, and near the main line of the Canadian National railway. At present it is attracting much notice because of the recent discovery of oil in No. 2 well of the British Petroleum Company, six miles north of the town of Wainwright. Leases have been taken out over six or seven townships adjoining and north of the railway line and there will be much drilling in this territory next year with the probability that large volumes of natural gas will be released.

The gas sands have been struck at 1700 to 2000 feet and are probably the beds of the Upper Cretaceous formation.

The first well in the neighbourhood was drilled by the Viking Battle Creek Syndicate, in 1920, on sec. 4, tp. 45, range 8, and a big gas flow was struck.

The Imperial Oil Company, subsequently taking over this company's interests, opened up another well, giving five million cubic feet of gas a day. This well has also been the subject of much notice on account of the spectacular display when the water which leaks into it is blown off, together with an oil-water emulsion which is formed.

The wells tested in this field were:—

*British Petroleum Ltd.*

*Well No. 1, L.S.D. 1, sec. 36, tp. 45, range 7 west 4th meridian.* This well was drilled early in 1923, the gas sands being found at 1683 feet, at 1800 feet and at 2010-2015 feet, and six million cubic feet of gas was reported by the press[1] in May. It was said to be a wet gas containing several pints of gasoline per 1000 cubic feet.

However, when it was examined in September 1923, the flow had decreased to a few hundred thousand cubic feet per day and the well was flooded with water. The gasoline content of the gas was nil.

---

[1] Oil and Gas Journal, May 10, p. 48, 1923

The analysis of the gas bubbling up through the water gave:—

| | Per cent |
|---|---|
| Methane $CH_4$ | 87·3 |
| Ethane $C_2H_6$ | 4·4 |
| Carbon dioxide $CO_2$ | 0·3 |
| Oxygen $O_2$ | 1·0 |
| Nitrogen $N_2$ | 7·0 |
| Specific gravity | 0·62 |
| Calorific value B.T.U. at 0°C and 760 mm | 1012 |

*Well No. 2, L.S.D. 13, sec. 30, tp. 45, range 6 west 4th meridian.* This well is situated on higher ground, about 200 yds. from Well No. 1. At the time of inspection it had been drilled to 2030 feet with a rotary drill, and the 8¼-inch casing was being cemented off for a test. On November 14th oil was struck. The flow was apparently not continuous but the oil was blown off by the gas when it was released periodically. The production was estimated at 60 to 100 barrels a day.

A report of analysis on a sample of this oil follows:—

FUEL TESTING LABORATORIES

Ottawa, March 3rd, 1924

REPORT OF ANALYSIS

Laboratory No. 2609.

Oil from Well No. 2 of British Petroleum Ltd., near Wainwright, Alberta, collected by Mr. C. Dingman.

The 4 oz. sample received consisted of an opaque brownish black emulsion of oil and water carrying a suspension of fine silt.

*Approximate composition*

| | |
|---|---|
| Oil | 70% Vol. |
| Water | 20% Vol. |
| Sediment | 10% Vol. |

| | |
|---|---|
| Sp. Gr. at 60°F. of oil after water had been separated | 0·984 |
| Sp. Gr. at 60°F. of oil filtered from silt | 0·948 |

| Distillation of the oil (water separated) | % Vol. | % Wt. |
|---|---|---|
| Total oil distillate | 84·8 | 83·4 |
| Coke residue | | 15·0 |
| Loss by difference | | 1·6 |
| Sp. Gr. at 60°F. of oil distillate | 0·882 | |

| Redistillation of oil distillate (Sp. Gr. 0·882) | % Vol. | Sp. Gr. at 60°F | % Total oil | Volume of original sample |
|---|---|---|---|---|
| Light oil (crude naphtha) up to 150°C | 4·5 | 0·851 | 3·8 | 2·7 |
| Medium oil (illuminants) 150°-300°C | 36·6 | | 31·1 | 21·8 |
| Heavy oil (lubricating stock) 300°C. and up | 54·8 | 0·916 | 46·5 | 32·5 |

*Remarks.* The sample submitted was too small to allow for determinations showing more than indications of the nature of oil as received and the proportion of light, medium and heavy oil fractions on a very small laboratory scale.

Analysis by: H. McD. Chantler
Jr. Chemist.

(Sgd.) R. E. Gilmore
Superintendent.

*Imperial Oil Company.*

As already mentioned this company drilled on the Gratton Oil Company's lease on L.S.D. sec. 18, tp. 45, range 7, to a depth of 2205 feet. A heavy gas flow of 10,000,000 cubic feet per day was struck but water was also encountered and proved difficult to case off. A sand at 1892 to 2205 feet gave a little heavy oil, reported as less than a barrel a day. Gas from this well was used in drilling a second well on L.S.D. 2, sec. 14, tp. 45, range 8.

*Tests made.* The well was visited on October 3rd. A few moments after the valve was opened a quantity of a dark brown heavy fluid shot up to a height of 60 to 80 feet, followed by a stream of water, mud and gas.

After ten or fifteen minutes the well had blown clear and tests for the gasoline content were carried out. Samples for analysis, including some of the heavy brown fluid, were collected. The results were as follows:—

*Gas analysis*

| Constituents | Per cent |
|---|---|
| Methane $CH_4$ | 88·6 |
| Ethane $C_2H_6$ | 2·6 |
| Carbon dioxide $CO_2$ | 0·3 |
| Oxygen $O_2$ | 0·8 |
| Nitrogen $N_2$ | 7·7 |
| Helium | 0·06 |
| Gasoline content | Nil |
| Specific gravity | 0·61 |
| Calorific value B.T.U. at 0°C and 760 mm | 992 |

Rock pressure after blowing off one hour 650 lbs. per square inch.

*Analysis of dark viscous fluid.* The examination was made by Mr. Kohl, chemist of the Fuel Testing Division, Mines Branch.

The report was as follows:—

The sample of black viscous material was contained in a quart sealer. A little greyish mineral matter had settled to the bottom of the jar, covered by water to a depth of about one inch. Above this was a dirty, dark brown emulsion.

The volume of the water was 180 cubic centimetres. The emulsion was drawn off, a measured volume put in a distilling flask and distilled.

The operation was carried out with great difficulty on account of the frothing and bubbling over of the material in the flask.

This treatment separated the water and oil forming the emulsion and the mineral matter suspended in it. A residue of coke remained in the flask after the distillation.

The quantities of these materials were:—

| | | |
|---|---|---|
| Mineral matter | 2·1 | per cent by vol. |
| Water | 45·3 | " " |
| Oil | 40·0 | " " |
| Petroleum coke | 10·4 | " " |
| Specific gravity of oil at 15·5°C | 0·878 | " " |

The oil thus obtained was then redistilled with the following results:–

| Temperature | Product | Per cent of initial volume | Per cent of volume of emulsion | Sp. Gr. at 15·5°C |
|---|---|---|---|---|
| 25° — 150°C | (naphtha fraction) | 20 | 8 | 0·765 |
| 150° — 300°C | (illuminating oils) | 35 | 14 | 0·869 |
| 300° — 400°C | (lubricating oils and coke) | 45 | 18 | 0·934 |

The quantity of the emulsion that could be obtained from this well is very small.

## The Athabaska field

Some exploratory drilling for oil has been carried out in several localities along the Athabaska river. In 1897 the Geological Survey drilled a well on the banks of the Athabaska, two miles above the mouth of the Pelican river. This well encountered a large flow of gas in the Dakota sand at a depth of 800 feet. The well was allowed to blow off for fifteen years before it was finally capped. A few years later two other wells were drilled within a radius of two hundred feet by the Pelican Oil and Gas Company, and at a depth of 800 feet strong flows of gas were struck.

An analysis made on a sample collected in 1916 gave:—

| | |
|---|---|
| Methane $CH_4$ | 83·5 per cent |
| Carbon dioxide $CO_2$ | 1·0 " " |
| Oxygen $O_2$ | 2·9 " " |
| Nitrogen $N_2$ | 12·6 " " |
| Calorific value, per cubic foot at 60°F and 760 mm | 850 B.T.U. |

Undoubtedly large reservoirs of gas exist in this area.

Farther down the Athabaska river, especially north of McMurray, a number of wells have been drilled but no oil and little gas has been found.

## The Peace River region

During the last ten years there has been spasmodic drilling in the Peace River field chiefly north of the town of Peace River. There have been slight showings of oil, usually a heavy asphaltic petroleum, in some of the wells, but no good gas sands free from heavy flows of water have been struck.

The water conditions cause much trouble in this locality and several drilling rigs have been completely destroyed by rushes of water at high pressure from water sands penetrated without the necessary precautions. Strong flows of gas have been struck in several of the wells drilled and rock pressures of 600 to 700 pounds per square inch are reported but the gas is seldom free from water. Little is known about the character of the gas, or the possibilities of extracting gasoline. The field is near the Edmonton, Dunvegan and British Columbia railway and is perhaps one of the best situated in Alberta for the establishment of carbon black plants if sufficient quantities of gas of a suitable composition can be found.

The chief companies operating are:—

| | Location of well | | | Depth |
|---|---|---|---|---|
| | Sec. | Tp. | Rg. | |
| Peace River Oil Co., Ltd. | 4 | 85 | 20 | 1136 |
| | 31 | 85 | 21 | 1119 |
| | 24 | 85 | 21 | 1280 |
| Canadian Petroleums Ltd. | 11 | 85 | 21 | 3000 |
| | 23 | 85 | 21 | |
| P. M. Oil Co., Ltd. | 36 | 83 | 22 | |
| Tar Island Oil and Gas Co. | 24 | 85 | 21 | 1087 |
| North Pacific Oil Co. | 11 | 85 | 21 | 850 |

The following analyses have been reported:—

| | Canadian Petroleums Ltd.,* Well No. 1 | | | Spring on** Tar Island 25 miles below Peace River Crossing |
|---|---|---|---|---|
| | Sample 1 | Sample 2 | Sample 3 | |
| Methane | 71·6 | 65·6 | 73·6 | 77·2 |
| Higher hydrocarbons | 14·1 | 15·4 | 16·2 | – |
| Illuminants | 0·1 | 0·1 | 0·1 | – |
| Carbon dioxide | 0·2 | 0·2 | 0·3 | 1·8 |
| Carbon monoxide | 0·1 | 0·0 | 0·1 | – |
| Oxygen | 2·1 | 3·1 | 1·2 | 3·7 |
| Nitrogen | 10·3 | 14·2 | 7·2 | 17·3 |
| Sulphuretted hydrogen | 1·5 | 1·4 | 1·3 | – |

*Analysis by J. A. Kelso, University of Alberta.
**Fuel Testing Plant, Mines Branch, Ottawa.

## Pouce Coupé field

The Imperial Oil Company, in 1922, drilled a well on L.S.D. 7, of sec. 26, tp. 80, range 13, 6th meridian, known as the Pouce Coupé well. This location is west of Peace River and about fifty miles from the railway.

At 1676 feet, 10,000,000 cubic feet of gas was struck. No information is available of its gasoline content or composition. The well after being drilled to 2733 feet was mudded off.

The Northern Alberta Oil Fields, Ltd., is now drilling on sec. 27, tp. 79, range 12, 6th meridian. It is evident that large supplies of gas are available in this neighbourhood.

The Prairie Oils, Ltd., is commencing to drill on L.S.D. 15, sec. 23, tp. 74, range 17, 5th meridian, near High Prairie.

84377—3½

## Analysis of Alberta Natural Gas

| Field | Well | Analysis | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Sp. Gr. | $CH_4$ | $C_2H_6$ | $CO_2$ | $O_2$ | $N_2$ | Gasoline gallons per 1000 cu. ft. |
| Medicine Hat | City Mains | 0·56 | 97·8 | 0·3 | 0·4 | 0·0 | 1·5 | |
| Many Islands Lake | Medicine Hat Devel. Co. | 0·57 | 95·6 | 0·0 | 0·2 | 0·1 | 4·1 | |
| | Can. American Oil Co. | 0·58 | 96·3 | 0·5 | 0·5 | 0·3 | 2·4 | |
| Bow Island | Pipe line | 0·59 | 91·6 | | 0·0 | 0·2 | 8·2 | |
| | Pipe line | 0·60 | 90·3 | | 0·0 | 0·0 | 9·7 | |
| | Well No. 22 | | 90·1 | 2·6 | 0·0 | 0·0 | 7·3 | |
| | Well No. 9 and 10 | | 89·2 | 0·9 | 0·0 | 0·0 | 9·6 | |
| | Well No. 25 | | 86·2 | 4·3 | 0·0 | 0·0 | 9·5 | |
| Barnwell | Well No. 1 | 0·61 | 94·2 | 0·8 | 0·3 | 0·3 | 4·4 | |
| Foremost | Ecklin well | 0·57 | 95·4 | 0·0 | 0·3 | 0·0 | 3·7 | |
| Craigmyle | Southern Alberta well No. 2 | 0·86 | 52·0 | 45·1 | 1·4 | 0·8 | 0·7 | 0·7 |
| Turner Valley | Illinois-Alberta, Well No. 1 | 0·72 | 67·4 | 30·0 | 1·0 | 0·2 | 1·4 | 0·3 |
| | Royalite Oil Co. Well No. 1 | 0·70 | 71·8 | 25·9 | 2·1 | 0·3 | 0·9 | 0·2 |
| | Well No. 3 | 0·71 | 67·2 | 30·3 | 1·7 | 0·0 | 0·8 | 0·3 |
| | Well No. 4 | 0·73 | 65·9 | 24·4 | 1·2 | 2·0 | 6·5 | 0·2 |
| Viking | Well No. 6 | 0·64 | 92·5 | 3·5 | 0·5 | 0·1 | 3·4 | |
| Wainwright | British Petroleum Well No. 1 | 0·62 | 87·3 | 4·4 | 0·3 | 1·0 | 7·0 | |
| | Imperial Oil Co., Fabyan No. 1 | 0·61 | 88·6 | 2·6 | 0·3 | 0·8 | 7·7 | |
| Athabaska River | Pelican Rapids | | 83·5 | | 1·0 | 2·9 | 12·6 | |
| Peace River | Tar Island Spring | 0·67 | 77·2 | | 1·8 | 3·7 | 17·3 | |

## Analyses of Some United States Natural Gases[1]

| No. | | Analysis | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | B.T.U. net air free | $CH_4$ | $C_2H_6$ | $CO_2$ | $O_2$ | $N_2$ | Gasoline gallons per 1,000 cu. ft. |
| 3 | Pennsylvania | 929 | 75·79 | 11·33 | 0·00 | 0·00 | 12·00 | 0·10 |
| 7 | Oklahoma | 1007 | 71·00 | 18·54 | 0·16 | 0·61 | 9·82 | 0·11 |
| 10 | West Virginia | 1010 | 65·08 | 22·00 | 0·24 | 0·12 | 12·57 | 0·22 |
| 14 | Oklahoma | 1116 | 51·60 | 37·20 | 0·25 | 0·40 | 10·39 | 0·24 |
| 20 | Texas | 1136 | 72·60 | 25·10 | 0·12 | 0·00 | 2·18 | 0·40 |
| 23 | California | 1174 | 54·30 | 37·65 | 7·20 | 0·12 | 2·80 | 0·50 |
| 25 | Oklahoma | 1278 | 43·59 | 49·78 | 6·63 | 0·00 | 0·00 | 0·90 |

[1]Taken from table in U.S. Bureau of Mines Tech. Paper 253, 1920. Effect of gasoline removal on the heating value of natural gas by D. B. Dow.

## THE USE OF NATURAL GAS IN ALBERTA

### DOMESTIC AND INDUSTRIAL USE

Natural gas is the best fuel known; it has a high calorific value, it is clean to use and leaves no residue; it is easily piped to where it is required; and it can be burned with the maximum of control and efficiency.

The following table[1] shows the quantities and approximate costs in Alberta of other substances which might be used as fuels that have the same heat value as 1,000 cubic feet of natural gas.

| Fuel | Amount required to equal calorific value of 1,000 cu. ft. natural gas | Rate per unit | Approximate cost |
|---|---|---|---|
| | | $ cts. | $ cts. |
| Natural gas | 1,000 cu. ft. | ·50 | ·50 |
| Manufactured gas | 2,000 cu. ft. | 1·50 | 3·00 |
| Electricity | 300 Kilowatt hours | 1½ | 4·50 |
| Gasoline | 6 gallons | 40 | 2·40 |
| Coal oil | 6 gallons | 25 | 1·50 |
| Soft coal | 90 lbs. | 8·00 ton | 0·36 |

The efficiency obtainable in the use of these fuels is not taken into consideration in this table, though it is probable that most of them are burned with about the same efficiency excepting soft coal from which only about half its available heat is usually obtained. Considering the convenience of using natural gas, it is readily seen that it is the cheapest and best fuel obtainable.

Most of the natural gas at present available in Alberta is used for domestic purposes. It is supplied to all the larger cities—Calgary, Edmonton, Lethbridge, Medicine Hat, and more than half the population of Alberta may benefit from its use.

The chief companies supplying gas to domestic consumers are:—

| | Wells at | Cities supplied |
|---|---|---|
| City of Medicine Hat | Medicine Hat | Medicine Hat |
| Dominion Glass Co. | Redcliff | Redcliff |
| Canadian Western Natural Gas Light, Heat and Power Co., Ltd | Bow Island | Calgary |
| | Monarch | Lethbridge |
| | Barnwell | Macleod |
| | Foremost | Nanton |
| | Turner Valley | Okotoks etc. |
| North Western Utilities Ltd. | Viking | Edmonton |
| City of Wetaskiwin | Wetaskiwin | Wetaskiwin |

To conserve the supply in the best interests of the consumers, attention should be paid to the efficient distribution and use of the natural gas. The chief wastes are caused by leakage in the transmission and distribution of the gas, and inefficient and careless use by the consumer. The first cause of waste can be remedied by the installation of meters at various

[1]Adapted from table by S. S. Wyer. 31st Annual Report Ontario Dept. of Mines, Vol. XXXI, Pt. V, 1922, p.32.

points in the pipe lines, so that the quantity of gas delivered from the wells can be compared with that paid for by the consumers, and if serious discrepancies exist the leak can easily be found and repaired. Some loss in transmitting through a long pipe line is unavoidable and the limit allowed in many parts of the United States is 200,000 cubic feet per annum per mile of 3-inch pipe. This minimum can be secured by efficient management and control. The second great waste can be prevented by educating the consumers by close inspection and regulation[1] of all appliances used, and by keeping the price sufficiently high to prevent unnecessary consumption.

Much thought has been given to this subject in the United States[2] during the last few years, especially in those states where the natural gas supply is waning. The results of the many investigations and the remedies put forward can be applied to forestall similar conditions in Alberta.

*Industrial use.* It is a well recognised principle that the industrial use of natural gas should only be permitted where the supply is large and the field is proved to be of long life, and where it is certain that the establishment of the industry is of great economic importance to the district. Medicine Hat is the only place where natural gas is being used in this way in Alberta. As already mentioned, several flour mills, the largest glazed pipe factory in western Canada, a pottery, and several smaller plants have been established there, mainly attracted by the advantage of natural gas as a fuel.

The Wainwright field, situated close to the main line of the Canadian National railway, will doubtless attract similar industries in the near future, when more wells are drilled and greater supplies of gas are available.

The other fields, with the exception of those in northern Alberta, should be reserved solely for domestic consumption.

## THE POSSIBILITIES OF EXTRACTING GASOLINE

The natural gas gasoline industry has become of considerable importance in the United States. The total output of gasoline in that country in 1921 was approximately 5,498,000,000 gallons of which 8·2 per cent or about 450,000,000 gallons valued at over $61,000,000 was obtained from natural gas. The quantity of natural gas gasoline recovered in Canada is less than 400,000 Imperial gallons, valued at about $85,000. Unfortunately, at present, there is not much prospect of this amount being greatly increased.

Dr. D. B. Dowling, of the Geological Survey, in 1917, examined many of the gases in the older fields. With the exception of the gas in the Turner Valley field, the tests showed that there were no gases in the Medicine Hat, Bow Island or Viking fields that contained gasoline hydrocarbons in commercial quantity.

[1] Wyer, S.S., Natural gas, its production, service, and conservation.
Smithsonian Inst. Bull. 102, part 7, 1918, p.42.
Natural gas manual for the home. R.A. Cattell.
Tech. Paper 325, U.S. Bureau of Mines, 1922.
Natural gas in 1919-1921. R. S. McBride and E. G. Sievers.
Mineral Resources of the United States, 1921.
Part II, pp. 335-36. U.S. Geological Survey.
Natural gas in 1921. 31st annual report Ontario Department of Mines, 1922, especially report by Samuel S. Wyer on the situation in Western Ontario, pp. 29-34.

[2] Op. cit.

The results obtained in the investigation carried out by the Mines Branch during 1923 confirm the report then made. At many natural gas wells no tests were carried out, because preliminary measurements of the specific gravity and of the rock pressure showed that no gasoline hydrocarbons were likely to be present, a condition afterwards confirmed by the analyses of the gases.

Three gases in the Turner Valley field were found to contain about two pints per 1,000 cubic feet and one approximately four pints; even these would be considered hardly worthy of treatment in the United States. Two plants[1] are established to recover gasoline from these gases, however, both using an oil absorption process.

The existence of gasoline in gases in the Many Islands Lake and Wainwright fields has been reported but the tests made this summer failed to confirm these reports. One of the wells, however, has filled with water and may not have been yielding gas of the same character or from the same sand as that in which several pints of gasoline per 1,000 cubic feet were reported to be present. Further investigations in this field should be made. It cannot be too strongly emphasized that before any capital is invested in the erection or operation of a gasoline extraction plant an exhaustive series of tests of the gases to be treated should be carried out. The possibilities of the establishment of gasoline extraction plants in Alberta are greatly dependent on the possibilities of finding oil. The richest gasoline containing natural gases are those which are found with oil, and oil in abundance has not yet been discovered in western Canada.

## THE MANUFACTURE OF CARBON BLACK IN ALBERTA

Carbon black is the fluffy black substance formed by the deposition of the solid products of incomplete combustion of natural gas. It is thus differentiated from other blacks such as lampblack, vine black, ivory black, bone black, acetylene black, etc., which are formed by the combustion of oil or similar hydrocarbons of high molecular weight or of such other carbonaceous materials as the names imply. Each of these blacks has its own specific uses, lampblack for paints and pigments, ivory black for high class varnishes, bone black for decolorizing purposes. With the exception of ivory black, carbon black has the highest average value because of its fineness and intense blackness, properties which make it indispensable in some industries.

The chief demand for carbon black is in the manufacture of printing ink and as a filler in automobile tires and other rubber goods, in which in certain cases it may be mixed in quantities up to 20 per cent of the total weight. The most complete account of the methods of manufacture, composition, properties and uses of carbon black yet published, is given in the U.S. Bureau of Mines Bulletin 192, by R. O. Neal and G. St. J. Perrott.

The usual type of plant consists of long, steel frame buildings covered with sheet iron. In these sheds the gas is burned at hundreds of small steatite burners set in rows of pipe. The draughts are carefully controlled and the products of incomplete combustion deposited on parallel

[1] A more detailed description of these plants is given in the section on the Turner Valley field, p. 26.

sheet iron trays or channels set above the burners. These channels slowly move back and forward. Scrapers are arranged so that the carbon black is automatically removed from the channels, dropped into hoppers beneath and transported by screw conveyers to packing houses where it is bolted and packed in paper sacks.

The process is very inefficient, an average of about one pound of carbon black being formed from the combustion of 1,000 cubic feet of gas, while the theoretical yield is about forty pounds. But no process giving a higher yield of the same high quality of black has yet been devised.

It is due to this inefficiency that the process is looked upon with disfavour and regarded as a wasteful use of natural gas, but the product is so indispensable to the printing and newspaper publishing industries that it is difficult to prohibit its manufacture and no satisfactory substitute for it has yet been found.

*Imports.* The imports of all forms of blacks into Canada during the last three years were as follows:—

| | | Twelve months ending March | | |
|---|---|---|---|---|
| | | 1921 | 1922 | 1923 |
| From— | | | | |
| United Kingdom | Lb. | 73,070 | 3,856 | 12,128 |
| | $ | 10,951 | 501 | 1,304 |
| United States | Lb. | 3,444,416 | 2,296,984 | 708,660 |
| | $ | 445,470 | 256,551 | 443,932 |
| Other countries | Lb. | | 12,300 | 22,621 |
| | $ | | 1,621 | 1,576 |
| Total | | 3,567,486 | 2,313,140 | 3,743,409 |
| | $ | 456,421 | 258,673 | 446,812 |

There is no import duty on any form of black.

It is probable that carbon black importations constitute at least three quarters of these quantities and certainly account for more than half of the values. Great Britain imports 8,000,000 to 10,000,000 lbs. of carbon black, principally from America. The European countries also take large quantities and Japan and China are becoming large consumers.

*Canadian market.* There are about twenty plants manufacturing rubber goods in Ontario and Quebec in which probably two-thirds of the carbon black imported into Canada is used. Most of these plants are situated in or near Toronto.

The rubber industry does not require as high a grade of material as the printing ink manufacturers, the chief requirement being freedom from grit. The present price for carload lots is from 10 to 12 cents per pound, f.o.b. Louisiana.

The freight rate is about one to one and a half cents per lb.

The printing and lithographic ink manufacturers use between a half and one million pounds a year, these requirements covering a number of grades, the prices of which range from 15-35 cents a pound. In addition there are between thirty and forty manufacturers of japans and varnishes chiefly

located in Toronto and Montreal, many of whom require quantities of gas black. Carbon paper and typewriter ribbon manufacturers in Toronto and Montreal also use a considerable quantity of the finer grades of carbon black.

It is evident therefore that if two or three plants were established in Canada, they could find a ready market for their product if they could compete in price with manufacturers in the United States.

*Freight charges.* The freight charges constitute one of the chief items of cost that must be taken into account by any company considering the establishment of a carbon black plant in western Canada.

Carbon black is usually shipped in paper bags. The standard bag contains 12½ pounds and is 21 inches long, 11 inches wide and 8 inches thick. Frequently the bags are compressed, when they are reduced in volume by thirty or forty per cent. The usual carload consists of 1600 bags weighing about 20,000 lbs. The rates in the United States are fourth class in carload lots or first class in less than carload lots.

The chief producing centres in Louisiana are about 1500 miles from Toronto, and the freight rate is from one to one and a half cents per pound. The Peace River district, probably the most favourable location for a plant in Canada, is about 2,300 miles from Toronto. There is no provision for gas or carbon black in the Canadian class rates but assuming it to be classed with lampblack the rate from the west to Toronto would be about $3.50 or $3 per hundred pounds.

Under present conditions, the industry would therefore be under the handicap of an extra freight cost of two cents, besides the extra capital charges for the freight on plant and equipment.

*Factors governing location of plant.* There are several factors which enter into the choice of a location for the establishment of a carbon black plant. They may be summarized as follows.

1. At least five million cubic feet a day of cheap gas should be available, and there should be good evidence in favour of a long life for the field.

2. The gas should be relatively rich in ethane. It has been found that the higher the ethane and higher hydrocarbon content the greater the yield of carbon black as shown by the following table.[1]

Carbon content and quantity of carbon black recovered:—

| | A Louisiana | B West Virginia | C West Virginia | D Wyoming |
|---|---|---|---|---|
| Methane (a) p.c. | 94·12 | 70·75 | 65·23 | 46·45 |
| Ethane, p.c. | 3·44 | 24·14 | 30·07 | 43·10 |
| Carbon dioxide | ·50 | ·28 | 1·56 | ·96 |
| Nitrogen, p.c. | 1·94 | 4·83 | 3·14 | 9·49 |
| Heating value (b) | 962 | 1,086 | 1,134 | 1,176 |
| Carbon per 1,000 cu.ft. of gas (c) Lb. | 33·8 | 39·9 | 42·3 | 44·3 |
| Carbon black per 1,000 cu.ft. of gas reported obtained | ·80 | 1·00 | 1·10 | 1·40 |
| Per cent recovery | 2·4 | 2·5 | 2·6 | 3·1 |

(a) Analyses were made by D. B. Dow, junior chemist of Bartlesville station, United States Bureau of Mines.
(b) Net heating value in B.T.U. per cubic foot at 0°C, and 760 mm. pressure.
(c) Calculated from carbon content of methane and ethane.

[1]U.S. Bureau of Mines Bulletin No. 192, p. 12.

3. There should be reasonably good transportation facilities by railway or by water. The materials for the construction of the plant have to be brought in and the product though not particularly bulky must be shipped out regularly. This can not be done profitably except by railway or barge.

4. There should be no immediately prospective demand for the gas by domestic consumers.

## Possible locations in Alberta

When the various gas fields in Alberta are regarded in the light of the preceding paragraph it is at once apparent that there are only four areas which can be considered, with the possible exception of one or two areas where shallow wells may provide for local production. The four are the Many Island Lake field, the Wainwright field, and the two areas in northern Alberta, Athabaska River and the Peace River. All the other fields are now used to supply domestic requirements or will soon be utilized for that purpose.

*Many Island Lake field.* Although comparatively small amounts of gas are immediately available in this field, large supplies exist, which will be soon opened up in the search for oil in that neighbourhood. The gas from the sands so far struck is of poor quality for the production of carbon black, and contains little or no gasoline, therefore the yield would be small. Transportation facilities in this field are good. On the other hand the field is only forty miles from Medicine Hat, whose supply is showing signs of depletion.

It is most probable that in a few years, gas from the Many Islands field will be required to supplement the Medicine Hat supply.

*Wainwright field.* In this field also the present available supply is comparatively small. Much gas exists however in the sands and many large flows will be struck during the activity that is bound to result from the recent announcement of the discovery of oil in the neighbourhood. There are no cities or towns where the gas is required and consequently no prospect of a domestic demand for many years, Edmonton being assured of a supply for a long period from the Viking field. If the gas is not used for the purpose there is bound to be much waste, unless drilling in this area is restricted and carefully regulated. This part of the country is sparsely settled and not as suitable for wheat growing as many parts of Alberta. Over 100 square miles immediately south of the gas field forms the Canadian National Park buffalo reserve. The gas at present available is mostly methane and would not give very high yields of carbon black. Neither would it warrant the erection of a plant for the extraction of gasoline, though richer gases may presently be found.

The field is close to the main line of the Canadian National railway and transportation facilities would be good.

If the establishment of a carbon black plant or plants in this field is economically possible, many people consider there are no valid arguments to be advanced against it from the point of view of conservation.

*The Craigmyle field.* This area lies about thirty miles northeast of Drumheller, in the Hand Hills district, covering tp. 32, range 17, W. 4th meridian.

There have been a number of shallow wells drilled in the district, notably at Castor and on the Ecklin farm near Delia, and in most of these wells small flows of gas are encountered.

The Prairie Natural Gas Company plans to manufacture carbon black near Craigmyle, but in September 1923 the only well drilled had the small flow of 40,000 cubic feet per day. An analysis of the gas is given in the table following. The territory is unproved and it is doubtful if sufficient gas can be found to warrant the erection of a plant large enough to be a commercial success.

There would be no considerable domestic demand for gas in this field. If large supplies can be found, the question of using some of the gas for the manufacture of carbon black must be considered.

The Canadian National railway runs through this district and the roads are good.

*The Peace River region.* A large amount of gas is available in this district, though drilling is difficult on account of the water conditions, and there is danger of flooding the gas sands unless great care is exercised. Insufficient analyses have been made to make a statement on the suitability of the gas for the manufacture of carbon black or for gasoline extraction. No argument for conserving the gas for future domestic use can be reasonably advanced.

The great drawback to the location of a plant in this field is the difficulty and high cost of transportation. It is connected by the Edmonton, Dunvegan and British Columbia railway with Edmonton, a distance of 312 miles. It should be repeated that the freight charges on the product from Peace River to the east or to the coast would be an important item in the costs, so long as the price of carbon black from the United States remains at the present level.

*The Pelican Rapids field.* Although little information exists of the quality and quantity of the gas available in the Pelican Rapids field, every condition would seem favourable for the location of a plant except the difficulty of transportation. It is even greater than in the Peace River field, as the only means would be by barge on Peace river. The distance to Athabaska Landing, the nearest railway point, is about 100 miles, and from there to Edmonton about another 100 miles. The river is navigable for a few months in the year only, on account of low water and ice.

*The quality of the natural gas available.* It has been found from experience in the United States that the most suitable natural gases for the manufacture of carbon black are those with a high ethane content.

As the following analyses show, the gases so far available in Canadian fields where plants might be established, are low in ethane and the higher hydrocarbons. This does not mean that no carbon black could be obtained from them, but rather that the yields would be relatively small.

Typical analyses from the following fields are:—

| | Many Islands | | Wainwright | | Craigmyle | Peace River | Pelican Rapids |
|---|---|---|---|---|---|---|---|
| Methane | 95·6 | 96·3 | 87·3 | 88·6 | 95·4 | 77·2 | 83·5 |
| Ethane | Nil | 0·5 | 4·5 | 2·6 | Nil | | |
| Carbon dioxide | 0·2 | 0·5 | 0·3 | 0·3 | 0·3 | 1·8 | 1·0 |
| Oxygen | 0·1 | 0·3 | 1·0 | 0·8 | Nil | 3·7 | 2·9 |
| Nitrogen | 4·1 | 2·4 | 7·0 | 7·7 | 3·7 | 17·3 | 12·6 |
| Specific gravity | 0·57 | 0·58 | 0·62 | 0·61 | 0·57 | 0·67 | |
| Calorific value | 1017 | 1074 | 1012 | 992 | 1016 | 785 | 850 |
| Gasoline content pints per 1000 cu.ft. | Nil | Nil | Trace | Nil | Nil | | |

*Regulations governing the use of natural gas for the manufacture of carbon black.* Regulations governing the use of natural gas for the manufacture of carbon black have been recently issued. The main points in these regulations are that the permission of the Minister of the Interior must be obtained for the gas to be so used, that gasoline if present in commercial amount must first be extracted, and that if any or all of the gas is subsequently required for domestic consumption that demand must first be supplied at a rate to be fixed by arbitration.

The general regulations under which natural gas leases may be granted, the carbon black regulations and all necessary information relating to such matters can be obtained from the Deputy Minister, Department of the Interior.

## HELIUM FROM NATURAL GAS

The commercial production of helium during the later stage of the war, a substance that in 1916 was almost a scientific curiosity and of which only a few cubic feet were in existence in scientific laboratories in Europe, is one of the many recent spectacular achievements of scientists.

Helium is a light non-inflammable gas which is a most valuable substitute for hydrogen for the inflation of the gas bags of airships. The inflammability of hydrogen and the explosive nature of its mixture with air was, to mention only a few recent accidents, the cause of destruction of the U.S. airships Roma, the U.S. Z.R. 2, in England, the British airship R. 34, and the French dirigible Dixmude.

The story of the early development and later large scale production of helium in Canada and the United States has been frequently related. The most recent achievement in the United States was the inflation of the U.S. airship Shenandoah with helium and its survival after being blown from its mooring mast in a heavy gale.

Helium is also of great importance to the scientist because of its relation to the phenomenon of radioactivity and the part it plays in modern theories of the structure of matter.

The results of a survey of the helium resources of the British Empire, carried out in 1916-1917 under the direction of Prof. J. C. McLennan of the University of Toronto, have already been published by the Department of Mines, Mines Branch Bull. No. 31. This survey showed that the Bow Island natural gas field in Alberta was the best source for the commercial production of helium in Canada.

Several natural gases in Ontario contained as large a per cent of helium, but the supplies available were small and the difficulties of extraction considerably greater.

A small experimental plant was built at Calgary in December 1919 and operated for four months. About 60,000 cubic feet of helium of varying degrees of purity were separated in experimental runs and from the experience gained a large scale plant was designed. Lack of means prevented the continuation of this investigation. Since that time no further work on the separation of helium has been carried out, although research on the liquefaction and solidification of this gas is being most successfully followed at the University of Toronto.

*Progress in the production of helium in the United States.* Much greater progress has been made in the United States chiefly owing to the large resources of helium available but also to their belief in the value of the development of the dirigible balloon. More than five million dollars have been spent on this work, and a similar sum will probably be available for future work. The two plants built during the war have been shut down, but a third, based on the design of the better of these has produced several million cubic feet of 95 per cent pure helium. The United States Bureau of Mines is actively engaged in perfecting a new process, in building repurification plants at airship stations and in carrying out many scientific investigations relative to helium.

*The helium resources of the United States.* A complete survey has been made of all the natural gas fields in the United States. The results of this extensive survey show that helium is a common constituent in small amounts of many gases, although relatively few samples contained more than 0·5 per cent, which the Bureau of Mines considers to be the minimum amount to justify commercial operation. It was shown that over 500,000,000 cubic feet of helium were going to waste annually, and that of this amount 50,000,000 cubic feet could be readily extracted, if plants were available.

## Helium in Alberta

The chief gas fields in Alberta are the Medicine Hat area, the Bow Island field, the Turner Valley field and the Viking and Wainwright fields. Samples of gas from the chief wells in these areas were examined for their helium content in 1916 and 1923 with the following results. Analyses of a few of the chief helium bearing gases in the United States are added for comparison.

## Alberta

| Field | Well | Depth of gas sand in feet | Open flow M. cu. ft. per day | Helium content per cent |
|---|---|---|---|---|
| Medicine Hat | Cousins and Sissons | 1075 | 3,000 | 0·13 |
| | Central Park | 1300 | 3,000 | 0·11 |
| | Electric Park | 1300 | 3,000 | 0·12 |
| | C. P. R. | 1020 | | 0·11 |
| Many Islands Lake | Canadian American | 1350 | 500 | 0·07* |
| Bow Island | No. 4 | 1879 | 2,000 | 0·29 |
| | Nos. 3,11 and 14 | 2200—2500 | 3,000 | 0·29 |
| | No. 16 | 2218 | | 0·34 |
| | Nos. 9 and 10 | 1910 | 2,300 | 0·30 |
| | No. 22 | 2151 | 538 | 0·33 |
| | Barnwell, No. 25 | 2166 | 1,000 | 0·36 |
| Turner Valley | Dingman | 400—800 | | 0·03 |
| | Dingman | 3900 | 3,000 | 0·01 |
| | Royalite No. 3 | 2830 | 3,000 | 0·06* |
| Foremost | No. 1 | 2180 | 15,000 | 0·20* |
| Viking | No. 9 (?) | 2300 | 3,000 | 0·05 |
| | No. 6 | 2203 | 7,617 | 0·07* |
| Wainwright | Imperial Gratton No. 1 | 2205 | 10,000 | 0·09* |
| Athabaska River | Pelican River | | | 0·002 |
| Peace River | Tar Island Spring | | | 0·10 |

## United States

| | | | | |
|---|---|---|---|---|
| Eldorado | Butler Co., Kansas mean of 19. | 900 | | 1·12 |
| Augusta | Butler Co., mean of 13 | 1200 | | 1·01 |
| | Butler Co., mean of 2 | 450—650 | | 2·04 |
| | Butler Co., mean of 2 | 1200—1400 | | 1·09 |
| | Butler Co., mean of 22 | 1200—1500 | | 0·43 |
| Petrolea | Clay Co., Texas | 1500—1750 | | 0·93 |

*Tested in 1923. Others in 1916.

These figures show the lower helium content of the Alberta gases. Extensive investigation has shown in the United States that the gases from the shallower sands are usually richest in helium and that gases of low thermal value, high in nitrogen (20-40 per cent), usually have a higher helium content than those having a lower nitrogen percentage, although the presence of much nitrogen is not always an indication of helium. So far as known no gas of this character has ever been found in Alberta, though it must be said that little attention has been paid to the small flows of gas which have been struck at shallow depths in several of the fields.

Another factor that may be of importance is the difference in the geological ages of the formations in which the gas deposits are found. Most of the gases in the United States are found in formations of the Pennsylvanian (Carboniferous) age, while the gas sands in Alberta belong to the Cretaceous age, and are therefore much younger. Several gases in the United States, known to come from formations of the Cretaceous age, have a low helium content like the Alberta gases.

*The Bow Island field.* It has often been stated in the newspapers that ten million cubic feet of helium escape annually from the chimneys in Calgary alone. This is not correct today, however true it may have been ten years ago.

The Bow Island field in the last few years has been fast declining and in the future it is likely to be drawn upon only in winter to supplement gas now obtained from the Turner Valley, and soon to be obtained from the Foremost field south of Bow Island.

The original open flow of the Bow Island field was 75,000,000 cubic feet in 1913. Today it is about 17,000,000 and the rock pressure has declined from 800 to 210 lbs. per square inch. The daily capacity of the field when gas is passed into the pipe line at 60 lbs. pressure is about 12,000,000 cubic feet. Probably this amount could not be taken out for more than six months of the year, on account of water encroachment, if the pressure is greatly lowered. Taking the mean helium content as 0·30 and assuming the high efficiency of 80 per cent obtainable in the extraction process the quantity of helium recoverable would now be under six million cubic feet per annum.

The original experimental plant established by the British Admiralty under the direction of Prof. J. C. McLennan of the University of Toronto was put up in Calgary in 1919. As already stated, Calgary is now supplied with a mixture of gases from the Turner Valley field, the Chin Coulee field and the Bow Island field, much of which has a low helium content. A more suitable location today for an extraction plant would be in the Bow Island field itself. The early experiments showed that the recovery of helium is possible from a low percentage helium gas, and the estimates of the cost in a large scale plant based on experience gained from the experimental plant were $50 per 1000 cubic feet of 95 per cent pure helium. In the opinion of engineers with practical experience of commercial production in the United States this figure is too low.

*The Foremost field.* A well recently drilled to a depth of 2190 feet which opened up a flow of over 15,000,000 cubic feet a day has proved the presence of a large gas reservoir at Foremost, forty miles south of Bow Island.

Other wells now being drilled give promise of providing a large quantity of gas, which will be available for Calgary and the other cities supplied from the Bow Island pipe line. A sample of the gas from No. 1 well recently tested, contained 0·20 per cent helium. This gas was probably from the main gas sands at 2181-2191 feet. It was not possible to make a test of the gas which was encountered at 1068 feet. If the other wells now being drilled give as large flows as No. 1 well, a conservative estimate of the gas available per day, piped at 100 lbs. pressure would be 20,000,000 cubic feet and the helium recoverable, allowing an 80 per cent efficiency in extraction, would amount to about 30,000 cubic feet per day, or about ten million cubic feet annually.

The difficulties of recovering helium from a gas containing as low a percentage as 0·2 would be great and the cost might prove prohibitive, valuable as helium undoubtedly will become if the development of commercial airships now projected in Great Britain is carried out. In time of war it would be indispensable.

*Other gas fields in Alberta.* Preliminary investigations so far made have not brought to light any other Canadian gases which might be sources of helium. As already pointed out, previous examinations have been of a more or less hurried character to meet the requirements of the hour. Additional and more intensive investigations may bring to light natural gases containing larger amounts of helium, especially in view of the activity in the Wainwright area, and in the practically undeveloped gas fields in the north, at Pouce Coupé, along the Peace river and in the Athabaska area.

*Summary.* The two fields, Bow Island and Foremost, might yield from ten to fifteen million cubic feet of helium a year if an efficient process was developed to treat gases with the low helium content of 0·3 to 0·2 per cent. The cost might be estimated at $50 to $100 per 1000 cubic feet.

The recovery of the helium now going to waste in Alberta would seem to be a true measure of conservation and of the greatest importance to the empire even in face of the present great need for economy and restriction of public expenditure. No private corporation could be expected to engage in such an enterprise and it is a work entirely for the state to develop.

# VI

## SODIUM AND MAGNESIUM SALTS OF WESTERN CANADA

L. Heber Cole

The investigation of the sodium sulphate deposits of western Canada, commenced during the season of 1921, was continued during the season of 1923. A second drill was employed and two parties operated in the field. The two drilling parties were in charge of Messrs. H. A. Leverin and M. F. Goudge, while the writer had general supervision over the whole work, as well as carrying on preliminary examinations on a number of deposits not so far examined.

Owing to numerous delays the second drill was not delivered at Swift Current, Sask., until the middle of July, and in consequence the detailed examination of the deposits was late in starting.

From June 15 to July 15 the two parties were engaged with the first drill in putting down a hole and surveying and otherwise testing the deposit of volcanic ash described in the Summary Report of the Mines Branch for 1922[1].

On the arrival of the second drill the two parties were immediately formed, the one under Mr. Goudge commencing work on the deposits near Ingebright, Sask., while the other under Mr. Leverin proceeded to the deposit 11 miles south of Regina Beach, Sask.

Six deposits were examined in detail, one party remaining in the field till the first week in November, while the second party operated till the end of November.

### INGEBRIGHT DEPOSITS

Townships 16 and 17, range 25, west of the 3rd meridian, are in what is known as the Ingebright district of Saskatchewan. The sulphate deposits in these townships are strung out in a line north and south. These deposits are eight in number and vary in extent from one of the largest crystal bodies yet discovered down to the so-called 'alkali slough', in which sodium sulphate is only formed when the brine evaporates in the late summer and leaves a white crust of sodium sulphate 1 to 4 inches thick on top of the mud over the whole surface of the slough. These deposits are all long and relatively narrow, occupying depressions in the bed of a well defined valley which can be traced for many miles. Two of these deposits were examined in detail during the season.

[1]See Mines Branch Report No. 605, pp. 15-20.

*Deposit No. 1*

This deposit occupies parts of sections 13 and 14, 23 and 24, 25 and 26 of township 16, range 25, west of the 3rd meridian. It is in a remote position as regards railway shipping facilities. The town of Maple Creek, on the main line of the Canadian Pacific railway, 38 miles to the southward, is the nearest shipping point, while to the northward the railway is slightly more distant. The roads in this district are of ordinary graded dirt, and at times, especially in the spring, are not in the best of condition for heavy traffic. It is quite possible that in the near future railway facilities will be available within a few miles, and if so, it will be an easy matter to run a siding to the deposit.

The deposit occupies a crescent-shaped basin over 700 acres in area. The level of the crystal bed is about 70 feet below the general level of the country, the banks of the basin rising sharply around the major part of the deposit from 40 to 50 feet above the crystal bed and then sloping gradually up to the general level of the prairie. There is an extensive crystal bed, averaging 22 feet thick, covering the bottom of this basin. One peculiar feature of this deposit was the discovery of two deep areas in the crystal bed. The deep area in the northern part showed a depth of approximately 140 feet of crystals, while the drilling in the southern part penetrated 120 feet of crystals without reaching the bottom of the bed. The deposit is by far the largest so far examined, a tonnage of approximately 25,000,000 tons of combined hydrous salts having been proved.

This deposit was examined and drilled during the field season of 1923, 36 holes being put down. The core from each hole was carefully sampled every 5 feet in depth and a composite sample taken representative of the material from the complete hole. The analyses of four of the composite samples from this deposit are given below and convey an idea of the composition of the material in this deposit.[1]

| | | Hole 1 | Hole 7 | Hole 16 | Hole 27 |
|---|---|---|---|---|---|
| | Per cent | | | | |
| Insoluble | " | 6·07 | 9·35 | 13·33 | 6·13 |
| $NaHCO_3$ | " | ..... | 1·01 | 0·52 | 0·76 |
| $CaSO_4$ | " | 1·02 | 5·37 | 7·60 | 5·92 |
| $MgSO_4$ | " | 1·20 | 7·30 | 2·95 | 2·60 |
| NaCl | " | 1·09 | 1·73 | 1·86 | 0·59 |
| $Na_2SO_4$ | " | 84·00 | 73·00 | 71·00 | 82·50 |
| Total | " | 93·38 | 97·76 | 97·26 | 98·50 |

The deposit is under lease to parties in western Canada, and it is hoped that a move will shortly be made to operate this property.

[1]At the time of writing the analyses of the 5-foot samples had not been completed, and while there are many variations in composition at certain depths, the composite samples above give an approximate idea of the general composition of the deposit.

*Deposit No. 2*

About five miles to the northwest of deposit No. 1 another deposit was drilled and sampled. This deposit is situated in sections 4 and 9, township 17, range 25, west of the 3rd meridian. The nearest shipping point on the railway is Prelate, Sask., 35 miles to the north on the Empress branch of the Canadian Pacific railway.

This is one of the larger of the series of alkali deposits that occur in the Ingebright district and occupies the bed of a valley that enters the southwest end of deposit No. 1, previously described. The deposit is about 8,000 feet long, north and south, and 1,500 feet wide at its widest part.

The banks of the southern part of the lake have very gentle slopes. The soil is sandy and almost free from boulders. In the northern portion, however, the banks are steep, rising sharply to a height of from 40 to 50 feet, and stony boulder clay is predominant, especially on the eastern shore.

There are four springs along the margin of the lake, two on the west side and two on the east side. These springs are more in the nature of seepages than true springs, as they each cover a considerable area and the actual flow of water is small. There was only one small spring observed welling up through the crystal bed.

The crystal bed extends to within 50 feet of the shore, except in the northern and southern extremities of the lake where the crystal does not extend into the narrow coves. The crystal is covered with a layer of mud varying in thickness from 10 inches to over 2 feet. On the surface of this mud there is deposited in the autumn a thin layer, one inch in thickness, of pure crystal. This layer readily dissolves in wet weather.

Twelve drill holes were put down in this lake and the holes showed that the bed of the lake is very uneven. The depth of the crystal in the middle of the southern part of the deposit varies from 7 to 25 feet, while in the northern part, with the exception of one deep area, the average depth was not more than 4 feet.

In the deep area in the northern part of this deposit, a depth of 80 feet of solid crystal was encountered. The quantity proved was approximately 2,800,000 tons of hydrous salts.

The crystal bed is comparatively free from both included mud and mud strata, the crystal being clear and hard from top to bottom. Underlying most of the southern part of the crystal bed is a soft calcareous ooze through which the drill rods sink of their own weight until a hard compact stratum is reached.

Analyses of three composite samples from this deposit are given below:[1]

| | | Hole 1 | Hole 4 | Hole 7 |
|---|---|---|---|---|
| Insoluble | Per cent | 2·70 | 11·20 | 2·33 |
| $NaHCO_3$ | " | 0·94 | 0·79 | 0·63 |
| $CaSO_4$ | " | 0·76 | 2·15 | 0·70 |
| $MgSO_4$ | " | 1·10 | 0·54 | 1·85 |
| NaCl | " | 0·32 | None | 0·16 |
| $Na_2SO_4$ | " | 94·20 | 84·71 | 93·90 |
| Total | " | 100·12 | 99·39 | 99·57 |

[1]See previous footnote on page 48.

## HORIZON DEPOSIT

This deposit, known locally as Horseshoe lake, is situated on sections 7, 8, 16, 17, 20, 21, township 9, range 25, west of the 2nd meridian. The nearest shipping point is 16 miles south, at Viceroy, Sask., a station on the Forward branch of the Canadian Pacific railway.

The crystal bed covers practically the whole lake basin and in general runs close to the shore. In the southern end of the lake, between the shore and the island, the bed is solid with no mud holes, the depth averaging about 15 feet. In the northern part of the deposit the crystal bed is more broken up and patchy.

The crystal encountered in the drill holes was very pure and free from mud and other foreign matter, being of a bluish colour and very firm. The thickness of the mud covering the crystal on the south end of the lake rarely exceeds 6 inches, but becomes deeper in the north end, especially near the islands, where it often reaches to a depth of 3 feet.

Saline water, in the early part of the summer, covered the deposit to a depth of about 8 inches, but during the latter part of the summer and early fall the intermittent crystal bed soon formed.

Analyses of composite samples taken from this deposit are given below:[1]

*Horseshoe Lake*

| | | Hole 1 | Hole 3 | Hole 5 | Hole 6 |
|---|---|---|---|---|---|
| Insoluble | Per cent | 5·50 | 3·76 | 2·03 | 4·10 |
| $NaHCO_3$ | " | ..... | ..... | 1·18 | 1·19 |
| $CaSO_4$ | " | 0·34 | 0·61 | 0·61 | 0·85 |
| $MgSO_4$ | " | 1·09 | 1·06 | 1·65 | 1·40 |
| NaCl | " | 1·53 | 2·14 | 0·62 | 0·56 |
| $Na_2SO_4$ | " | 89·00 | 90·00 | 93·00 | 91·70 |
| Total | " | 97·46 | 97·57 | 99·09 | 99·80 |

## REGINA BEACH DEPOSIT No. 1

This deposit is situated in a depression at the northeast corner of section 25, township 20, range 22, west of the 2nd meridian. The nearest point on a railway is Regina Beach, a station on the Canadian National railways, 11 miles distant.

The lake is nearly rectangular, about 1,600 feet in length and its greatest width is 600 feet. Notwithstanding its small size, compared with many other similar deposits in Saskatchewan, this deposit was one of the earliest to be operated, and shipments of natural Glauber's salt have been made from it annually for a number of years.

The crystal bed is irregular and intersected with a chain of large mud-holes, so that the crystal bed covers less than a quarter of the whole lake area. Mud covers the crystal bed, ranging in thickness from six inches to one foot. Saline water varying in depth from 3 feet to 3 feet 8 inches covered the whole deposit when examined in the month of July, 1923.

[1]See previous footnote on page 48.

The lake seldom dries up, but at a lower temperature, the Glauber's salt crystallizes in large quantities and sinks to the bottom, when it is harvested. This operation is performed entirely by manual labour, the men standing in the brine and shovelling the precipitated crystals on to scows from which they are unloaded on a wharf. After draining, the salts are bagged and shipped by wagon to Regina Beach station.

Four holes were sunk in the crystal bed; No. 1 in the south end with 10 feet of crystals; No. 2 in the centre with 9 feet 6 inches of crystals; No. 3 in the north end of the bed with a crystal depth of 12 feet 6 inches; and No. 4 in the west end of the bed with a depth of 5 feet 6 inches of crystals. The estimated tonnage of crystal in the permanent bed is approximately 50,000 tons.

The crystal in the permanent bed is of a bluish white colour, clear and hard and comparatively free from foreign substances.

Analyses of material from this deposit are:—

| | | Hole 1 5′–10′ | Hole 2 0–5′ | Hole 3 10′–12½′ | Hole 4 0–5½′ |
|---|---|---|---|---|---|
| Insoluble | Per cent | 5·03 | 5·70 | 5·17 | 6·00 |
| NaCl | " | 0·29 | 0·07 | 1·50 | 0·20 |
| $NaHCO_3$ | " | 1·62 | 0·89 | 0·92 | 1·51 |
| $Al_2O_3Fe_2O_3$ | " | 0·73 | – | – | – |
| $CaSO_4$ | " | 3·40 | 3·00 | 4·08 | 1·87 |
| $MgSO_4$ | " | 2·20 | 2·15 | 1·50 | 2·13 |
| $Na_2SO_4$ | " | 83·80 | 88·80 | 86·80 | 85·80 |
| Total | " | 97·07 | 100·61 | 98·47 | 97·51 |

This deposit is controlled by a company called The Regina Oil and Chemical Co., Ltd.

## REGINA BEACH DEPOSIT No. 2

An alkali lake situated in section 21, township 20, range 22, west of the 2nd meridian, was reported to contain a crystal bed of considerable area and depth. Detailed examination, however, revealed only a narrow strip of crystal bed about 2,000 feet in length and 100 feet wide, following the east shore, and two smaller beds, one on the west shore, opposite the south end of the main bed, the other between the two beds. The crystal beds are covered with 3 feet of mud, and the depth of brine was about 2 feet when the deposit was examined in August, 1923. The crystal beds above mentioned are free from mud holes as far as could be ascertained. There was no possibility of getting the drill on the deposit on account of the treacherous nature of the mud bottom, so that no drilling was done, but sufficient bar tests were made to delimit the permanent crystal beds. The depth could not be obtained owing to the heavy covering of mud. The harvest crystal bed which forms in the fall could be readily gathered as the north end of the lake is close to the road, but so far practically no development work has been done by the owners.

## SALT LAKE DEPOSIT

A chain of four lakes, joined by narrow channels, and carrying sodium salts in solution and in crystal form, is situated in sections 1, 12, 13, 24, township 4, range 21, west of the 2nd meridian. The nearest railway shipping point is at Hardy, a station on the Bengough branch of the Canadian National railways, situated 14 miles to the north of the lakes.

The three southern lakes all contain crystal beds covering their total areas, and coming close to the shore.

Twelve holes were drilled in the two southern lakes and crystal depths varying from 2 feet to 8 feet 6 inches were encountered. The third lake was tested with a bar and showed depths of from 3 to 4 feet, including the intermittent crystal. The northern lake contained no permanent bed.

The intermittent crystal bed averaged 12 inches in depth. Harvesting and shipping of the intermittent crystal has been carried on in a small way each fall for a number of years, and a very pure crystal is obtained from this top bed, since there is very little mud on top of the permanent bed. The permanent bed, however, carries considerable mud inclusions.

The following analyses are of samples taken from this deposit:—

| | | Hole 2 | Hole 11 | Surface crystal |
|---|---|---|---|---|
| Insol. | Per cent | 15·87 | 12·93 | 0·15 |
| NaCl | " | ..... | trace | trace |
| $NaHCO_3$ | " | 0·68 | 0·68 | trace |
| $Al_2(SO_4)_3$ | " | 1·00 | 2·08 | trace |
| $CaSO_4$ | " | 0·94 | 0·70 | trace |
| $MgSO_4$ | " | 0·84 | 1·85 | 1·25 |
| $Na_2SO_4$ | " | 77·97 | 79·18 | 98·30 |
| Total | " | 97·30 | 97·42 | 99·65 |

## Summary and Conclusions

The production of sodium sulphate from the natural deposits of western Canada is still in its infancy. There is a fairly steady market for this material in the anhydrous form, in the pulp and paper industry, but the main consuming centres are in eastern Canada, and the present high freight rates from the deposits to the markets are an important factor. Very little of the crude material, as such, can be marketed, and this necessitates the installation of refining plants. The product has to compete against that produced as a by-product from acid manufacture, but there are hopes that simple refining methods and lower freight rates will eventually help this industry.

The resources of sodium and magnesium sulphate of western Canada are among the very few resources of which estimates of reserve material can be obtained with any degree of accuracy. The deposits of these materials are confined to well-defined areas and it is only a matter of investigation to determine the tonnages.

While the work carried on by the Mines Branch on these deposits in western Canada cannot be expected to cover in detail all of the already known deposits, it has proved, in the twelve lakes so far drilled, the presence of hydrous sodium and magnesium salts, mainly sodium sulphate, to the extent of fifty million tons (50,000,000). Private reports by engineers and chemists on other deposits not so far examined by the Mines Branch in detail, give estimated tonnages of another twenty million (20,000,000). It can be readily seen that, although it may be a number of years before these deposits are being worked to their fullest extent, Canada has in such deposits a resource of great potential value.

# VII

# CURRENT ACTIVITIES IN ZINC-LEAD MINING IN BRITISH COLUMBIA

A. H. A. Robinson

The following observations on conditions prevailing in the silver-lead-zinc mining industry in the Skeena and Kootenay districts of British Columbia were made during the course of a visit to the chief mining centres in these districts, in September and October, 1923. Some remarks on the copper situation in the same localities have been added.

## SKEENA DISTRICT

### Omineca Mining Division

For a number of years, beginning with 1913, there was a fairly steady and at times considerable output of silver-lead and silver-zinc ore, and, later, concentrates from the vicinity of Hazelton, chiefly from the Silver Standard mine, but this production has now ceased entirely.

*The Silver Standard* is situated on the northwest side of Glen mountain, about six miles by road from New Hazelton station on the Canadian National railways, the shipping point for the ore. The first shipments, consisting of silver, lead, and zinc ores, were made in 1913. In the spring of 1918, an ordinary wet concentrating mill was built, and from that time until operations practically ceased, in the fall of 1920 (it was worked for three months in 1922) the output consisted of silver-lead concentrates and silver-zinc concentrates. The mill, in which the concentrating was done on jigs and tables, has a rated capacity of 50 tons of ore per 24 hours, and is situated about two miles from the mine, from which the ore was conveyed to the mill in motor trucks. Mill water was obtained from Twomile creek, and also sufficient power to run the tables and the dynamo for a small electric plant; the other necessary power was supplied by a steam plant using wood for fuel.

There are nine known veins on the property, but only two have been important producers, and the bulk of the production has been obtained from one only, the main vein. The ore was at first won by shaft entry, later by cross-cut tunnels.

As indicative of the grade of ore obtained, it may be said that from the time the mine commenced to ship, in 1913, up to June 1917, there had been shipped 2,229 tons of ore, carrying 746,259 pounds of lead, 516·8 ounces of gold, 304,411 ounces of silver, and about 20·3% of zinc. In 1919, from 3,000 tons of ore treated in the mill there was obtained 128 tons of silver-lead concentrates carrying about 35% lead and 225 oz. of silver to the

ton, and 390 tons of zinc concentrates carrying about 35% zinc and 120 ounces of silver per ton. In 1920, 4,000 tons of ore were milled and 279 tons of lead concentrates and 602 tons of zinc concentrates containing 218 ounces of gold, 103,020 ounces of silver, 189,488 pounds of lead and 453,512 pounds of zinc were obtained.

As already stated, the Silver Standard mine and mill are now both idle, and so far as could be learned there is little likelihood of any immediate resumption of operations. The reasons given locally for the closing down of the plant, a shut-down that has apparently reacted unfavourably on the whole district, are, failure to keep development work at the mine sufficiently far ahead of extraction and the failure of the mill to make an efficient recovery from the ore.

*American Boy Mine.* The American Boy mine is situated on the southwest slope of Ninemile mountain, and is about two miles east of the Silver Standard. It can be reached from New Hazelton by a wagon road about eight miles in length, that passes close to and about 11,000 feet below the main workings.

Six veins are known on this property, but most of the work has been done on Nos. 1 and 3, most of the shipments having been made from No. 3 vein. A shaft 100 feet deep has been sunk on No. 1, and one 260 feet deep on No. 3. About 100 tons of hand-sorted silver-lead ore was shipped in 1912, the smelter returns from which were $7,000. In addition to high grade there is also a considerable amount of concentrating ore on the property, and, in 1918, an arrangement was made whereby American Boy ore was treated in the Silver Standard mill. Under this agreement about 250 tons was so treated, but the recovery is said by the owners, Harris Bros. of New Hazelton, to have been not altogether satisfactory, the milling process apparently not being adapted to the ore.

In addition to silver-lead there is a considerable amount of zinc ore in No. 3 vein.

Since the shipments made in 1912, the only production reported from the American Boy was the 250 tons of low-grade ore hauled from the dumps to the Silver Standard mill for treatment, in 1918. At present no work whatever is being done on the property.

*Silver Cup, Sunrise, Lead King, etc.* On the north side of Ninemile mountain, considerable work in the form of open-cuts and short tunnels has been done on good showings, consisting of bunches and bands of high-grade silver-lead-zinc ore associated with larger amounts of what may be classed as milling ore, on the Silver Cup, Sunrise, Lead King, and adjoining claims, but at the time they were visited the only work going on was a little desultory development in some of them.

*Rocher De Boule Mine.* Unlike the properties on Glen, Fourmile and Ninemile mountains north of the Bulkley river near New Hazelton, all of which are essentially silver-lead-zinc propositions, the ore of the Rocher De Boule mine, on Rocher Deboule mountain, south of Bulkley river, is copper-gold-silver. Though now idle, it was a steady producer and the most important mine in the district from April, 1915, to October, 1918, and produced during that time 39,833 tons of ore containing 4,214 ounces of gold, 62,865 ounces of silver and 5,746,306 pounds of copper.

The mine is connected by a wagon road with Skeena Crossing on the Canadian National railway, ten miles distant. The ore, however, was sent to the railway at Tramville, by a combination of surface and aerial tramways 4½ miles in length. The property is also equipped with a hydro-electric plant on Juniper creek, bunk houses for 100 men, offices and other necessary buildings, as well as an inclined power tramway for taking men and supplies from the camp to the mine workings situated 1,200 feet above on the hillside.

There are five veins known on the property, though only two have been proved to contain high grade ore shoots in addition to the milling ore that is found in greater or less amounts in all the veins. The metallic minerals found in them are chalcopyrite, pyrite, pyrrhotite, magnetite, mispickel, galena, sphalerite, and tetrahedrite with a gangue consisting of altered granodiorite, hornblende, quartz, calcite, and siderite. The most important mineral is chalcopyrite, though in one vein the galena and tetrahedrite content is perhaps predominant and the ore might be classed as a silver-lead-copper ore.

The mine is developed by cross-cut tunnel entry and contains nearly three miles of underground workings—cross-cuts, drifts, raises and winzes.

The reasons given for the closing down of the mine are the exhaustion of the known bodies of high-grade shipping ore and the lack of milling facilities for the treatment of lower grade material, the installation of which is not considered to be warranted in the present condition of the copper market.

### Smithers

In marked contrast to the lethargy in the mining camps immediately surrounding Hazelton was the activity in evidence in the neighbourhood of Smithers, about 60 miles farther east, due in large part to the commitments recently made by the Federal Mining and Smelting Co. (a subsidiary of the American Smelting and Refining Co.) in the purchase and development of mining property on Hudson Bay and Dome mountains.

*Henderson Group Claims: Hudson Bay Mountain.* This group of claims on Hudson Bay mountain is now being operated by Duthie Mines, Ltd., a subsidiary of the Federal Mining and Smelting Co. It is connected with the railway at Smithers by a recently constructed wagon road suitable for hauling ore by motor truck.

Active development of the Henderson group was undertaken by Mr. J. F. Duthie, of Seattle, in July, 1922, and the property equipped with two small gasoline driven air compressors, a drill sharpener, power drills, etc. The results obtained by Mr. Duthie in 1922-23 in three tunnels and several open-cuts were so encouraging that early in the second half of 1923 control of the property was purchased by the Federal Mining and Smelting Co., and Duthie Mines, Ltd., incorporated as an operating company to work the Henderson and other properties acquired by the Federal in this vicinity. The operations of the Federal Mining and Smelting Co. are at present being largely directed to the installation of heavier and more complete equipment and general preparations for an intensive campaign of development.

Surface work and drift tunnels have partly developed considerable ore, both high grade and milling, on two veins, known as the "grey copper" and "ruby silver" veins, and a little stoping has been done. The veins occur in a volcanic rock, rhyolite or andesite; the metallic minerals include galena, zinc blende, freibergite, and a little chalcopyrite, and small amounts of ruby and native silver have been noted. It is said to be due to the presence of freibergite in considerable amount that the ore is so high grade.

During the early part of 1923 small but steady shipments of high grade silver-lead ore were made by the Duthie interests, to the Trail smelter. The present operators, however, intend to ship their output to the parent company's smelter at Selby, California, and up to the time of writing 1,000 tons of silver-lead ore, carrying in the neighbourhood of 150 ounces of silver per ton, have been reported as shipped to Selby since the present owners took charge.

The activities of the Federal Mining and Smelting Company have had a most stimulating effect on prospecting and development generally in the vicinity of Smithers, and it is hoped and believed that this effect will ultimately extend to Hazelton and other neighbouring camps—indeed, to the whole long stretch of the eastern border of the Coast batholith lying tributary to the Canadian National railway east of Prince Rupert. This area, which during and immediately following the construction of the railway received considerable attention from the prospector, later fell into the background, but undeservedly so. It still possesses great unknown possibilities, including as it does the eastern contact zone of the great granite mountain core that has produced such mines as those at Stewart, a little over 100 miles to the northwest.

## WEST KOOTENAY DISTRICT

### Slocan, Slocan City, and Ainsworth Mining Divisions

The Slocan country has the distinction of being one of the oldest lode-mining districts of British Columbia and has been celebrated for the production of rich silver-lead-zinc ores ever since the first shipments were made from its mines in the early eighteen-nineties. The first discoveries were succeeded by a somewhat feverish boom period, the effects of the collapse of which are still visible in the overbuilt business sections of such mining towns as New Denver, Silverton, and Kaslo; and production has fluctuated in a remarkable way, due in part to corresponding fluctuations in the metal market and in part to alternations of bonanza and borrasca in the numerous properties throughout the district. For a time it looked as if the silver-lead camps of West Kootenay had seen their best days, but the persistence of the more optimistic operators, a better understanding of the geology of the ore-bodies, and improvements in metallurgical practice that have made available grades of ore that were formerly worthless have changed the whole aspect of affairs, and the outlook today for a long continued period of steady output and prosperity is probably better than ever before.

The Slocan silver-lead-zinc deposits are found in a series of slates, quartzites, and limestones, of Carboniferous age, that have been penetrated by dikes and stocks sent out by neighbouring batholithic masses of granite; the deposits themselves occurring as lenses in sheared fissures in the sedimentaries near their contact with porphyritic dikes, and, occasionally in the porphyry itself. The common ore is argentiferous galena associated with more or less zinc blende in a gangue of siderite, calcite and quartz. The silver values are associated with tetrahedrite, and, in a general way, the ores carry about 2 ounces of silver to the unit of lead. From the metallurgical point of view the shipping products may be divided into silver-lead ores, zinc ores (usually argentiferous), and dry ores, in which the silver values are not accompanied by sufficient lead to be smelted alone.

In the earlier history of the camp, the zinc blende that practically universally accompanies the galena in greater or less quantity was oftener a detriment than an asset, as its presence in silver-lead ores was heavily penalized by the lead smelter, while zinc ores or concentrates, even where they could be satisfactorily separated by hand sorting or the mechanical devices then available, could only be marketed with United States zinc smelters at an exorbitant cost for freight and treatment charges. In addition to these drawbacks—lack of a profitable market for zinc ores and lack of efficient and economical methods of separating lead and zinc ores—the lack of continuity characteristic of the high-grade ore shoots on which most of the mines depend for their profit was another discouraging feature. In contrast with all this, increased knowledge of the geology of the ore-bodies now enables the operator to conduct exploratory operations with greater intelligence and follow his veins through barren ground with more confidence than before; improvements in ore-dressing practice, chiefly through the introduction of flotation methods of concentration, have made possible the working of ores that formerly had little or no value; and the Consolidated Mining and Smelting Company's custom plant at Trail now affords an accessible and profitable market for zinc ores and concentrates. The result is that old workings that have been lying idle for years are almost constantly being re-opened and again made productive. The irregularity of the ore-bodies, however, is not a condition favourable to the development of large reserves, so that in only a few of the mines is there much ore actually blocked out ahead of extraction.

Good roads and trails are general throughout the district, and aerial tramways and small water power developments common. In most cases the ores can be extracted through tunnels without expensive equipment for hoisting and pumping, and these easy working conditions, together with the richness of some of the small high-grade ore shoots, make conditions almost ideal for the lessee and small operator generally, who is probably more in evidence in the Slocan country than in any other area of equal size in Canada. At the time the district was visited in 1923 operations were reported as being carried on on between 50 and 60 properties in the Slocan, Slocan City, and Ainsworth mining divisions alone, without counting those in the adjoining Arrow Lake, Trout Lake, and Nelson divisions. Of these, 36 had already reported shipments of one ton or upward during 1923, and a number of others expected to make shipments before the end of the year.

In so far as could be learned all the zinc ores and concentrates, and practically all the silver-lead output of the district, were being sent to Trail for treatment.

It must not be understood, however, that the district is one of small operators only. A number of companies operate on a considerable scale and this number is likely to increase rather than decrease. Among those now operating may be mentioned:—

*Silversmith Mines, Ltd.* This company's mine, which under its old name of the Slocan Star was one of the earliest and largest producers of the Slocan, while never actually abandoned, nevertheless, later encountered lean years and faced none too bright an outlook just before a big ore shoot was discovered on the 1,000-foot level in 1918. It is now the largest and steadiest producer in the Slocan, turning out between 100 and 200 tons of lead and zinc concentrates per week, and has enough ore in sight to maintain production at the present rate for at least four years. The mine, which is opened by cross-cut tunnels, has between five and six miles of workings, drifts, cross-cuts, and raises, and is equipped with a 746 cu.ft. per min. water-driven air compressor to supply the drills and air-hoists used throughout the mine. An aerial tramway, 4,600 feet in length, connects the mine with the company's mill at Sandon.

The Silversmith mill, which is the old Ivanhoe mill remodelled and practically rebuilt, is the newest and most modern mill in the district designed for the treatment of silver-lead-zinc ores by gravity and oil flotation processes. Its rated capacity is 125 tons a day. It is supplied with power from the company's hydro-electric plant at Sandon, supplemented by water power derived from the overflow of the Sandon plant and from Miller creek. At the time it was visited it was running three eight-hour shifts per day.

For the period between June 1, 1922, and May 1, 1923, the mine produced 522 tons of clean ore and 34,843 tons of milling ore, the average assay of the milling ore being 24·02 ounces silver, 8·92 per cent lead and 7·60 per cent zinc.

*Clarence Cunningham Properties.* Clarence Cunningham of Alamo was operating the following properties in 1923: the *Wonderful* and *Sovereign* at Sandon, *Queen Bess* at Three Forks, and *Van Roi* at Silverton.

Milling ore from the Wonderful is treated in the 150-ton mill at Alamo by a combination of gravity and flotation methods, producing both lead and zinc concentrates, in the proportion of a little more than two tons of lead concentrate to one ton of zinc concentrate. The mill was being operated on one shift only, and about 1,100 tons of silver-lead and 460 tons of zinc concentrates had been produced to Nov. 14. Silver-lead shipping ore also was being produced in small amount in both the Wonderful and Sovereign.

On the Queen Bess, which after lying idle for a number of years was re-opened by Mr. Cunningham in 1916, with the result that an ore-body was discovered that yielded its fortunate owner something like $1,000,000 clear profit in about three years, development work only is now being done.

The Van Roi at Silverton is producing both silver-lead and zinc ores, the production during 1923, to Nov. 14, being about 490 tons.

*Standard Silver-Lead Mining Co.* The company's standard mine at Silverton, a few years ago the largest producer in the Slocan, was worked by lessees in 1923, producing some 1,500 tons of lead and zinc ore, chiefly the latter, up to November. The company's mill at Silverton (tables, jigs, and flotation) was idle when visited, but the recent discovery of a new and promising ore shoot at the mine will, it is expected, again put the mill into continuous operation.

The same company is carrying on development work on the McAllister property at Three Forks, where considerable bodies of dry silver ore said to carry about 30 ounces of silver have been partly developed. By the driving of a low level cross-cut tunnel, now under way, it is hoped that enough ore will be put in sight to justify the erection of a mill, power plant, etc.

The Standard Silver Lead Mining Co. is also doing development work on the Mammoth at Silverton and on the Iva Fern, at Cultus creek in the Nelson mining division, also a silver-lead-zinc proposition, with, it is said, very encouraging results.

*Rosebery-Surprise Mining Co.* The Rosebery-Surprise Mining Company's operations are at present confined to the Bosun at New Denver, where silver-lead concentrates and zinc ore are being produced. The company's mill at Rosebery was shut down when the property was visited.

The Bosun, which was a steady producer from 1898 to 1904, the ore then shipped running as high as 110 ounces of silver and 55 per cent lead, was idle from 1904 to 1917, when it was taken up by the Surprise, later the Rosebery-Surprise Mining Co., and has since been a steady shipper. An aerial tramway 600 feet long connects the mine with ore bins on the shore of Slocan lake from which it can be transported by barge to the company's mill at Rosebery.

The Monitor at Three Forks and the Surprise at Sandon, both of which also belong to the Rosebery-Surprise Company, are being worked at present by lessees and made small shipments of silver-lead ore during the year.

*Ruth-Hope.* This mine, which in the earlier history of the Slocan was one of the most important producers, later lay idle for a number of years. In 1921 it was re-opened by lessees and good showings of high-grade ore were uncovered in the old No. 3 tunnel. It has now passed into the hands of Vancouver parties and developments to date are of such character as to lead to the belief that this old property will again become a steady and important producer.

The underground workings are extensive, the mine being opened up by five levels, the lowest being some 600 feet below the outcrop. The surface equipment includes an aerial tramway and concentrator, the latter being situated alongside the railway at Sandon.

It produced considerable silver-lead ore during 1923, some 400 tons having been reported as shipped up to Nov. 14.

*Cork-Province Mines, Ltd.* This company resumed operations in the early part of the year and made considerable shipments of silver-lead concentrates from their mine and mill on the south fork of Kaslo creek, in 1923. Zinc concentrates are also being made.

*Whitewater Mine.* This mine, situated at Retallack, which has the record of being one of the steadiest producers in the district, having commenced shipping in 1896, continued to ship lead and zinc ore in 1923. Recently the property has been worked by lessees, but it is announced that it will now be again worked by the owning company. In regular operation it has a total production record of 34,477 tons of silver-lead ore of a net value of $1,579,213, and 16,086 tons of zinc ore of a net value of $209,595. As all the ore yet extracted has come from a small area of ground, years of life are anticipated for the property.

Other properties in operation that either had already or expected to make shipments in 1923, in the Slocan, Slocan City, and Ainsworth mining divisions include: the Rambler, Mountain Chief, Molly Hughes, Noonday, Galena Farm, Black Colt, Victor Hewitt, Lone Bachelor, Metallic, Soho, Washington, Canadian, R. E. Lee, Reco, Gem, Caledonia, Silver Bear, Martin, Florence, Silver Hoard, Krao, Maestro, Tariff, Anna, L.T., Meteor and Ottawa. On still others development and exploratory work is being carried on.

*The Consolidated Mining and Smelting Company's Operations at Trail.*

The Consolidated Mining and Smelting Company have at Trail a lead smelter, a copper smelter, a zinc plant including an electrolytic zinc refinery, an electrolytic lead refinery, together with a plant for the recovery of gold and silver, a copper rod mill, a sulphuric acid plant, and other subsidiary and auxiliary plants.

The company's electrolytic zinc plant, under Superintendent B. A. Stimmel, is producing 88 tons of refined zinc per day, in two units of 44 tons output each. Nearly all of this is derived from Sullivan concentrates, though about 25 tons of custom zinc ores, all from the Slocan district, in West Kootenay, are also being received daily. As far as could be learned all the zinc ore and concentrates produced in British Columbia are now being treated at Trail. This is in marked contrast to conditions before the Trail plant was put in operation when all Canadian zinc ore and concentrates had to be sent abroad for treatment.

The Sullivan concentrates as they are received at Trail carry about 37 per cent zinc. After roasting, the zinc content amounts to about 40 per cent and lead 5 per cent. The leached zinc residues are sent to the lead smelter to be smelted with lead ores for the recovery of lead and any precious metals present. Large quantities of these residues are now stacked awaiting treatment, but it is hoped soon to be able to effect such a complete separation of the lead and zinc minerals at the new Kimberley concentrator that it will not be necessary to smelt the zinc residues from this source for the recovery of lead, and that it will be possible in the future to waste them without loss and thus relieve the lead smelter of part of the burden it is now carrying.

The schedule, with amendments, under which custom ores were being accepted at Trail in September, 1923, are as follows:—

TRAIL, B.C., April 7, 1922.

SCHEDULE "A"—ZINC ORES

1. *Zinc:* Will be accounted for to the extent shown in the table which follows (Clause 4) at the London Metal Exchange spot quotation for G.O.B. spelter converted into Canadian funds at the Bank of Montreal's price for the sale of sterling exchange, less three and six-tenths cents (3·6c.) per pound. Both quotation and exchange rate used will be the average for the calendar week including the date of arrival at Tadanac, B.C.

2. On ores and concentrates other than flotation concentrates, a charge of $1 per dry ton of ore will be deducted from the zinc value as above ascertained.

3. If there are sufficient values in gold, silver and lead to pay for smelting the residues after leaching, the following payments and charges will apply in valuing these metals, otherwise this clause will not apply.

A. *Gold:* Pay for 80% of the assay at $20 per ounce, with allowance for U.S. exchange as hereinafter mentioned. Provided that the minimum deduction from the gold assay will be ·03 oz. per ton.

B. *Silver:* 80% of the silver will be paid for on the fire assay at the average of the Engineering and Mining Journal New York quotations for foreign silver, converted into Canadian funds at par, but with allowance for U.S. exchange as hereinafter mentioned, for the calendar week which includes the date of arrival at Tadanac, B.C. In no case will the deduction from the silver assay be less than one-half (0·5) oz. per ton.

C. *Lead:* The lead contents will be determined by the wet method of analysis. From the contents so determined there will be deducted 5 units or 100 pounds of lead per ton of ore and then 80% of the remainder will be paid for as follows:—

The London Metal Exchange spot quotation for soft Spanish lead converted into Canadian funds at the Bank of Montreal's price for the sale of sterling exchange, less one and one quarter cents (1¼c.) per pound for refining and marketing. Both quotation and exchange rate used will be the average for the calendar week including the date of arrival at Tadanac, B.C.

D. *Smelting Charge:* A charge for smelting residues will be made for the various grades of ore as set out in the table which follows. (Clause 4).

4. Table of percentages of zinc to be paid for under Clause 1, and charge for smelting residues under Clause 3.D:—

| If the ore contains zinc to the extent of: | The following percentage of zinc will be paid for: | And the following charge per dry ton of ore for smelting residues will be made: |
|---|---|---|
| 50% or over | 85% | $ 5 00 |
| 49% " | 84% | 5 20 |
| 48% " | 83% | 5 40 |
| 47% " | 82% | 5 60 |
| 46% " | 81% | 5 80 |
| 45% " | 80% | 6 00 |
| 44% " | 79% | 6 20 |
| 43% " | 78% | 6 40 |
| 42% " | 77% | 6 60 |
| 41% " | 76% | 6 80 |
| 40% " | 75% | 7 00 |
| 39% " | 74% | 7 15 |
| 38% " | 73% | 7 30 |
| 37% " | 72% | 7 45 |
| 36% " | 71% | 7 60 |
| 35% " | 70% | 7 75 |
| 34% " | 68% | 7 90 |
| 33% " | 66% | 8 05 |
| 32% " | 64% | 8 20 |
| 31% " | 62% | 8 35 |
| 30% " | 60% | 8 50 |

5. *Sampling:* If the shipment is less than a car lot or contains more than one lot per car a deduction may be made for extra sampling, assaying, etc., of $10 per lot.

6. *Weights and Samples:* to be used in settlement shall be those made at the smelter.

7. *Representation:* Shippers are expected to notify us as to who will represent them while their shipments are being weighed and sampled. Failure to do so will be construed as meaning that the smelter will have authority to appoint one of the local mine representatives at the shipper's expense unless the shipper notifies us that a representative is not required. All shipments will be released for treatment as soon as sampled.

8. *Assay:* Shippers will supply the smelter with their assays on smelter pulps shortly after sampling. In case of difference in assays requiring it, the umpire pulp will be referred to an umpire mutually agreeable. The party whose result is farthest from the umpire's result will pay his fee.

9. *Exchange:* All payments will be made in Canadian funds but an allowance for U.S. exchange will be made the shipper based on the net value of the gold and silver paid for on the following basis:—

(*a*) When the rate is 5% or less, all exchange will be allowed in excess of 1%.
(*b*) When 10% or less, all in excess of 2%.
(*c*) When over 10%, all in excess of 3%.

(e.g., if the rate is 4%, allowance to the shipper is 3%; if 9%, allowance is 7%; and if 12%, allowance is 9%).

Provided that the allowance under (c) shall not be less than the maximum under (b) and that the allowance under (b) shall not be less than the maximum under (a).

All allowances will be calculated upon the Bank of Montreal's average quotation for the purchase of U.S. funds for the calendar week including the date of arrival at Tadanac, B.C.

10. *Settlement:* Payment will be made in full shortly after sampling.

11. *Date of Arrival:* Shall be considered as the date upon which the cars containing the ore reach the Tadanac railway yards.

12. *Impurities:* As there may occasionally be an ore of a composition that will not respond readily to treatment by our process, it will be necessary for shippers to supply us, before shipping, with a fifty pound sample for laboratory test, unless we are already familiar with the ore.

13. *Effective Date:* Ores which do not contain sufficient values in gold, silver and lead to pay for smelting residues may be shipped at once. The plant for treating the other ores is now under construction and it is hoped will be ready in June, 1922. You will be notified of the exact date shipments of such ores can be received.

14. *Advices:* Shippers must notify us promptly at time of shipment. All advices, railway billing and other shipping documents must state distinctly that material is zinc ore. This is very important.

15. This schedule will apply only to ores containing 30% zinc or over.

TRAIL, B.C., February 28, 1923.

To Ore Shippers:

*Re Schedule "A" Zinc Ore Rates.*

Effective March 15, 1923, we will amend Schedule "A", so that when the zinc quotation in London exceeds £24:10, we will deduct from the quotation one-quarter of the amount by which it exceeds £24:10, in addition to the other deductions provided in the schedule. Below £24:10 the rates remain unchanged. For instance, if the market is £34:10, settlement will be based upon £34:10 less ¼ (£34:10—£24:10) = £32:

The amendment is made necessary by the fact that subsequent to publication of Schedule "A", wage adjustments have taken place under which the wages upon which this schedule was figured increase as the market increases over this same base rate of £24:10.

Yours truly,

THE CONSOLIDATED MINING AND SMELTING CO. OF CANADA, LIMITED.

TRAIL, B.C., March 23, 1922.

*SCHEDULE "E"—LEAD ORES

PAYMENTS

*Gold:* Pay for 95% of the assay at $20 per ounce. No pay for gold unless three one-hundredths of an ounce (·03 oz.) per dry ton or over, with allowance for U.S. exchange as hereinafter mentioned.

*Silver:* 95% of the silver will be paid for on the fire assay at the average of the Engineering & Mining Journal New York quotations for foreign silver, converted into Canadian funds at par, but with allowance for U.S. exchange as hereinafter mentioned, for the calendar week which includes the date of arrival at Tadanac, B.C. In no case will the deduction from the silver assay be less than one-half (·5) oz. per ton.

*Lead:* The lead contents will be determined by the wet method of analysis, deducting one and one-quarter units to arrive at the dry lead assay. 90% of the lead will be accounted for on the said dry lead assay, provided, however, that in no case will the deduction from said dry lead assay be less than one unit or twenty pounds per dry ton of ore. The price for lead to be used in settlement will be either:

1. The London Metal Exchange spot quotation for soft Spanish lead converted into Canadian funds at the Bank of Montreal's price for the sale of sterling exchange, less one and one-quarter cents (1¼c.) per pound for refining and marketing. Both quotation and exchange rate used will be the average for the calendar week including the date of arrival at Tadanac, B.C.

or:

2. That obtained under a pooling scheme which is outlined as follows:—

Commencing with our unsold stocks of lead and lead not yet delivered against sales as at October 1, 1921, and including that in ore and in process at our smelter and refinery as well as finished metal, and receipts from all sources monthly, and deduct deliveries against sales from month to month until all of said stocks are accounted for. After this, apply further deliveries against each month's receipts in order commencing with October, 1921. Each month's receipts and each month's deliveries against sales to be treated as a unit. The net settlement price for each month's sales deliveries will be that obtained at point of delivery, less freight and other charges incurred in effecting such delivery, and also less ¾c. per pound for refining; i.e., the actual delivery charges and the ¾c. refining charge will be substituted for the usual 1¼c. deduction. Statements will be sent monthly, commencing with October, 1921, showing the condition of the pool.

Either settlement for lead may be chosen at any time before shipments are commenced but whatever choice is made it will be understood will govern all settlements of receipts up to and including December 31, 1922.

DEDUCTIONS

*Smelting* per dry ton of material eight dollars and fifty cents ($8.50) as a base rate, which will be modified in accordance with the following formula:—

(1) Add to the base rate per ton thirty cents (30c.) per unit for all zinc contained.

(2) Deduct from this result the total units of silica and lime at seven cents (7c.) per unit.

Provided that in no case shall said base rate be reduced more than four dollars ($4) per ton as the net result of the said additions and deductions.

Provided also, that in making the above computation, silica and lime, if 1% or under, will be disregarded.

*Sulphur:* A charge will be made in addition to the above for all sulphur contained in excess of two per cent, at thirty cents (30c.) per unit per dry ton of material, provided that such charge shall not exceed three dollars per ton in any case.

*Moisture:* A minimum moisture deduction of ¼% will be made. The following penalty for moisture will apply to fine concentrates and clayey ore only:

If over five per cent, charge for all contents at ten cents per dry ton per unit.

*N.B.—A revision in these lead rates, in favour of the shipper was made in December, 1923.

*Size:* Coarse and fine concentrates and ores should be shipped separately. If mixed, so that over 30% will pass through a ¼-inch screen, an extra charge of fifty cents (50c.) per ton will be made.

*Sampling:* If the shipment is less than a car lot or contains more than one lot per car, a deduction may be made for extra sampling, assaying, etc., of $10 per lot.

*Weights and Samples:* to be used in settlement shall be those made at the smelter.

*Representation:* Shippers are expected to notify us as to who will represent them while their shipments are being weighed and sampled. Failure to do so will be construed as meaning that the smelter will have authority to appoint one of the local mine representatives at the shipper's expense unless the shipper notifies us that a representative is not required. All shipments will be released for smelting as soon as sampled.

*Assays:* Shippers will supply the smelter with their assays on smelter pulps shortly after sampling. In case of difference in assays requiring it, the pulp will be referred to an umpire mutually agreeable. The party whose result is farthest from the umpire's result will pay his fee.

*Exchange:* All payments will be made in Canadian funds but an allowance for U.S. exchange will be made the shipper based on the net value of gold and silver paid for on the following basis:—

(a) When the rate is 5% or less, all exchange will be allowed in excess of 1%.
(b) When 10% or less, all in excess of 2%.
(c) When over 10%, all in excess of 3%.
(e.g., if the rate is 4%, allowance to the shipper is 3%; if 9%, allowance is 7%; and if 12%, allowance is 9%).

Provided that the allowance under (c) shall not be less than the maximum under (b) and that the allowance under (b) shall not be less than the maximum under (a).

All allowances will be calculated upon the Bank of Montreal's average quotation for the purchase of U.S. funds for the calendar week including the date of arrival.

*Settlement:* Payment will be made in full shortly after sampling to such shippers as selected the spot settlement basis for lead. An advance payment will be made to those selecting the pooling scheme on the same basis as if they had selected the spot lead quotation, but less 25% of the net value of the lead. In this case there will be an adjustment when the lead value is finally ascertained in the operation of the pool.

*Date of Arrival:* Shall be considered as the date upon which the cars containing the ore reach the Tadanac railway yards.

*Effective Date:* This schedule cancels all previous schedules and will be effective on shipments arriving on and after March 23, 1922, except the allowance for exchange which is effective from March 1, 1922.

The lead smelter made some 48,000 tons of lead bullion from 225,000 tons of ore, in 1923, a considerable increase over the 1922 output. Improvements made to the plant in 1923, together with a better supply of ore from the Sullivan, will insure a still greater production in 1924.

In 1922 additions made to the lead refinery increased its rated capacity to 150 tons of refined lead a day. During the early part of 1923 the bullion supply was not large enough to keep the enlarged refinery in full operation, but towards the end of the year the refinery was turning out nearly 170 tons of refined lead per day and further additions had become necessary.

The large supply of ore and concentrates that is now assured from the Sullivan mine and Kimberley concentrator is much greater than can be handled by either the zinc or lead refineries at Trail until the capacities of both have been considerably increased.

As a temporary measure, to bridge the period required to make the necessary additions at Trail and thus bring into balance the operations of the concentrator and refining plant it is proposed to dispose of the surplus zinc concentrates and lead bullion beyond the capacity of the present refining plants to handle, to European refiners.

The company's copper smelter and refinery, which has been idle since 1920, was not operated during the year. The copper rod mill has not been operated since it was completed early in 1921. Meantime experiments in the electric smelting of copper ores are being carried on by the company's staff.

The re-opening of the company's mines at Rossland, which commenced shipping low-grade copper ore to Trail for treatment in November, is expected to supply an appreciable quantity of gold-copper ore to the plant in 1924.

At the company's gold-copper mines at Rossland, after some time spent in putting the underground workings into condition and overhauling the surface plant, mining operations were resumed in the second half of the year. All the Rossland mines of the company, in which, by the way, inclusive of those in the recently acquired Le Roi No. 2, there are some 79 miles of workings, are now connected with the old Centre Star shaft, through which all the hoisting will be done in future. A Symons disc crusher and a set of 54 × 20-inch rolls, through which the ore will pass after leaving the jaw crusher, were added to the surface plant. In addition to stoping in the latter part of the year, underground operations included 3,526 feet of drifting, cross-cutting, raising, and sinking, and 1,789 feet of diamond drilling.

Shipments of Rossland ore to the concentrator at Trail, that previous to the starting up of the Kimberley concentrator was used for the treatment of Sullivan ore, commenced early in November, but later had to be stopped, on account of power shortage in East Kootenay, curtailing operations at Kimberley, thus necessitating the Trail concentrator being again put in operation on Sullivan ore. During 1924 it is expected that an output of 800 tons of low grade copper-gold ore per day will be maintained from Rossland to the Trail concentrator.

## EAST KOOTENAY

### Fort Steele Mining Division

*Sullivan Mine.* At the now famous Sullivan mine the big cross-cut tunnel run in from the hillside on the 3,900-foot level several years ago, to tap the ore-bodies at depth below the old, or hill workings, was extended another 500 feet in the north ore zone, and some 600 feet near the portal was widened to 12 feet, and the timber replaced by concrete sides and steel I beam caps, conformable with the remainder of this great adit. This, now the main haulage way for the mine, is electrically equipped, the ore being drawn through it for, approximately, two miles to daylight at the new town of McDougall, by 500-volt electric locomotives running on a 36-inch gauge track. The installation of the second of the two new 3,000-cubic feet Nordberg air compressors which supply air for the operation of drills, hoists, etc., at the mine, was also completed in the early part of the year.

At the tunnel portal, at McDougall, is the new coarse crushing plant, consisting of a receiving bin, Buchanan jaw crusher, Gates crushers, and a railway bin holding 2,500 tons. This coarse crushing plant is capable of handling 6,000 or 7,000 tons of ore per day, or double the rated capacity of the completed Kimberley concentrator. From the mine the ore is sent to the concentrator over about three miles of newly built railway. The receiving bins at the tunnel portal are also connected by railway with the Canadian Pacific railway at Kimberley so that ore can be shipped directly from the mine to outside points.

In the mine itself some 2,736 feet of cross-cuts, drifts, and raises were driven during the year, for the purpose of opening up for extraction ore in both the south and north ore zones, between the main haulage level and the old hill workings. This work has already materially increased the number of working faces, and new productive stopes have also been opened in the south ore zone, on the 4,400-foot level and on the 1,100-foot level in the upper mine. There is now approximately an aggregate length of 10 miles of underground openings (drifts, cross-cuts, and raises) in the Sullivan mine.

Some 8,350 feet of diamond drilling was also done during the year and has resulted in a better delineation of the ore-body in the north ore zone. It is believed that the presently known ore reserves are sufficient to maintain production on the present scale for 20 or 25 years.

Shipments from the Sullivan mine in 1923 included 424,835 tons of zinc-lead ore, 25,435 tons of lead ore, and 1,982 tons of pyrites.

*Kimberley Concentrator.* The mill-rock from the coarse crushing plant at the Sullivan is delivered, after weighing, into a 1,000-ton receiving bin blasted out of solid rock at the new concentrator near Kimberley. From the receiving bin the ore, after passing through rolls, is conveyed to a 2,500-ton feed bin situated above the concentrator, whence it is fed to Hardinge mills for fine grinding, and then passes on to the concentrating machines. In these the separation of the zinc and lead minerals is made by a process of differential flotation using alkaline solutions. Large storage bins are provided for stocking the zinc and lead concentrates, which are shipped over the Canadian Pacific railway to Trail for the production of metallic zinc and lead.

This immense mill, on which work was started in June, 1922, was completed and put into operation in August, 1923. In actual operation it has exceeded expectations in every way—as to operating costs, tonnage capacity, and efficient recovery. As already stated, it is believed that it will be possible in this mill to effect such a clean separation of the lead and zinc minerals that the residues from the zinc leaching plant at Trail will require no further treatment for the recovery of lead. It is also worthy of note as indicating the comprehensive and efficient nature of the company's activities, that not only was the Kimberley concentrator designed and built by the company's staff but that most of the machinery was made in the company's shops at Trail, with considerable advantage both as regards cost and quality.

Since the first section of the concentrator was started in August, 1923, its operation has been interrupted and badly hampered by the failure of the East Kootenay Power Company, which supplies both the Sullivan mine and Kimberley mill (together they will require between 5,000 and 6,000 horse-power per annum) to furnish sufficient power to keep both going at capacity. With the East Kootenay Power Company's new hydro-electric plant at Elko nearing completion, however, it is expected that the full capacity of approximately 3,000 tons of ore per day will be attained early in 1924. It may also be remarked incidentally that the Consolidated Company's subsidiary, the West Kootenay Power and Light Company, is also making large extensions to its hydro-electric plant at Bonnington Falls that will eventually provide 60,000 horse-power for the Consolidated Company's plants at Trail and Rossland as well as for custom contracts.

The success that has been attained at Kimberley and Trail in evolving a process for the effective treatment of the highly refractory Sullivan ore, a problem that a few years ago was thought to be next to hopeless, and the development of this process to its present high degree of commercial efficiency, is one of the remarkable achievements recently made in the field of metallurgy, and for which too much credit cannot be given to the Consolidated Mining and Smelting Company's staff by whom it was brought about.

*North Star and Stemwinder Mines.* During the year development work on these properties, both of which are near the Sullivan, was done by O. C. Thompson, of Kimberley, and associates.

Considerable silver-lead ore, both carbonate and sulphide, has been shipped from the North Star since its discovery in 1892, and large bodies of ore similar to the Sullivan ore are believed to occur on the Stemwinder. It is now proposed to erect a 100-ton mill to treat ore from both properties, and it is expected that this mill will be in operation sometime in 1924.

The only mines in the Fort Steele mining division besides the Sullivan, reporting any production in 1923, are the St. Eugene at Moyie and the Park at Marysville, both of which made small shipments of silver-lead ore.

### Windemere Mining Division

*Paradise Mine.* The Paradise mine at Invermere, which under the ownership of Mr. R. Randolph Bruce has for many years proved itself the steadiest producer and most important property in the division, maintained its reputation in 1923. The ore, chiefly soft sand, argentiferous lead carbonates (though sulphide ore is now being mined below the No. 4 level) is hauled 18 miles to the railway, by motor truck.

Other properties operating in the Windermere division are the Steele Group, which shipped considerable silver-lead ore during the first three months of the year, but closed down later, and the Isaac at Briscoe and the Nip and Tuck at Windermere, both of which also report small shipments of silver-lead ore.

# VIII

## CANADIAN EXPOSITION TRAIN IN FRANCE AND BELGIUM 1923

*Report by Representative of the Department of Mines*

**Arthur Buisson**

Following instructions from the Deputy Minister of the Department of Mines, the writer sailed on the 10th of July for France to join the members of the Exposition Train.

Instructions were to follow the Train on its journey through France and Belgium and to endeavour to gather some information dealing with the economic situation in relation to the mineral and metal trade between Canada and France or Belgium.

The Canadian Exposition Train was a complement to the French train which visited Canada in the fall of 1921, and held expositions in the principal cities and towns of Canada from the Atlantic to the Pacific.

The complexity of the French railway system contrasted with the facilities offered by the splendid highway system induced the organizers of the scheme to adopt transportation by means of automobiles and tractors.

The train consisted of 30 lorries with detachable tractors for the exhibits, two auto cars for the members, and five lorries for the baggage, cinematograph apparatus and other accessories. These lorries were supplied by the French government and were under their control. The exhibition lorries were provided with side panels which could be raised giving the effect of a show window.

The organization of the exposition consisted of an Honorary Committee and an Executive Committee for the Canadian section and also of similar committees for the French section.

The schedule of the journey had been prepared in advance by the French Executive Committee and was arranged so as to enable us to visit many points of interest along the route.

Lectures on mining and metallurgical industries were given in a number of towns and were usually well attended. Motion pictures were shown in the evenings at some suitable place adjoining the exposition, either in the open air, or at some of the theatres.

An information bureau was established and inquiries were either answered then and there, or note was taken for attention later.

The exhibition lorries contained both crude and manufactured products. These illustrated, with the aid of statistical tables and pictures, the principal Canadian industries, such as mining, agriculture, forestry, pulp and paper, fur, water power and others. The manufactured industries represented included machinery (mostly agricultural), furniture, textiles, dry goods, rubber, and others.

The purpose of the exhibits was to illustrate the remarkable progress which has taken place in Canada and the public was greatly interested in all the different exhibits.

The journey through France started at Havre on July 16 and finished at Paris October 8, thus lasting close to three months. It covered almost every section of the country and extended to about 4,000 miles. We stopped at 65 towns and cities and held expositions at 32 points, a total of 41 days of exposition.

After the termination of the tour in France, the train journeyed to Belgium, in which country we visited 7 cities and held 10 days of expositions.

The final exposition was held in Paris and lasted 29 days, making for the whole tour a total of 80 days of exposition.

It might be safely estimated that about five million people attended the expositions of the Canadian Train.

The public in general appeared to know very little about Canada, everyone, however, was keen on hearing about the country and marvelled at its great extent and wonderful natural resources. We found the business men very anxious to see closer connexion established with Canada and they deprecated existing conditions under which they have to buy Canadian products through agencies established in other countries. The French and Belgian people are anxious to buy from us and it would be an opportune move on the part of the Canadian producers if they would investigate conditions affecting business relations between Canada and France, or Canada and Belgium.

Firms producing materials for which there is a market in France and Belgium might be well advised if they sent competent representatives into these countries. These representatives would find their task greatly simplified and would obtain much better results if they were conversant with the French language, and understood, moreover, the temperament and the ways of the French people

Although France is largely self-supporting as far as many of the non-metallic commodities are concerned, there are a number of products which she is forced to import. Amongst the minerals and metals that concern Canada may be mentioned: asbestos, arsenic, bentonite, chromite, cobalt, copper, feldspar, lead, molybdenite, nickel, and zinc.

Belgium, as is well known, is forced to import most of its minerals and metals, and zinc concentrates for example might find a market in this country.

No doubt part of the Canadian production of the above mentioned minerals and metals is reaching these countries through other-countries. This is due probably from lack of advertisement of our products, possibly from indifference on the part of some producers, and also to the fact that French and Belgian consumers have been in the habit of dealing for many years with firms established in the United States or elsewhere, and were not aware of the progress made in Canada during the last ten years—progress in the development of its mines and progress in the establishment of metallurgical and chemical industries. We are now capable of competing with other countries for the world's markets in many lines of business, and as France and Belgium are looking to secure better trade conditions with Canada, the Canadian tour was made at the psychological moment and the effect will soon be noticeable by increased trade relations.

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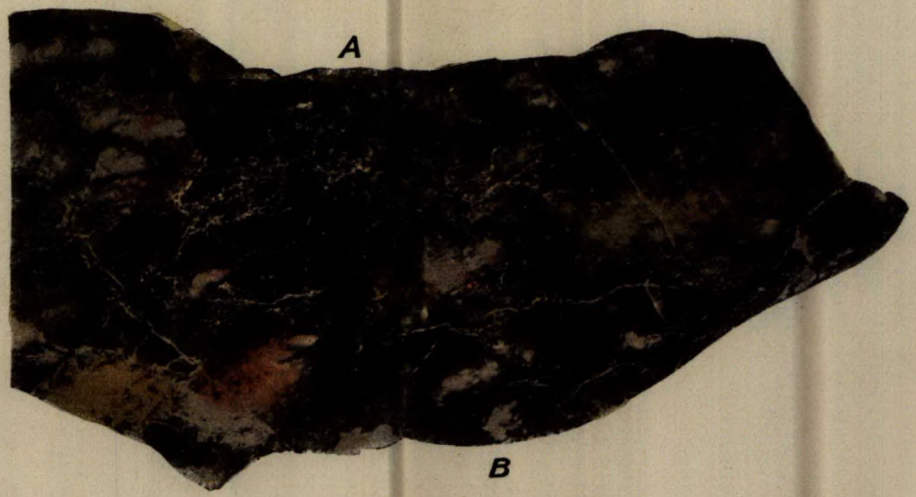


*Sulphides*

*Native Gold and Gold Telluride*

Polished specimen, Wright Hargraves No. 1 ore natural size. Showing native gold associated with gold telluride. Chalcopyrite and pyrite are also present. The sides marked A and B are slickensided and show amorphous molybdenite. The serious fracturing of the ore is also illustrated.