CANADA

DEPARTMENT OF MINES

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER.

MINES BRANCH

JOHN MCLEISH, DIRECTOR.

INVESTIGATIONS IN 1920

MINERAL RESOURCES AND TECHNOLOGY

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SUMMARY REPORT OF MINES BRANCH INVESTIGATIONS: 1920

METALLIFEROUS MINES DIVISION

I

THE DEVELOPMENT OF CHEMICAL AND METALLURGICAL INDUSTRIES IN CANADA

Alfred W. G. Wilson

Chief of Division

A comprehensive report on the development of the Chemical and Metallurgical Industries in Canada has been in course of preparation during the last four years. This work has entailed investigation and inquiry in all branches of industry where metallurgical or chemical products or processes are employed. The work was undertaken as a contribution towards the foundation of new industries in this country; to assist in the development of our natural resources; and to show where these resources might be further utilized to advantage. This report, which is now nearing completion, is to be regarded only as preliminary to similar and more comprehensive reports. It presents a generalized view of the present status of the chemical and metallurgical industries in Canada. The subject under review is too broad and too comprehensive to be adequately covered in a single report, or by a single individual.

The most important economic problem before the people of Canada to-day is the expansion of industry, not alone to meet local needs, but also to furnish surplus manufactures to be exchanged for commodities required by us, but not produced in this country. The four primary or fundamental industries of Canada are agriculture, mining, forestry, and fisheries; all other industries are based upon these, both as sources of raw materials and for the maintenance of the industrial workers. Agriculture provides occupation for a very large part of our population, and the annual value of its products exceeds that of any other group. It is erroneous to assume that these facts alone constitute agriculture as the basic industry of this country. To do so is to ignore the meaning of the term basic. Very little investigation and thought are necessary to demonstrate that minerals and mineral products are the basis of all the fundamental industries. The progressive development of civilization since the dawn of recorded history has been marked by the invention and development of processes or methods of utilizing mineral products for industrial or other purposes. Plant growth even under natural conditions can take place only where plant food is available, and certain mineral products form essential plant foods. Agriculture and forestry under the most primitive conditions are dependent upon plant growth, and are thus dependent also upon the presence of suitable mineral products as sources of food. The most advanced agricultural practice of to-day is dependent for its success not only upon an adequate supply of plant foods derived from mineral products by chemical processes, applied artificially or under natural conditions, but also upon implements suitable for intensive cultivation and economical operation, which are fashioned largely from mineral products.

Minerals and mineral products are essential to the production of all other commodities. The winning of minerals—that they may be utilized in the industries—is, therefore, the basis of all industry, and this fact alone constitutes mining as the basic one of the four fundamental groups.

While, however, mining is the basic industry of this country, it is the second in importance of the fundamental industries. Its products are essential to progress in all other industries, and when not produced at home, must be imported, often at considerable expense. Ten years ago, according to data obtained from the last census records, 34·4 per cent of our workers were engaged in agriculture, 18 per cent in manufacturing of various kinds, and only 2·3 per cent in and about mines. It is probable that the next census (1921) may show a considerable increase in the percentage of workers engaged in manufacturing and in mining, and a decreased percentage occupied in agricultural pursuits. A study of the per capita values of the returns credited to the workers in various industries shows that the workers in the mining industry produce, on an average, annually, larger values as the result of their labours than do the average workers in any other large group. A very large proportion of our foreign purchases are fabricated mineral products. Expansion of other industries than mining will naturally lead to increased importations of necessary products not available at home. Owing to the demands of our own industries, and the requirement of the workers in these industries, and owing to the demands of foreign markets for many fabricated mineral products, it is probable that the mining industry and its related groups of industries offer better opportunities for greater expansion and development than any other group. In these days of economic stress, increased production in essential industries is urgently needed; but it must not be forgotten that markets to absorb this production and purchasing power in these markets are also equally essential.

How far the prosperity of the country is dependent upon the Mineral Industry can be determined only by a broad and close economic study of the intimate interlocking relationships which exist between all industries. The dependence of this country upon mining as one of the principal sources of national prosperity is well illustrated by a study of railway statistics. In the year ending June 30, 1916, 34·52 per cent of the total freight loaded upon railway cars in Canada was classed as "Products of the Mine." In the same year the "Products of Agriculture" supplied 24·72 per cent; Forests, 15·10 per cent; and Animals, 3·56 per cent. Manufactures contributed 15·30 per cent, of which 7·18 per cent were primary manufactured products derived from minerals, and 8·20 per cent were partly, at least, of other origin. This last item, however, includes machinery and other materials containing metals and chemicals prepared from minerals. Making allowances for the freight tonnage delivered to Canadian railroads by the United States in 1916, 22·6 per cent of the total freight loaded on cars in Canada was the product of Canadian mines, with which may be included 5·2 per cent of primary manufactured products derived from ores and minerals. If the total freights of Canadian origin only are considered, these amounts become 29·7 per cent and 6·9 per cent respectively. Summarizing these data, it may be stated that 36·6 per cent of the freight of Canadian origin loaded on Canadian railway cars, in Canada, was supplied by the mining industry. These figures do not include the inward bound supplies required by the mining industry and its workers. No information is available with respect to this item, but it is probable that if this were included, it would be found that nearly half the freight loaded on cars in Canada is due to the existence of the mining industry. In the United States the mining industry supplies about sixty per cent of the total freight carried on United States railways. Coal and iron ores are the principal mine products contributing to this total.

While about one-third the freight loaded on cars in Canada is directly or indirectly produced by the mining industry, only about 1 per cent of the total population, or, at most, 2·5 per cent of that portion of the population engaged in gainful occupations, is required in the whole Canadian mining industry. It is believed that this proportion has increased slightly during the last ten years.

As previously mentioned, mineral products and commodities made from minerals are essential to all other lines of industry. Where these are not produced, it is necessary to obtain them outside the country, by barter and exchange. The total value of the imports of minerals and manufactures of mine products was $324,263,177 in 1919 and $356,990,627 in 1918.[1] These statistical data do not include many chemical products made from minerals, or products made from other materials by processes requiring the use of minerals. Were these items included, the total importations of this class of commodities would be found to be about $450,000,000 per annum. In 1919, we imported iron and steel products to the value of $181,332,310 in addition to $4,706,440 worth of iron ores. In the same year our coal and coke importations were $63,566,539, and petroleum and petroleum products cost $29,451,974, a total of $279,047,263 for these three items alone. In 1917, these three items totalled $292,213,006, and in 1918, $295,402,436. These valuations represent, approximately, the purchasing cost, exclusive of exchange, of materials of the classes here under discussion that are required by Canadians, and by Canadian industries, over and above the materials now supplied to these industries and to our people, from domestic production. The total value of our imports in 1918 was $963,510,679, and in 1919 was $919,705,802. It is, therefore, apparent that nearly one-half of our annual imports are the products of the mineral industry and of industries closely related thereto, particularly the metallurgical and chemical industries.

Canada is known to be rich in mineral resources, and these resources are by no means fully utilized. Many of the products imported are fabricated by the use of minerals known to occur in Canada. It, therefore, becomes desirable to ascertain underlying causes which result in these large importations of minerals and other products related to them, since it would be of national advantage if our own resources were further utilized in satisfying our own needs, whenever this is at all commercially practicable. The utilization of our own resources for this purpose alone would mean either the expansion of existing industries or the development of new ones.

The successful development of a new industry depends upon the co-operative operation of at least eight different factors, not including the personal factor of organization ability which must be supplied or otherwise procured by those initiating a new enterprise. These eight factors are : (1) supplies of suitable raw materials; (2) capital; (3) industrial research, or a knowledge of the results of research; (4) technical operating skill; (5) labour; (6) salesmanship; (7) transportation facilities; and (8) markets. Each new development will have to be considered by itself, and also in its possible relations to existing developments of like character. The initial steps in the development of a new industry involve a study of the present situation in respect to the supply of raw materials, markets available, transportation facilities, and existing industries of like character. This report has been prepared to facilitate inquiries of this kind.

The report upon the Development of the Metallurgical and Chemical Industries in Canada presents a general summary of the Canadian situation in this field. This review was first planned early in 1916, but special war work prevented the initiation of the principal field investigations until 1917. Since then, almost all the information contained in this report, and much that has been omitted, has been available to those entitled to it; but it did not appear desirable to publish any results of the inquiry, in report form, until after the close of the war. Pressure of other duties and the preparation of certain special reports have delayed the completion of this report until the present time.

The investigations upon which the report is based were primarily undertaken to supply information for war purposes. It was also realized that when peace came it would be very desirable to have accurate information available with respect to the present development of the metallurgical and chemical arts in Canada. The initiation of new lines of endeavour, and the expansion of the old, would necessarily depend upon a knowledge of what had been already accomplished.

[1] Statistical data compiled by the Division of Mineral Resources and Statistics from returns prepared by the Department of Customs.

The mineral industry is our most important economic industry, in that it supplies raw materials not alone to the two allied industries under discussion, but also to all other industries. Metallurgical industries are based upon the mineral industry, and those manufacturing industries which fabricate metallic products, are, therefore, all dependent upon mineral products. Chemical industries also draw at least seventy-five per cent of their raw materials from the mineral industry. Probably less than one-fourth of our chemical manufacturing industries draw their principal raw materials from the other basic sources of supply. Even in these cases it will be found that certain materials, required in minor quantities, but none the less essential, are either minerals or chemical products derived from minerals. Because of this very intimate dependence of practically all chemical industry upon the mineral industry it has been considered desirable to include in this report references to a number of chemical industries whose principal raw materials are derived from other basic sources.

The more important subjects presented in this report are:—

1. Metallurgical and chemical industries now established in Canada.
2. Metallurgical and chemical products now being produced in Canada.
3. Mineral products, including chemicals, used in industry.
4. Home markets, and the export trade.
5. Sources of raw materials, domestic and foreign.

II

INVESTIGATION OF TITANIFEROUS ORE DEPOSITS

A. H. A. Robinson

During 1920, part of the months of March and April, all of July, August, September, and part of October, were devoted to field work; the remaining portion of the year was spent in the office in working up data collected in the field; in the preparation of reports and maps; abstracting and filing information of interest in connexion with the Canadian iron industry; and supplying, in answer to inquiries, such information as is available regarding Canadian iron ore deposits.

The field work in March and April was undertaken for the Ontario Department of Mines, as a consequence of certain reports on the results of field observations made by officials of that Department, during the summer of 1919, at Kashaweogama lake, a long, narrow body of water situated about twelve miles north of Bucke station, on the Canadian National Railway, near the western extremity of what is known as the Lake Savant iron range, Thunder Bay district, Ontario. In view of the nature of these reports, the Deputy Minister of Mines for Ontario, Mr. Thos. W. Gibson, deemed it advisable to have the more or less casual observations on which they were based supplemented by an accurate magnetometric survey of the lake, and applied to the Mines Branch for the skilled assistance necessary to put such a proposal into effect. In response to this request, the services of the writer were placed at Mr. Gibson's disposal, and, it being necessary to carry out the work on the ice before the spring break-up, a start was made for the field in the early part of March; Kashaweogama was reached about the nineteenth of the same month, and work commenced.

Concurrently with the magnetometric survey, a traverse of the lake was made, also for the Ontario Department of Mines, by J. S. Dobie, O.L.S., of Thessalon, Ont., to whose capable and experienced hands was entrusted the provision of transportation from the railway to Kashaweogama and return, camp accommodation in the field, and the help necessary to carry out the magnetometric survey as well as his own work. Grateful acknowledgment is due to Mr. Dobie, whose able management and hearty co-operation did much to facilitate the magnetic work. A chart showing the results, together with a report on the magnetometric observations made at Kashaweogama lake, were forwarded in due course to the Ontario Bureau of Mines.

The investigation of our titaniferous iron resources, which was begun in 1919, was continued during the months of July, August, September, and the first half of October, 1920; also, many non-titaniferous iron ore occurrences, not previously reported on by Mines Branch officers, were visited and examined, to make more complete the data for a revised edition of "Iron Ore Occurrences in Canada."

Leaving out of consideration titaniferous iron sands, Canadian deposits of titaniferous iron, if we include in this category only those containing a noteworthy quantity—say 2 per cent and upward—of titanium, show the general characteristics of titaniferous iron deposits the world over; that is to say, they occur as magmatic segregations in the interior portions of basic igneous rocks of the gabbro family, either as sharply-outlined, irregular, often dike-like bodies, or as irregular masses that pass gradually on all sides of their central core to normal rock. The sharply-outlined type is characteristic of the non-magnetic, high-titanium ilmenites, found in anorthosite at St. Urbain and Ivry, and of some of the deposits that occur in parts of the great anorthosite mass that lies along the north shore of the lower St. Lawrence, in Quebec. They probably owe their form to segregation having taken place at depth, and the resulting titaniferous iron subsequently intruded into the already partly solidified anorthosite. The gradational type of deposit includes many occurrences in Quebec and all those in Ontario; all consisting of titaniferous magnetite (titanomagnetite), as contrasted with non-magnetic ilmenite, and characteristically associated with gabbro rich in ferromagnesian minerals. These show every evidence of segregation *in situ.*

Restricting, as before, the term to those containing two per cent or more titanium, the known titaniferous iron deposits in Canada of any considerable size are, with one exception, confined to the provinces of Ontario and Quebec; and close examination of these deposits leads to the conclusion that a not uncommon belief in great tonnage reserves contained in them is not entirely warranted by facts. Titaniferous iron deposits originating by magmatic segregation occasionally attain considerable dimensions, such as those at Routivare and Taberg in Sweden; and at Sanford Hill, N.Y., and Iron Mountain, Wyo., in the United States. The greater number, however, are substantially smaller. Many are quite small, but may occur as numerous aggregates collected near one another that give rise on a mere cursory inspection to false ideas of their size and continuity; neighbouring outcrops are assumed to represent a single partly hidden ore-body, whereas they actually represent numerous but small, separate ore-bodies scattered through a matrix of lean or barren rock. It may also be pointed out that even when the total amount of material contained in a number of such small neighbouring bodies is large, when scattered about in this way it presents difficulties in prospecting, mining, and handling that may materially affect, economically, its availability. In the case of the titanomagnetites, the magnetometer often affords a cheap and fairly rapid means of determining the continuity or otherwise of deposits of this kind; the non-magnetic ilmenites, however, do not lend themselves to magnetometric methods of investigation.

Some of the ilmenite deposits at St. Urbain and at Ivry, in Quebec, show promise of considerable size for deposits of their class, and they are known to be surrounded by large areas of possibly ore-bearing rock; but exploration has not been extensive enough to make possible any numerical estimate of the amount of material contained in them, either individually or in the aggregate.

Some large bodies of titanomagnetite, together with more numerous small ones, occur north of Seine bay and Bad Vermilion lake in the Rainy River district of Ontario, and in Bourget township in the Lake St. John district of Quebec. The size and extent of the Rainy River district deposits have been investigated to some degree by magnetic surveys and diamond drilling; knowledge of the Bourget township deposits is confined to the evidence afforded by natural outcrops and some dip-needle readings. Less important occurrences of titanomagnetite are those found at Bay of Seven Islands on the north shore of the lower St. Lawrence, and in the townships of Lake and Tudor in central Ontario. These latter consist of numerous small bodies of titaniferous magnetite lying in such close proximity to each other and surrounded by rock so closely resembling magnetite on casual inspection, as to simulate, at first glance, large continuous ore-bodies. Oft-mentioned deposits near Gooderham, Ontario, are of the same nature, but apparently contain fewer concentrations of ore.

In addition to the deposits in Ontario and Quebec, the only other deposit of titaniferous iron of notable size so far reported to occur in Canada is one near Burmis in Alberta—differing both in origin and mode of occurrence from any of those previously mentioned in that it consists of indurated beds of titaniferous magnetite sands intercalated in a series of sandstone beds. At least three different beds of the magnetic black sand have been recognized, and the deposit has been traced in prospect workings for a distance of eight miles in the vicinity of Burmis; similar beds of titaniferous black sands, at the same geological horizon, are reported by the United States Geological Survey to occur to the southeast, in the state of Montana. The titanium content of the beds, though above the maximum usually allowed in iron blast-furnace practice, is small; and the deposit, owing to its probable great extent and proximity to the coal fields, may, in the absence of more suitable material, have a possible future importance as the basis of a local iron industry.

NON-METALLIFEROUS MINES DIVISION

I

MINERAL PIGMENTS IN EASTERN CANADA

Howells Fréchette

Chief of Division

The investigation of the resources of iron oxide pigments was commenced in 1919, in which year the majority of known deposits in the province of Quebec were visited. During the summer field season of 1920, the investigation was continued in the eastern part of Quebec, in New Brunswick, and in Nova Scotia.

Quebec

The only deposits of importance seen in that part of the province of Quebec visited in 1920, are situated on the property comprising lot 18, range I, and lots 19, 20, 21, and 22, range II, Iberville township, Saguenay county, near the mouth of Petite Romaine river, which flows into the St. Lawrence river at a point about 130 miles below Quebec. Iron oxide has been deposited in a more or less crescent-shaped deposit, or series of deposits, about three-fourths of a mile in length, along the southern margin of a very large bog. The ochre varies considerably in depth. In places, on the flat, it approximates to four or five feet in depth; while in some gullies the depth is greater. Twelve feet of ochre was observed in one place; and it is said that in another, drilling revealed over eighteen feet of the mineral. Several shades of ochre were seen, and duly sampled for testing.

These deposits were first worked as a source of pigment, in 1883, but were later abandoned. In 1916, work was again started, and a small quantity of crude ochre was produced for use as a pigment in paper making. Since then, several small shipments have been made. At the time of my visit, a company—under the management of Mr. P. L. Jobidon—had begun the installation of a plant for calcining and grinding the ochre for paint. There is no railroad in the district, shipment being made by small schooners, which are loaded at low tide.

Deposits, which are said to be of considerable size, are known to occur in the township of Manicouagan on the north shore of the St. Lawrence. Owing to their remoteness from markets, and the difficulty of reaching them, they were not visited.

To the south of the St. Lawrence, ochre was observed in a number of places, but nowhere were any deposits seen that could be classed as of commercial interest.

New Brunswick

A number of localities were visited in New Brunswick, for the purpose of examining reported occurrences of iron and manganese pigments. The more important of these are mentioned below.

Near Dawson Settlement, Albert county, there is a deposit, or rather a group of deposits, of bog manganese. These are low spreading mounds, built up by deposition from several springs; and consist of loose, earthy hydrated oxides of manganese and iron, mixed throughout with much peaty matter. At one time this material was used for the production of ferro manganese, but none has been excavated since 1900. In connexion with an investigation of the manganese resources of Canada, Mr. W. L. Uglow made a thorough examination of the two main deposits for the Munition Resources Commission.[1] In his report, he estimates an equivalent of 13,486 tons of

[1] Final Report Munition Resources Commission of Canada, 1920, page 79.

dry ore in the deposits and in the stock sheds and gives as an averaged analysis, based on dry ore: manganese 22·79 per cent, and iron 15·89 per cent.

The writer visited these deposits for the purpose of determining whether the material could be used for the manufacture of paint. It was found that there is a considerable variation, both of colour and composition, in the different parts of the deposits. The variation of colour, or rather shade, should not render the deposits unworkable for pigment production, but would mean that careful grading would be necessary in the handling of the material.

When washed, dried, and ground in oil, samples produced a warm, dark brown paint, of strong tinting power, similar to raw umber; though of a somewhat redder tone.

When calcined, and ground in oil, some of these samples produced a true burnt umber; while others developed a much redder brown. In all cases, a paint of good body and tinting power was produced.

In Westmorland county, about twenty miles to the northwest of Dawson Settlement, similar beds of bog manganese occur along the main Canaan river and its upper north and middle north branches. A group of these on the west bank of the upper north branch, is estimated by Mr. Uglow[1] to contain about 5,000 tons (dry weight) of ore. According to the report, this material contains a greater percentage of manganese and of organic matter, and a lesser percentage of iron than the material in the Dawson Settlement deposits. Irregularity in composition, and the hard gritty nature of the ore, in places, would indicate that it is much less desirable for pigment purposes than that from Dawson Settlement. In view of the inferior nature of the material of these deposits, as pigment, they were not visited in connexion with the present investigation, but yet are worthy of mention.

About three miles northeast of Canaan station on the Canadian National Railway (Intercolonial), there are deposits of ochre situated within an immense swamp. In places, springs have deposited iron oxide on top of the debris of the swamp. One such deposit, several acres in extent, was examined and sampled. Much of the iron oxide is mixed with a large proportion of peaty matter, though in patches high grade material was obtained. Owing to many logs and roots embedded in the deposit it was impossible to determine its depth. In some sections, the ochre is found merely as a surface layer, a couple of feet thick; while the greatest depth observed was eight feet thick. Samples tested in the laboratory show that a good paint may be produced by calcining the material. The colour of the raw material, ground in oil, varies from a very dark brown to a medium toned sienna; and when calcined produces a paint of good intensity, somewhat similar to burnt sienna. Owing to the large amount of embedded wood, and the difficulty of draining such a large swamp, the exploitation of this deposit would probably be costly.

Nova Scotia

Some twenty reported occurrences of mineral pigments were visited in Nova Scotia. These were of three classes: namely, iron oxides, iron-manganese oxides, and clays. The clays, in all cases, may be dismissed from consideration as raw material for colour making, on account of their lack of brilliancy and low staining power.

With few exceptions, the iron oxide deposits are very small, and consequently of no commercial value. Most of these deposits are formed by the precipitation of iron from water oozing out of beds of shale containing pyrite, the weathering of which yields the iron in solution.

Such deposits were observed in Inverness, Antigonish, Pictou, Halifax, Lunenburg, Queens and Kings counties.

[1] Final Report Munition Resources Commission, p. 65.

The ore in the iron mines near Londonderry, Colchester county, contains much earthy limonite, which, in some cases, is of very fine texture, and of good sienna colour, and is said to be quite suitable for paint manufacture. These mines have been shut down since 1908; and as none of the workings were accessible, no samples could be obtained for examination. It is doubtful if it would pay to open any of the old workings for the production of pigment; but should the mining of iron ore be resumed at any time, a separation of the ochre from the ore might be a profitable enterprise.

On the Southwest Branch Avon river, between Benjamin Mills and Upper Falmouth, Hants county, about seven or eight miles by road from Windsor, there are a series of deposits of manganiferous iron oxides, some of which are of workable size. Several shades of paint of good quality were obtained from samples of the material. Owing to the covering of timber on the deposits and the distance from the railroad, exploitation would probably be costly. It is understood that a license to the property is held by John A. Spencer of Windsor.

In Kings county, about 3½ miles southwest of Kentville, there is a fairly extensive deposit of manganiferous iron oxide on the farm of Chas. W. Ward. According to How,[1] several hundred tons of pigment was taken from this deposit, and marketed in the United States. The samples collected, when ground in oil, yielded paints of good quality. The colours of the paint, made from the uncalcined material, ranged from dark raw sienna to a warm seal brown, while the calcined gave paints ranging from a bright red to very dark brown, similar to burnt umber. The deposit contains, in places, thin beds of nodular wad and bog iron ore. There is little intermixed sand, except in a few isolated patches.

About twenty years ago, umber was shipped from a property at Chester Basin, Lunenburg county. The deposit is situated close to the railroad on the property of Mrs. Chas. H. Mills. The deposit, which is about four feet thick, is overlain by two or three feet of soil. The old pits have caved in, but one of these was opened up sufficiently to obtain samples. Good grades of paint were obtained by grinding the material, both raw and calcined, in oil. The respective colours were raw and burnt umber, although slightly warmer in tone than the standards.

II

INVESTIGATION OF MISCELLANEOUS NON-METALLIC MINERALS

Hugh S. Spence

BARYTES

During the field season of 1920, an examination was made of several barytes deposits in northern Ontario, in order to complete the data for the writer's report on "Barium and Strontium in Canada" which will shortly go to press. None of the properties visited have attained the producing stage, the majority being situated too far from a railroad to permit of their being worked under present conditions.

A deposit in Lawson township, near Elk Lake, was described in the Summary Report of the Mines Branch, 1919. Analyses since made of the samples of ore taken from this deposit show the barytes to be of exceptionally good grade, running 98 per cent barium sulphate, in addition to being soft and very white. While surface indications do not point to there being a very large body of ore, the deposit should prove of value as soon as rail communication is extended from Elk Lake to Gowganda. At present, the 15-mile road haul to Elk Lake renders development of the property impracticable.

[1] Mineralogy of Nova Scotia by Henry How, 1868, p. 109.

The deposit of the Ontario Barium Company, situated in Yarrow township, about 35 miles northwest of Elk Lake, comprises several important veins, and the property is capable of yielding a large tonnage of barytes. The remoteness of the locality, however, renders exploitation out of the question at the present time. The barytes is of good quality, and two heavy veins have been uncovered, in addition to several smaller leads. Up to the present time only surface work of a prospecting nature has been conducted. The four claims controlled by the company were surveyed for patenting during 1920, and the construction of the projected railroad to the Matachewan area is being awaited before further development is undertaken.

A deposit of barytes also exists in the township of Cairo, Matachewan district, about 12 miles in a direct line northeast of the above noted occurrence in Yarrow township. This deposit, known as the Biederman property, consists of a single vein of fair quality barytes, measuring 16 feet between walls, but containing a considerable amount of included country rock. In addition, sulphides occur in the ore, and a narrow siliceous zone persists to a width of about 30 inches along the hanging contact. In general, the ore may be considered as rather inferior in grade to that of the other deposits examined in northern Ontario. The length of vein exposed is about 85 feet. Lack of transportation hinders any attempt to develop this deposit, upon which only surface work has been done.

A deposit of barytes near Tionaga, 135 miles west of Sudbury, on the Canadian National railway, was stripped and diamond drilled by C. H. Hitchcock and associates, of Sudbury, during 1919-20. The occurrence consists of a single ore body made up in part of anastomosing stringers of good, white barytes. These stringers are associated with a considerable amount of massive quartz, and a proportion of the ore would probably have to be cobbed. The ore body has been stripped for 450 feet, and is exposed on a low knoll; at each end of the outcrop the lead passes under a swamp. Drill holes have been carried to a depth of 150 feet, and the tonnage of barytes available to this depth is estimated by the operators at 50,000 tons. The property is situated within a few hundred feet of the railroad tracks, though below their level, and the construction of a spur of about half a mile will be necessary to enable ore to be dumped directly into cars.

CELESTITE

The celestite deposit in Bagot township, Renfrew county, Ontario, described in Mines Branch Summary Report, 1919, was again visited, late in the season. Considerable mining was done on the deposit during 1920, and a small experimental mill was erected, to grind the material. Some shipments were made to domestic paint firms, and the celestite is reported to have substituted satisfactorily for barytes in paints.

The ore of this deposit is very mixed, consisting of irregular, detached masses of fibrous and rather friable celestite, enclosed in a dolomite matrix. It is probable that this mode of occurrence will alter in depth to a more regular vein formation, as the detached masses of celestite at the surface appear to be portions of a brecciated vein. All of the celestite recovered is secured by hand cobbing, and the actual amount of celestite recoverable by this means from the mixed celestite-dolomite cobbing ore probably does not exceed 30 per cent of the total present. The remaining celestite is present intimately mixed with dolomite, and the mixed rock would require to be concentrated in order to effect a satisfactory recovery. Such mixed rock averages about 50 per cent celestite.

TALC

Examination was also made this season of several talc properties in British Columbia.

A deposit of massive talc, or steatite, that has been known for many years, is situated 3 miles west of Keefers Station on the main line of the Canadian Pacific railway. No talc has been shipped from this property but the talc body has been exposed in several openings made for gold. The talc occurs as a band of green, massive steatite, enclosed in slates; the entire series being tilted into a vertical attitude and being much jointed and squeezed. Little of the talc comes out in the form of compact blocks of any size, the material breaking up into irregularly shaped pieces, with slickensided surfaces. As far as could be ascertained from an examination of the tunnel that crosses the talc body, the latter has a width of about 8 feet, and is bordered on both sides by about 25 feet of more or less talcose slate (soapstone). The talc grinds to a soft, grey-white powder, that should prove suitable for the paper, paint, rubber, and roofing trades. The property is well situated for working, lying close to, and higher than, the railroad tracks. The present operators are the B.C. Silica & Talc Company, Rogers Building, Vancouver, who mined only quartz during 1920.

A talc deposit on Wolf creek, Victoria mining division, Vancouver island, was visited and found to be working on a small scale. The property is situated 33 miles from Victoria, and about three-fourths of a mile from the track of the Canadian National railway. The deposit consists of a narrow band of grey-green talc schist, dipping about 60°. The talc zone is enclosed in slates, and the whole is considerably squeezed and crumpled. A tunnel has been carried 50 feet along the talc body, and is reported to show 18 feet of ore. The operator is W. G. Dickinson, 576 Dallas Road, Victoria, who has taken out about 300 tons of talc. This material was shipped to his grinding mill at Sydney, and ground for roofing purposes. Mr. Dickinson states that the quality of the talc has been favourably reported on by Pacific coast paper mills, and that contracts have been entered into to supply crude talc to American mills in Washington. The talc of this deposit is evidently an altered, coarse-grained schist, and contains an appreciable amount of dolomite; it grinds to a light grey powder. The deposit carries no massive talc, suitable for cutting into slabs.

A small tonnage of talc has been obtained in recent years from deposits at Mile 92, near D'Arcy, on the Pacific Great Eastern railway, Lillooet mining division. All of the talc taken out has been utilized for surfacing roofing paper, the principal operator being the Pacific Roofing Company, Granville island, Vancouver. The talc is grey-green in colour, carries minute specks of disseminated bornite, and grinds to a soft, nearly white powder. It shows evidence of crumpling, and breaks up readily into thin layers.

No work was done during 1920 on the steatite deposit near Vermilion Summit, Windermere mining division, but it is understood that the deposit has been found to extend beyond the limits of the original claim.

BENTONITE

Consequent upon inquiries directed to the Department by the Imperial Mineral Resources Bureau, regarding possible sources of bentonite in Canada, the writer was instructed to visit localities in Alberta and British Columbia, from which bentonite had already been recorded; to gather all available data regarding the occurrences; take samples, and to examine, also, any new deposits that might be brought to his attention. In accordance with these instructions, visits were made to three localities along the line of the Canadian National railway, between Edmonton and Calgary, and to one known occurrence in the interior of British Columbia. Samples were taken of the various beds examined, and the material was shipped to the Mines Branch laboratory for investigation as to its chemical and physical properties. Samples were also sent to the Imperial Mineral Resources Bureau, in order that similar work might be carried out upon the material by the Department of Scientific and Industrial Research.

The work being done in the Mines Branch laboratory has not yet reached a stage that will enable definite conclusions to be drawn regarding the suitability of these

Canadian bentonites for industrial purposes. It has been shown, however, that certain of the samples compare very favourably with the Wyoming bentonite that was employed as a standard in the investigation. Unfortunately, the deposits from which this good grade of material was taken, are all very thin, scarcely exceeding 12 inches, and consequently they can in most instances hardly be regarded as of economic importance.

Mr. A. E. Thompson, chemist in charge of the laboratory work being conducted on bentonite, states he has reason to believe that certain samples of what was at first regarded as inferior bentonite, owing to the apparent failure of the material to gelatinize readily on the first addition of water, show indications of improved behaviour on prolonged immersion, with agitation. It is possible, therefore, that certain deposits of workable dimensions, which were at first thought to carry only material of inferior grade, may yet prove to be of economic importance.

III

ALKALI DEPOSITS OF WESTERN CANADA

L. H. Cole

Occurrence.—Natural occurrences of soluble mineral salts are known in the provinces of Manitoba, Saskatchewan, Alberta, and British Columbia, either in the form of bedded deposits, or as brines. Some are of considerable extent, and are probably of sufficient size to warrant commercial development.

The occurrences of these salts may be broadly classed under two types:—

(1) Solid salts and brines in undrained or partially drained basins;

(2) Brines of flowing streams or springs.

Type 1

Those of the first class are very numerous in the Prairie Provinces.

It is probable that the accumulation of salts is due to leaching out of the soluble salts in the prairie soils by surface waters, and their concentration and deposition in the undrained basins which are found in the glacial morainic covering of the western prairies.

These deposits are generally of a similar character, although the percentage of the different salts will vary in different localities. In many cases the name "alkali lake" has been appropriately applied to deposits of this nature, since in the early spring and often into late summer the deposits are covered with water. The water accumulating through the melting snow and rain is often a foot or two in depth, and carries a considerable quantity of the alkali salts in solution. Beneath this water one generally finds a solid bed of crystallized salts. In the late summer, especially when the season is a dry one, these so-called lakes become deposits of snow white alkali, which when seen from a distance resemble snow covered basins.

The deposits will vary in size from a few acres to many acres in extent, and in thickness from a few inches to possibly 15 feet. The salts are generally found interbedded or mixed with mud or peaty material, and in very few instances are the deposits in a pure enough form to be commercially marketable in their raw state. The mud beds also contain numerous crystals of the alkali salts.

Type 2

Brine streams or springs occur in many places, and may carry sufficient salts in solution to warrant their commercial exploitation for medicinal and other purposes. In some of the occurrences of this nature the principal salt present is sodium chloride, the other salts being present only in small quantities. The brine springs of northern Manitoba are good examples of this class of deposit.

Composition.—The composition of the salts occurring in these basins consists chiefly of mixtures of sodium and magnesium sulphates in varying proportions, with, generally, small quantities of sodium chloride and possibly other salts such as sodium carbonate, etc.

Sodium Sulphate

Sodium sulphate in the hydrous form (known as *Mirabilite* or *Glauber's Salt*) has the following composition:—

$$Na_2SO_4.10H_2O = \begin{cases} SO_3 & 24\cdot8\% \text{ (sulphur trioxide).} \\ Na_2O & 19\cdot3\% \text{ (soda).} \\ H_2O & 55\cdot9\% \text{ (water).} \end{cases}$$

In its pure state it is white, transparent to opaque, and has a hardness 1·5-2 with a specific gravity 1·48. It is readily soluble in water, and at first is cool to the taste, and afterwards saline and bitter.

Sodium sulphate in the anhydrous form (known as *Thenardite*) has the following composition:—

$$Na_2SO_4 = \begin{cases} SO_3 & 43\cdot7\% \text{ (sulphur trioxide).} \\ Na_2O & 56\cdot3\% \text{ (soda).} \end{cases}$$

Its colour, when pure, is white, translucent to transparent, and the mineral has a hardness of 2-3, with a specific gravity of 2·68.

Magnesium Sulphate

Hydrous magnesium sulphate (known as *Epsomite* or *Epsom Salts*) has the following composition:—

$$MgSO_4.7H_2O = \begin{cases} SO_3 & 32\cdot5\% \text{ (sulphur trioxide).} \\ MgO & 16\cdot3\% \text{ (magnesia).} \\ H_2O & 51\cdot2\% \text{ (water).} \end{cases}$$

This is a soft, white or colourless mineral, readily soluble in water, and with a bitter saline taste. Its hardness is from 2 - 2·5, and a specific gravity, 1·75.

Sodium Chloride

Sodium chloride (known as *Halite* or *Common Salt*) has the following composition:—

$$NaCl = \begin{cases} Na & 60\cdot6\% \text{ (sodium).} \\ Cl & 39\cdot4\% \text{ (chlorine).} \end{cases}$$

The natural salt is nearly always impure. It has a hardness of 2·5 and a specific gravity of 2·1 – 2·6. It is colourless or white when pure, but often yellowish, or red or purplish, from the presence of metallic oxides or organic matter. It is readily soluble in cold water, and has a saline taste.

With these salts may be associated other soluble salts such as sodium carbonate, and in small quantities, the salts of the calcium, potassium and alum groups.

On account of the nature of the natural alkali deposits and brines of western Canada, it will be necessary in nearly all cases to purify the raw product from such deposits, in order to produce marketable commodities. A pure Glauber's salt can be obtained by evaporating the brines or by dissolving the soluble salts already deposited and separating the sulphate of soda by differential crystallization. To produce salt cake from the hydrous salt it will be necessary to develop processes for eliminating the water of crystallization. Theoretically, this appears easy, but there are a number of practical difficulties in the way of development which have not yet been overcome.

Uses.—Sodium sulphate in the anhydrous form is more commonly known by its trade name *Salt Cake.* As salt cake, it finds its chief use in the manufacture of sulphate pulp in metallurgical work in the refining of nickel; in the manufacture of window, plate and bottle glass; and in making water glass. In the hydrous form, it is marketed as Glauber's salts, and as such, is used in dyeing; in tanning; in the textile industry as a mordant; and in medicine.

Magnesium sulphate or Epsom salts is largely used in the cotton trade for warp-sizing; it is also employed for medicinal and agricultural purposes, and in dyeing with aniline colours, since goods thus dyed are found to stand the action of soap better.

Sodium chloride is the ordinary common salt of commerce, and as such, does not need further mention.

Market Situation.—Sodium Sulphate.—So far there has been no steady production of sodium sulphate from the alkali lakes of western Canada. The Salts and Potash Company, Ltd., of Kitchener, Ont., operating Muskiki lake (Tp. 39, R. 16, W. 2nd), Sask., have erected refining plants at their lake and also at Kitchener, Ont., in which they have carried out considerable experimental work and hope shortly to be in a position to place the refined products regularly on the market. The salt cake so far used in the country has been obtained as a by-product from the manufacture of hydrochloric acid. Glauber's salts are made from the anhydrous form by dissolving the salt cake and recrystallizing below 32·4° C.

Salt cake is manufactured in Canada by the following firms:—

Grasselli Chemical Co., Hamilton, Ont.
Nichols Chemical Co., Montreal, Que.
Plants:—Sulphide, Ont.
Capelton, Que.
Victoria Chemical Co., Victoria, B.C.

The Canadian production of salt cake and Glauber's salts as furnished by the Dominion Bureau of Statistics for 1918 and 1919 was as follows:—

	1918		1919	
	Tons	Value	Tons	Value
		$		$
Salt cake	6,001	133,544	3,197	57,045
Glauber's salts	2,358	60,281	1,423	45,731

Canadian imports of salt cake and Glauber's salts are as follows:—

Calendar Year	Salt Cake		Glauber's Salts	
	Amount	Value	Amount	Value
	lbs.	$	lbs.	$
1910	17,728,543	95,054	1,080,309	5,217
1911	13,782,241	88,761	1,531,555	7,826
1912	19,243,823	97,768	1,951,619	9,129
1913	25,902,190	133,030	811,053	3,815
1914	38,175,604	170,333	810,062	3,407
1915	30,970,231	147,047	840,994	8,058
1916	42,194,077	178,370	522,703	8,133
1917	71,583,645	560,711	722,913	16,248
1918	68,773,441	676,571	686,712	9,748
1919	47,905,004	343,007	738,423	9,763

Magnesium Sulphate.—During the year ending March 31, 1920, there was imported into Canada $67,074 worth of Epsom salts, and in the same period, 1,523 cwt., valued at $893, was exported. This export was from the natural deposits of Epsom salts in British Columbia.

Market Prices.—The market prices of these commodities are constantly varying. The following figures as reported in the *Oil, Paint and Drug Reporter,* New York, give the New York market prices for the years 1914 to date.

	Aug. 14 1914	Jan. 1 1915	Jan. 1 1917	Jan. 1 1918	* 1919	* 1920
	$	$	$	$	$	$
Salt cake, ground—bbls. per ton	11·00 to 13·00	11·00 to 13·00	....	30·00 to 35·00	12·00 to 30·00	17·60 to 60·00
Glauber's salts, cwt	0·65 to 0.75	0·60 to 0·75	0·60 to 0·65	0·90 to 1·00	1·00 to 2·25	1·15 to 3·00
Epsom salt, U.S.P. cwt	not quoted	prior to 1918		3·62½ to 3·90	2·75 to 3·62½	2·50 to 6·00
Epsom salt, tech. cwt	1·00 1·10	1·75 2·00	1·75 1·85	3·37½ 3·50	1·80 3·37½	1·75 3·75

*High and low figures for year.

IV

BITUMINOUS SANDS OF ALBERTA

S. C. Ells

The field work carried on during the season of 1920 may be considered under two headings: (I) Examination of an area reserved for the use of the Parks Branch, Department of the Interior, situated on Horse river, and known as the "Horse River Reserve"; and (II) Provisional classification of outcrops of bituminous sand in the McMurray district, with regard to their probable economic importance.

(I)

Horse River Reserve.—An examination of the Horse River reserve was undertaken in order to determine the tonnage of bituminous sand commercially available; the quantities of overburden that the mining of such a tonnage would involve; and general conditions affecting development on a commercial scale. Twenty-one test pits were sunk in order to determine the thickness and character of the overburden, and the extent of the area underlaid by commercially available bituminous sands. Subsequently, bore holes were sunk from the bottom of the test pits, and representative samples of the bituminous sand secured. A report dealing with the results of the above work was forwarded to the Department of the Interior in December, 1920.

The following comment on methods applicable to the examination of bituminous sand areas is based on the results of the work on Horse river.

The method adopted in prospecting any bituminous sand area will depend on the thickness and character of material overlying bituminous sand of commercial grade; on the accessibility of the deposits, and the facilities for transportation by water or pack trail.

(*a*) *Where overburden is light.*—Residual river bottom areas usually have a relatively light overburden of clay, sand, and gravel. Where the thickness of overburden does not exceed 40 feet, exploration by means of test pits will usually be found satisfactory. In only three of the twenty-one test pits sunk during the past summer was cribbing necessary. In these three instances, caving was checked by using light poles and backfilling with brush. When the test pits have reached the bituminous sand, accurate core samples may then be secured by the use of standard asphalt hand augers. In sinking test pits, light pole derricks, rigged with double blocks, winding drum, and self dumping bucket, were used.

This equipment could be erected in from one to two hours. The weight of the heaviest single part did not exceed 75 pounds. A double action hand-pump, equipped with 10 feet of suction and 40 feet of discharge hose, was also used in order to keep down the very considerable volume of seepage water. Men worked in parties of three; but by using an efficient type of windlass, parties of two would have been adequate. The average rate of sinking, up to 25 feet, was approximately 3½ feet per day of 9 hours.

(*b*) *Where overburden is heavy.*—At points where a stream impinges against the side of a valley, exposures exhibit a thicker section of bituminous sand and also a much heavier overburden. Consequently, in determining the importance of areas represented by such outcrops, prospecting by means of test pits is not practicable. Usually, measurements, and boring by hand augers, along adjacent outcrops, will determine with sufficient accuracy the quality and quantity of the bituminous sand itself. It is more difficult, however, to determine definitely the thickness of the various strata of which the overburden consists. Under such conditions, two methods are possible:—

(i) A trench may be excavated above the outcropping bituminous sand, in order to expose a complete section of the overburden. The use of such a method is, however, rarely satisfactory. Slips in the unstable overburden along the precipitous slopes are frequent; and, apart from the large amount of excavation that trenching will ultimately involve, the final results are rarely reliable.

(ii) A bore may be sunk at some centrally located point within the area under consideration; and although such work involves the use of more elaborate equipment, the information secured is dependable. Light gasoline driven drills,[1] suitable for such work can be secured, of which the weight of the heaviest part does not exceed a few hundred pounds.

In preparing final estimates of quantities of overburden and of bituminous sand, accurate, detailed mapping is obviously essential. In the type of country under consideration the writer has found that maps, showing contours drawn at intervals of five feet, and plotted to a scale of one-inch equal to 200 feet, are satisfactory.

Conditions met with in the Horse River reserve may be considered characteristic of a large area lying south of township 93. As an indication of the importance that will attach to the removal and disposal of overburden, it may be stated that on the Horse River reserve, the estimated overburden amounted to approximately 3,180,000 cubic yards. The removal of this overburden would render available, approximately 3,360,000 tons of bituminous sand.

(II)

Classification of outcrops of bituminous sand with regard to their present possible economic importance.

Following the completion of the examination of the Horse River reserve, a short period was spent in visiting various outcrops of bituminous sand along the Athabaska and tributary streams, within the McMurray district. Conclusions arrived at as a result of the work on Horse river were of value in making a provisional classification of the various sub-areas represented by these outcrops.

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1 Manufactured by the Longyear Co., Minneapolis, U.S.A.

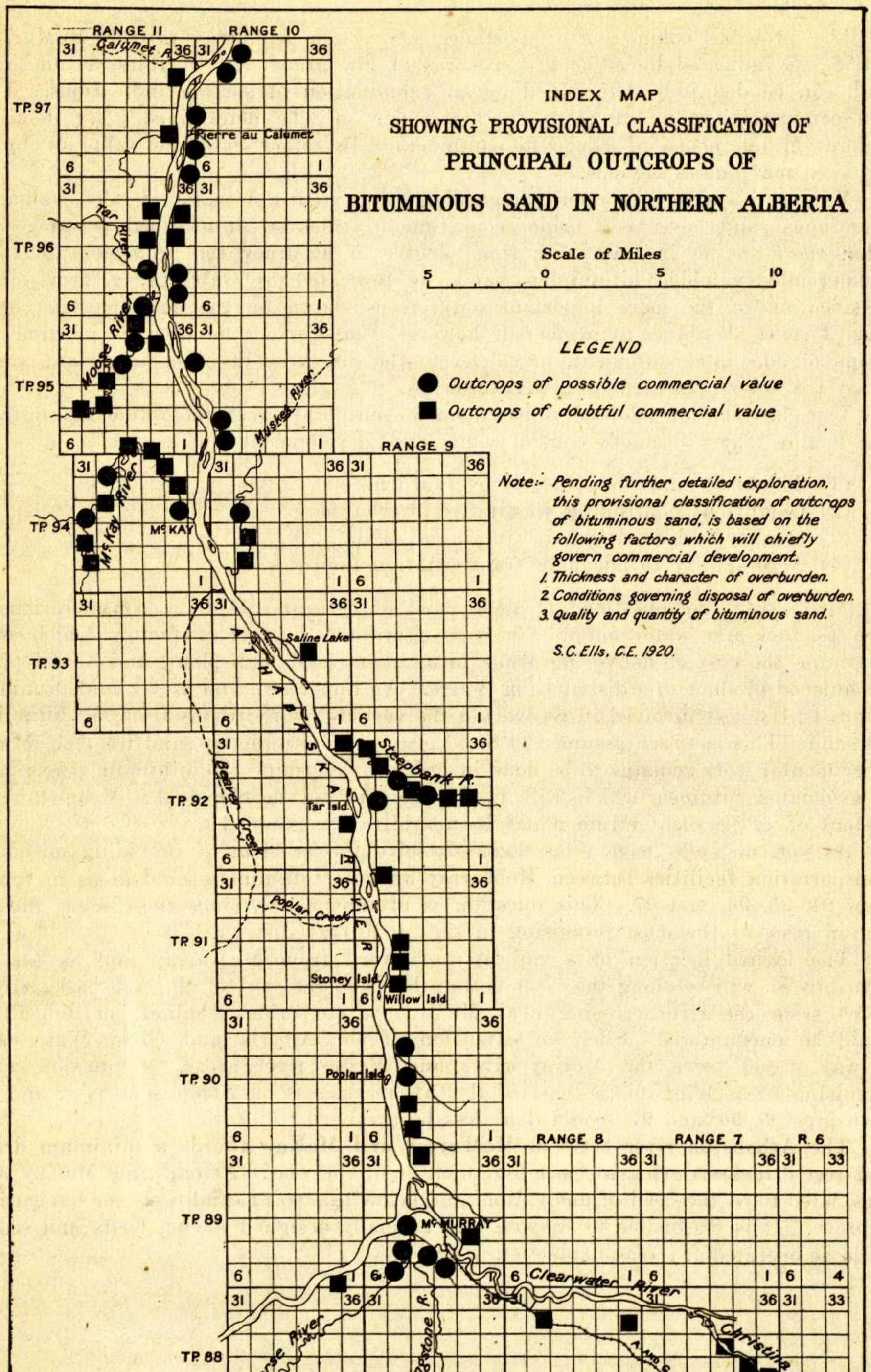
INDEX MAP
SHOWING PROVISIONAL CLASSIFICATION OF
PRINCIPAL OUTCROPS OF
BITUMINOUS SAND IN NORTHERN ALBERTA
Scale of Miles
5 0 5 10
LEGEND
Outcrops of possible commercial value
Outcrops of doubtful commercial value
Note:- Pending further detailed exploration, this provisional classification of outcrops of bituminous sand, is based on the following factors which will chiefly govern commercial development.
1. Thickness and character of overburden.
2. Conditions governing disposal of overburden.
3. Quality and quantity of bituminous sand.
S.C. Ells, C.E. 1920.
RANGE 11
RANGE 10
RANGE 9
RANGE 8
RANGE 7
R. 6
TP. 97
TP. 96
TP. 95
TP. 94
TP. 93
TP. 92
TP. 91
TP. 90
TP. 89
TP. 88
Calumet R.
Pierre au Calumet
Tar River
Moose River
Muskeg River
McKay River
McKAY
Saline Lake
ATHABASKA RIVER
Steepbank R.
Tar Isld.
Beaver Creek
Poplar Creek
Stoney Isld.
Willow Isld.
Poplar Isld.
McMURRAY
Clearwater River
Christina River
Horse River
Hangingstone R.
A. and G.W. Ry.

Fig. 1.

The probable commercial importance of certain sub-areas in the McMurray district, as indicated by adjacent exposures of low grade and worthless bituminous sand, can be definitely determined by an examination of surface indications. The true commercial value of other sub-areas can only be determined after detailed exploration by means of adequate equipment. In either case the value of topographical mapping is obvious.

Many misleading statements regarding the extent of commercially valuable bituminous sand have been made from time to time by uninformed persons. In order, therefore, to indicate with some degree of accuracy the probable extent of commercially valuable bituminous sand, as indicated by outcrops, a provisional classification of the more important outcrops is shown on the accompanying map (Fig. 1). It should be remembered, however, that further detailed exploration by means of adequate equipment, may lead to the discovery of other important areas which are not represented by actual outcrops.

The classification adopted is based on a consideration of the following controlling factors that will chiefly control commercial development:—

(1) Thickness and character of overburden.
(2) Conditions controlling wasting of overburden.
(3) Quality and quantity of bituminous sand.
(4) Accessibility to adequate transportation facilities.

Apart from the question of labour, and of certain subsidiary considerations—such as fuel and water supply—the above are the four chief factors which will determine the cost of delivering crude bituminous sand to a plant, and of shipping the finished product to a distribution centre. An important, and as yet undetermined factor, is, the cost involved in recovering the various hydrocarbons from the bituminous sand. This has been assumed at $1.50 per ton of bituminous sand treated. Much experimental work remains to be done in order to determine the minimum percentage of associated bitumen which will justify commercial development. Meanwhile, a content of 12 per cent bitumen has been arbitrarily assumed.

As yet, no steps have been taken to solve the problem of providing adequate transportation facilities between McMurray and the bituminous sand areas in townships 94, 95, 96, and 97. This question is of importance, since these areas are in certain respects the most promising in the McMurray district.

The logical location of a railway northward from McMurray and as far as township 96, will be along the river bottom lands to the west of the Athabaska river. Apart from the river crossing near McMurray, no serious engineering difficulties would be encountered. Such an extension of the Alberta and Great Waterways railway would serve the McKay river and Moose river areas. Connexion with promising areas lying to the east of the Athabaska—as on Steepbank river, and in townships 95, 96, and 97—could doubtless be arranged.

The Athabaska river between McMurray and McKay affords a minimum draft of 2 feet 6 inches during at least four months of the year. At one time McKay was considered to be the head of navigation, and below this point conditions for navigation improve. It is reasonable to suppose that specially designed towing boats and scows could be operated at a reasonable cost.