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The New Canadian Potash Discoveries

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Potassium is essential for healthy plant growth, and is rapidly depleted from the soil in many types of farming. As a result, the demand for potash salts for fertilizer has increased tremendously in recent years. In the first issue of *New Mexico Quarterly*, in February 1931, Professor John D. Clark discussed "Potash in New Mexico: Its Possible Significance." At the time he wrote one American company, in California, produced 12 per cent of our national potash requirements. The remainder was imported from Europe. But even then shafts were being sunk in the Carlsbad area, the beginning of an industry which now employs more than 3400 people, shipping annually more than three million tons of potash salts, with a value of nearly $64 million in 1954. These shipments amount to more than 90 per cent of United States potash requirements, indicating that the Carlsbad area dominates potash mining in North America. The period of domination may be coming to an end, however, for in the last few years potash deposits have been found in Saskatchewan. *New Mexico Quarterly* has asked Mr. Daly to give us the facts currently available on Canadian potash.—EDITOR.

Canada's Province of Saskatchewan, stretching 750 miles from Montana and North Dakota to the Northwest Territories, has traditionally made its living from the surface of the soil. Wheat growing on the southern plains is succeeded northward by mixed farming in the wooded parkland belt, and in the northern forests by timber and pulp cutting, and by fishing and trapping. In recent years new resources have been discovered: oil and natural gas, copper, uranium, and potash. The deposits of uranium and potash, in particular, may give Saskatchewan an important place in world mineral production.
Uranium is found in the province's rugged northland, while potash and petroleum resources are being developed in the southern areas. L. Heber Cole, mining engineer of the Canadian Federal Bureau of Mines, has described the discovery of potash in western Canada. As with most of the major world deposits, Saskatchewan potash is closely associated with beds of halite, or common salt. Salt springs and salt lakes on the prairies suggested the hope of finding extensive beds of salt at shallow depths. Some of the first drilling in western Canada was done in Manitoba, in search of salt as well as oil and gas. The results there were not encouraging.

Between 1907 and 1912 near McMurray, Alberta, holes drilled to nearly 1500 feet in depth penetrated thick salt beds. A churn drill was used, and no cores were recovered for analysis. "Later wells in the same district proved the presence of a thick bed of very pure sodium chloride with practically no other associated salts," according to Mr. Cole. A well drilled to 3201 feet at Unity, in west-central Saskatchewan, between 1927 and 1929 encountered rock salt near its bottom. Similar drillings elsewhere in the province also showed the presence of salt strata. After 1940 improved techniques permitted deeper drilling and many holes in Saskatchewan penetrated lower formations and proved the existence of a vast salt bed. (See map, p. 310)

Then, in January 1943, as Mr. Cole has noted, "A discovery of the first importance was made when a hole drilled by Norcanols Oil and Gas Limited (Imperial Oil) near Radville [in southeastern Saskatchewan] penetrated a series of salt beds approximately 250 feet in thickness at a depth of more than 7500 feet below the surface." Potash was definitely recognized in this well at a depth of 7653 feet.

The great depth of the potash bed ruled out any excitement over mining possibilities, but the discovery did quicken interest in exploration. Other wells were watched carefully for signs of potash nearer the surface, and in 1946 the first discovery of potentially recoverable potash was made in a well near Unity. At a
depth of 3466 feet an 11-foot bed was encountered, containing the equivalent of nearly 22 per cent potash.

After this discovery the provincial government, holder of most of the rights to subsurface minerals (a few private landowners still hold their mineral rights, also), gave some thought to developing the potash by means of a public company. The provincial Minister of Natural Resources, the Honorable J. L. Phelps, said, "Government enterprise is the only feasible way of developing production of this mineral." He added, in newspaper statements, "Conservation and maximum utilization of such deposits as ours should be the dominant principle in their development, since they are irreplaceable and essential to long-term agriculture. Such development cannot be expected from private capital, which seeks speedy and high returns from its efforts, and is therefore likely to strip a deposit of its richest concentrates, with the abandonment of marginal portions."

There was talk, in 1947, of provincial government plans to sink a shaft and build a plant at Unity, and in 1948 it was reported that the provincial government had tried without success to interest the federal government in joint development of the Unity potash field.

The government settled on a firm policy after that, and in July 1948 the provincial natural resources department announced that, under special terms laid out by the Saskatchewan government, potash deposits in the west-central area of the province were open to exploration by private interests.

Even then private interests were slow to commit themselves. It was not until February 1951 that a new Minister of Natural Resources for the province, the Honorable J. H. Brockelbank, announced that the first permit for exploration and development of potash in Canada had been issued in Saskatchewan to Bata Petroleum, Limited. Bata, a firm controlled by Saskatchewan residents, had made the original Unity discovery while sinking an exploratory oil well. By its contract Bata agreed to experiment with brine mining, and if that proved not feasible the company was
to sink a shaft and go underground. Bata's interests were taken over by Western Potash Corporation, Limited, of Calgary, not long after this.

Meanwhile reports of salt and potash in oil well cores had continued to come in. Pieced together, they pretty well defined both the limits and the form of the Saskatchewan salt basin. It begins in the north on the province's western border, about where the North Saskatchewan River enters from Alberta, and trends southeast to cross Saskatchewan's eastern border just south of the fifty-first parallel, southeast of Yorkton.

This salt bed slopes downward toward the south, so that near its northern limit it lies about 3000 feet below the surface, while in the vicinity of Weyburn, near the United States border where the Williston Basin extends in Saskatchewan, it lies 6500 feet or more below the surface. The salt bed is not continuous under the southern part of the province, nor is it of uniform thickness. A broad area in the central part of the province has been marked barren of salt. Here the salt has apparently been removed by dissolution in ages past. "A well near the edge of this area may have several hundred feet of salt in it; a short distance away another well will show no salt, and upper formations will be several hundred feet lower than in the salt-bearing well," R. V. Tomkins of the Saskatchewan Department of Mineral Resources reported to the 1954 western annual meeting of the Canadian Institute of Mining and Metallurgy.

The thickness of the salt bed varies from about 100 to 600 feet. The potash salts, where present, are usually found near the top of the salt formation. "In two areas where the salt reaches maximum thickness of over 600 feet, the best potash deposits are found. One follows around the north end of the barren area, and the other centres about 50 miles west of Yorkton," Tomkins said. No significant potash has been detected in the southwestern portion of the salt basin.

The salt bed is Devonian in age, and the potash, where present, is found in the upper part of the Prairie Evaporites formation.
Both Cole and Tomkins have noted that the Saskatchewan potash section consists of halite (common salt) with associated sylvite (potassium chloride) and carnallite (the hydrous chloride of potassium and magnesium). Pure carnallite contains slightly less than 17 per cent potash, while pure sylvite contains 63 per cent, so sylvite finds are more important. The most common form of Saskatchewan potash is sylvinite, an intimate mechanical mixture of halite and sylvite, comparing favorably with Carlsbad sylvite deposits.

Prior to 1951, during drilling of certain deep exploratory oil wells, cores were taken of the potash section, and chemical analyses of these cores have been published. Since the entry of private companies exploring for potash exclusively, the provincial mineral resources department is no longer having cores taken, and no new analytical data have been available for the past four years, although of course the potash companies have accumulated their own confidential analyses.

Also, since 1951 it has been common practice to run a gamma-ray log on each hole, showing the natural radioactivity of the formations. The radioactivity of a potassium isotope makes it possible to detect the potash section easily. Two hundred or more deep wells, about half of them in the salt basin, have been reviewed in this way.

This exploratory work has outlined the extent of the potash-bearing salt, and made possible some estimate of the amount of potash underground. The reserves are “almost unbelievably large,” in the words of the provincial Department of Mineral Resources. A paper by E. Y. Carlson of the provincial department, delivered to the 1955 convention of The Canadian Institute of Mining and Metallurgy, in Saskatoon, reported:

A review of the information from nearly 200 deep wells has indicated that Saskatchewan has vast deposits of potash but at a somewhat greater depth than those being mined elsewhere in the world. Considering those areas that have beds five feet thick or over, and a depth of less than 4000 feet, a reserve of five billion tons was estimated. If
the remainder of the potash ore which is found at less than 4000 feet is considered, the reserve should reach 30 billion tons. If all the known reserves regardless of depth are considered the reserve figures become fantastically large.

The phrase “fantastically large” has been interpreted in terms of perhaps 100 billion tons or more—greater than all other known world reserves combined. However, much of this potash in Saskatchewan may not be economically recoverable. Even the recoverable ore may be relatively costly to produce: depth to potash beds in New Mexico is 900 to 1700 feet below the surface, while beds from which production is contemplated in Saskatchewan lie from 2900 to 3500 feet below the surface.

Bata Petroleum, Limited, which drilled the Unity discovery well in 1946, and its successor, Western Potash, had an early start on all other companies. Bata held the first Saskatchewan permit for exploration and development of potash, issued in January 1951, and had been doing work in the few years before that. By August 1951 Western Potash had a brine leaching test-plant operating in the Unity field. In January 1952, A. S. Dawson, geologist and field manager of the company, reported that brining experiments were still in progress, and that he believed that the problems of recovering potash by this method could be solved. Research was continuing, meanwhile, at the company's field laboratory.

Then, in May 1952, the Saskatchewan mineral resources minister, Mr. Brockelbank, announced changes in potash prospecting regulations designed to speed up the exploration and development of the mineral. These changes were based on a “withdrawal” or “pre-exploration” arrangement to enable companies interested in the development of potash to take full advantage of information obtained during oil-drilling operations. Under the new system a company could obtain rights on as much as 100,000 acres at a rental of 1 1/2 cents an acre for a six-month period. No specific investment was required during withdrawal status. The system was intended to enable interested companies
to work with oil companies drilling in the same area. The potash concern could pay the cost of coring the potash and salt zones, pay part of the entire drilling costs, share in the costs of logging the well, or pay to have exploratory wells deepened to test the salt zones. “This would lessen the cost of potash exploration and make possible a faster and more thorough investigation of the province’s deposits,” Mr. Brockelbank said.

Shortly after he announced the new regulations governing withdrawals, Mr. Brockelbank received the first pound of potash produced in Canada. It was turned out of the field laboratory of Western Potash at Unity, by evaporation and crystallization of brine from a company well in the field.

By June 1952 The Potash Company of America, long established as a major producer in the Carlsbad, New Mexico area, had joined the search for commercial deposits of potash in Saskatchewan. Province officials heralded the company’s interest as “confirmation of the potential importance of our potash resources... a major step toward more complete assessment of the value and extent of Saskatchewan’s potash reserves.” Potash of America had come to Canada the previous year and had spent several months in general geological investigations in the salt basin in Alberta, Saskatchewan, and Manitoba. During this period the company obtained cores of the salt section from two oil and gas test holes in Saskatchewan, which stimulated their interest in the Saskatchewan deposits.

While Western Potash and Potash of America continued their activities (the latter as a Canadian subsidiary called Potash Company of America, Limited), other companies entered the field. Several of these were American potash producers from the Carlsbad area: United States Potash Company — the pioneer Carlsbad operator; Duval Sulphur and Potash Company; and International Minerals and Chemical, operating in Canada through a wholly-owned subsidiary known as Canadian Flint and Spar. Other concerns active in the search for potash in Saskatchewan in the fall of 1955 were Campana Oil of Calgary; Poplar Oils,
The Saskatchewan potash deposits lie about 1400 miles due north of New Mexico. Much of the blank area within the salt beds, keyed here as "no information," may contain important potash deposits which are known only to the developing companies.
Limited, of Calgary; Palmer Oil Development, of Calgary; General Petroleum of Canada, Limited; and interests designated as A. A. Allison, Toronto; M. W. Caldough, Toronto; and K. Kelman.

At that time they held, altogether, 2,661,642 acres under potash withdrawals, and three of the interests held 400,000 acres under potash permits: Potash of America holds one 100,000 acre bloc just east of Saskatoon and another in the Quill Lake-Lanigan area further east; Western Potash holds one 100,000 acre permit at Unity; and Campana holds a 100,000 acre permit in the Biggar area. When plotted on a map these holdings extend in an arc across the province, coinciding roughly with areas under which the potash is presumed to lie at depths of 3000 to 3500 feet.

The holdings also illustrate the system whereby the provincial government is directing and controlling the search for, and development of, potash. Companies can obtain crown-land rights by three methods: withdrawal, permit, and lease. Under a withdrawal, as we have seen, a company can obtain up to 100,000 acres for six months, at a rental of 1 1/2 cents an acre, and this is renewable for one additional six-month term. If a company locates a favorable area during the six-month withdrawal, it can then obtain an exploration permit on up to 100,000 acres for a maximum of three years at an annual rental of 5 cents an acre. It must spend at least $220,000 on exploration and development during the term of the permit. And no company can hold more than two permits at one time.

At the end of the permit period, or if production is undertaken before that, the company can obtain a twenty-one year lease on from 640 to 12,500 acres of the permit area, at an annual rental of $1 an acre. A permit area can only be explored, while a lease area allows actual production.

Lease terms are renewable for additional twenty-one year periods. A lessee must spend money equivalent to the amount required to erect a plant and other mining improvements, the total value of which must be estimated at the permit stage. When
a permittee applies for a lease he may also apply for a reservation of all or part of the area then covered by the permit which is not included in the lease application. Such reservations may be held for five years at 5 cents an acre. Before the five-year period is up a further reservation may be obtained for a period extending to the end of the lease term on a portion not larger than the leased area, at 10 cents an acre. The provincial government undertakes, among other things, to respect as confidential during the term of withdrawal, permit, or lease, information relevant to exploration and production details.

Western Potash has started sinking a 7 by 12 foot shaft on its Unity holding, and by mid-November 1955 Potash of America had head frame and shaft collar in place and was nearly ready to start sinking a shaft on its holding near Patience Lake, about fifteen miles east of Saskatoon.

"For further development of this resource," a provincial resources department summary has said,"much will depend on the success or failure of the companies engaged in shaft-sinking. There is no precedent in the world for sinking a shaft through the type of material that must be penetrated for such a great depth. Although similar techniques have been applied elsewhere, it was to a depth of about 2500 feet, whereas here the companies are attempting a shaft in excess of 3000 feet. Other companies will be watching with interest."

Other companies have indeed been watching with interest since Western Potash in the summer of 1952 let the contract for shaft sinking on its Unity holding. The estimate then was that the shaft would take twelve to eighteen months to sink. After a year of work, however, it was down less than 200 feet. Delays were caused by two water and sand zones. One section was successfully cemented after months of work, and a start was made on freezing for future digging. By July 1954, with a giant refrigeration unit working, Western Potash had sunk its shaft to the 500-foot level, and the 1160-foot level was reached before the company stopped
d digging in December 1954 to reorganize and refinance, with which it was occupied late in 1955.

The Potash Company of America started east of Saskatoon with plans to sink a shaft of 16 feet inside diameter for some 3000 feet through layers of semi-consolidated deposits that could be expected to cave. To prevent cave-ins, refrigeration was decided on from the start. The Palmer Oil Company was given a contract to drill twenty-eight holes, alternately 2000 and 3000 feet deep, around the circumference of a circle only 36 feet in diameter — specifications which left little margin for error. These holes were to serve to circulate a refrigerant to solidify a column of earth through which the mine shaft is to be sunk.

Speaking in Saskatoon in January 1955, G. F. Coope, president of The Potash Company of America, noted that the drillers were then two months behind schedule, but he predicted that the holes would be completed by May and that shaft sinking should start about August. His predictions were optimistic by a few months; actual shaft sinking had not started by mid-November 1955.

The uncertainty of such predictions emphasizes why spokesmen for the potash industry have been reluctant to discuss its future in Saskatchewan. Mr. Coope, speaking for his company alone, has noted that there still might be unforseen problems in shaft sinking — an operation which he has suggested might take two years or so. Thus it may be well into 1957 or even 1958 before the true prospects of potash mining in Saskatchewan are known.

And until they are known, many other details must remain indefinite. Potash of America, for example, has estimated that the company will have a capital investment of $15 million in its Saskatchewan operations by the time production begins, including mine and surface installations. But the scope of future operations, staff to be employed, and amount of production to be attempted will depend on successful shaft sinking, and on market conditions.
Mr. Coope has stressed that operations will be highly mechanized. Even at full production the planned operations of his company will employ hundreds of workers rather than the thousands mentioned in some reports. Potash of America, he has added, has no intention of building a company town on its holdings. Accommodations in nearby Saskatoon, a city of 65,000, where more than 5000 new houses, including several hundred new, low-rental multiple units, have been built since the war, are considered adequate. City schools are better than any on the holding could be. Most of the employees, company officials have added, will be hired locally, with key staff being brought in from the company's New Mexico operations to handle special equipment and train local employees. Except for technical, supervisory, and administration staff, the company has had no employees of its own in Saskatchewan during the operations preparatory to shaft sinking. Most of this work has been done by contractors, such as the drilling companies.

No potash company operating in Saskatchewan is aiming at the Saskatchewan market, because there will be none to speak of. Scientists of the University of Saskatchewan soils department point out that present potassium content of almost all soils in the province is adequate for the predominant cereal crops. In some areas, as in the new northern developments, tests with potassium fertilizers have shown that they are useful, but the acreage of these areas is low. In thirty to fifty years the situation might change, particularly if irrigation developments lead to such crops as potatoes or celery, but this will never be on a large scale.

There are markets in other parts of Canada, especially in the Atlantic Coast provinces. Canadian consumption of potash for the 1954-55 season ran over 88,000 short tons, most of it in this eastern area. But to reach the eastern Canadian market, Saskatchewan potash will have a cross-continent rail haul at rates which, at their most favorable, are still almost certain to price the Saskatchewan product above all competitors, including potash shipped by boat from Europe.
Indeed, Potash of America is planning to ship the expected products of its Patience Lake mine into the American market in the northern, central, and western states. Describing the potash business as highly competitive, Mr. Coope has said that his company is engaged in Saskatchewan operations with the idea of supplying the market from two sources and "to develop additional ore reserves which would ensure the company of extremely long life." In Saskatoon during the spring of 1954 he said: "Should a new operation be brought into production in Canada it would be as an adjunct to the present operation in Carlsbad, and not in any sense as a replacement. Under the most favorable conditions several years of development would be necessary before any production would be made. This conforms to the present market condition in which potash is in excess of demand."

Because this new resource lies hidden underground, and because most recent information about it lies hidden in confidential files, Saskatchewan citizens have not become much excited about it. Nor have their lives been particularly affected so far. But as development continues, potash and the other industrial minerals recently found under the prairies and the parkland will make great changes in a province which has been known as a major wheat producer, but which has also suffered all the hazards of a one-crop economy.