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PEACE RIVER IRON DEPOSITS

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ABSTRACT

The Peace River iron deposits are situated in the Clear Hills district of northern Alberta, about 300 miles northwest of Edmonton. The deposits are close to all-weather roads and lie within 35 to 45 miles of railway facilities at Hines Creek.

The deposits consist of flat-lying oolitic sandstone 5 to 30 feet thick, exposed along the southeastern slopes of the Clear Hills. The iron content of the bed grades between 32 and 35 percent Fe, mainly in the form of goethite ($Fe_2O_3 \cdot H_2O$). Resources have been estimated at 1,124 million tons of which 227 million tons are considered "proved" and 897 million tons are classed as "probable" or "possible" resources. On the basis of grade and volume, the deposits constitute the largest potential source of iron ore in the four western provinces.

The composition of the deposits presents some problems to beneficiation and smelting by conventional techniques. The major impurity is silica (SiO_2), present both as discrete quartz grains and as an intergranular cement (opal). Also, the phosphorus content of the deposits is high, although alumina and sulfur contents are relatively low. Consequently, the ore must be beneficiated to increase the iron and lower the silica contents prior to smelting in a blast furnace or electric-arc furnace.

A number of attempts have been made to upgrade or extract the iron content of the Peace River ore using magnetic separation, flotation, direct reduction, and acid leaching techniques. Large scale direct reduction tests carried out by the R-N Corporation at Birmingham, Alabama, in 1960, resulted in production of metallic briquets grading

INTRODUCTION

Sedimentary (oolitic) iron deposits of Late Cretaceous age underlie the Clear Hills district in the Peace River area of northwestern Alberta, about 300 air miles north of Edmonton. The deposits were known to settlers in the area in the 1920's and 1930's, but were "rediscovered" in the 1950's as a result of petroleum exploration activities and were subsequently drilled, sampled, and tested to determine their economic potential. However, it was apparent at the time that development of the deposits was dependent upon the establishment of an integrated steel industry in Alberta, for the deposits are too remote and of too low grade to exploit for export markets. This situation still prevails. However, the basis for establishing an integrated steel industry in Alberta is now on much firmer ground than 10 to 15 years ago, and it seems appropriate at this time to review existing knowledge of the Peace River iron deposits and to compare the economic potential of the deposits with that of alternative sources of iron ore in western Canada.

The report is divided into two parts. The first reviews the geology, composition, and resources of the Peace River iron deposits. The second summarizes aspects dealing with processing and economic evaluation of the deposits.

PART ONE: GEOLOGY, COMPOSITION, AND RESOURCES

Location and Access

The Peace River iron formation is located in the Clear Hills district of northwestern Alberta, about 300 air miles northwest of Edmonton (Fig. 1). The southern margin of the deposits is about 35 miles from a spur line of the Northern Alberta Railway which extends from the town of Peace River to Hines Creek. These deposits are within 5 to 20 miles of an all-weather gravelled road which extends northwestward from Hines Creek along the southern margin of the Clear Hills to Fort St. John, British Columbia.

A small-scale map showing the precise location of assessed areas is given in figure 2.

Geology and Terrain

The Clear Hills form a gently sloping upland which extends between the Peace River on the south and east and the British Columbia border on the west. The hills rise gradually from the surrounding wooded plains, and attain a maximum elevation of about 3,600 feet near their southwestern margin. Local relief is in the order of 1000 feet along the southern margin of the hills; to the north and east the hills slope gradually into the wide glaciated valleys of the Notikewin and Whitemud Rivers and their tributaries (Fig. 2).

The Clear Hills region is underlain by nearly flat-lying sandstone and shale formations of Cretaceous age, covered in most places by unconsolidated glacial deposits of variable thickness (Kidd, 1959; Green and Mellon, 1962). Bedrock exposures are scarce and discontinuous, being confined to some of the small streams which form a radial drainage pattern about the hills. The upper surface of the hills, beneath the glacial deposits, is capped by the Upper Cretaceous Wapiti Formation, which consists of sandstone and shale with thin coal (lignite) and bentonite interbeds. The iron bed is intercalated among dark grey marine shales of the Smoky Group which underlie the lower slopes of the hills and the surrounding lowlands (Fig. 3).

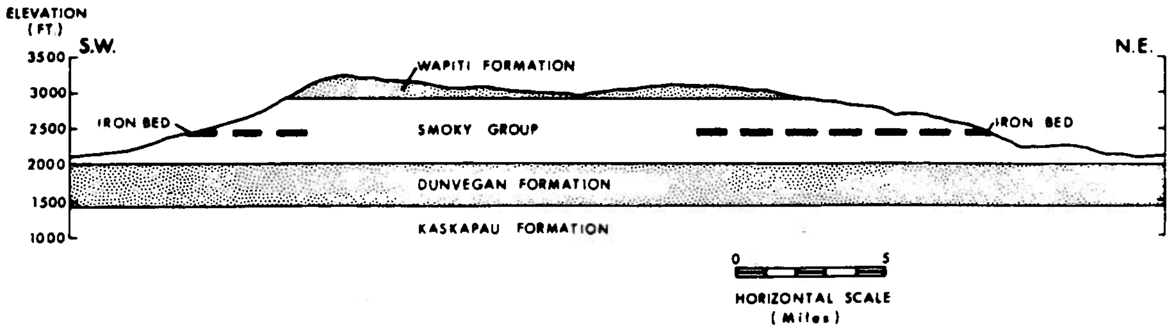

FIGURE 3. Schematic cross section through the Clear Hills showing the stratigraphic position of the oolitic iron formation.

The iron formation consists of dark brown to black oolitic sandstone with thin lenses and interbeds of hard sideritic ($FeCO_3$) "ironstone" and greenish grey mudstone. Near the outcrop margin the sandstone has been oxidized to form a soft, compact, reddish brown aggregate with harder carbonate-cemented lenses. Where present, the formation ranges in thickness up to 30 feet and forms a series of northwest-trending sandstone bodies which are exposed in places along the flanks of the hills at elevations between 2500 and 2700 feet. The mineable deposits are restricted to those areas near the outcrop margin where overburden is thinnest. The thickest and most widespread deposits underlie the northeast slopes of the hills, and thinner less extensive deposits have been found along the southern slopes north of Worsley (Fig. 2).

Scattered showings of oolitic sandstone also have been found in the northern, less accessible part of the Clear Hills, but these have not been explored in detail (Green and Mellon, 1962).

Composition

The Peace River iron deposit is an oolitic sandstone grossly comparable in mineral composition and texture to certain sedimentary iron formations in other parts of the world. The sandstone consists of densely packed oolites 0.5 to 1 mm in diameter, large nodular rock fragments, and angular quartz grains in a finely crystalline "matrix" composed of hydrated silica (opal), siderite (iron carbonate), and "clay" (Mellon, 1962). The oolite content (and hence the iron content) is highest in the upper part of the bed, decreasing progressively towards the base of the sandstone which grades into underlying dark grey shale.

The major iron-bearing minerals are *goethite* ($Fe_2O_3 \cdot H_2O$) and *siderite* ($FeCO_3$); small amounts of *pyrite* (FeS_2) and *glauconite* (Fe silicate) are found in some samples. Silica (SiO_2) is present as discrete quartz grains and as an amorphous opaline substance which forms part of the intergranular "matrix". This opaline substance (or "cement") is also a constituent of the iron-bearing oolites, having been co-deposited with goethite to form the outer concentric shells of the oolites (Plates 1 and 2).

Chemical analyses show that the various deposits are relatively uniform in average composition (Table 1). The salient features revealed by the analytical data are:

(1) Total iron (Fe) content averages between 32 and 36 percent. The Worsley deposits contain lower iron contents than the thicker deposits to the northeast (Swift Creek, Whitemud River, see Fig. 2).

(2) The silica content is relatively high, and the alumina content is correspondingly low.

(3) The phosphorus content is higher than desirable for a conventional iron ore. However, the sulfur content appears to be consistently low.

(4) The lime (CaO) content of the Swift Creek deposit is lower than that of the Worsley deposits. This may be caused by partial oxidation of the Worsley deposits in which siderite ($FeCO_3$) has reacted with groundwater solutions to form goethite ($Fe_2O_3 \cdot H_2O$) and calcite ($CaCO_3$).

(5) The water content is unusually high due to abundant opaline "cement".

and Natural Resources. Copies of the reports are now kept in the Industrial Minerals Files, Alberta Research Council (Edgar, 1961, 1962, 1964, 1965).

The distribution of areas for which resources have been calculated is shown in figures 2 and 4. The areas are situated along the southern flank of the Clear Hills 5 to 6 miles north of Worsley (block A), and along the southeast margin adjacent to the Notikewin-Eureka River forestry access road (blocks B, C, D).

The degree of precision associated with the resource estimates varies substantially among the four areas: the resources for blocks A and B have been calculated from more than 100 borehole intersections in each area, whereas those for blocks C and D are based on only 8 and 2 borehole intersections respectively. Consequently, the resource estimates in table 2 are classified as "proven", "probable", and "possible" according to the data available for each area.

The total resources of iron ore inferred to be present in the four blocks are in excess of 1.1 billion tons grading between 32 and 36 percent total iron (Fe). About 227 million tons of this are considered "proven" and underlie blocks A (Worsley) and B (Swift Creek). The remaining 897 million tons are classed as "probable-possible" and underlie blocks C and D. Additional drilling is necessary to confirm the extent and grade of the iron bed in blocks C and D and to determine the exact thicknesses and composition of overburden deposits.

Table 2. Reserves and grades of sedimentary iron ore, Clear Hills district, northwestern Alberta

Block	Reserves (tons)			No. of Drillholes	Average Thickness Iron Bed (ft)	Grade (% Fe)	Maximum Overburden Thickness (ft)
	Proven	Probable	Possible				
A	25,750,000	8,225,000	-	120	8	33	65
B	201,000,000	-	-	115	22	34	130
C	-	684,000,000	-	8	17	-	200
D	-	-	205,000,000	2	11	-	200
Total	226,750,000	692,225,000	205,000,000				

The most accessible resources are contained in block A, which extends as a narrow strip along the southern slope of the Clear Hills for a distance of approximately 10 miles. Although shown as a continuous band on figures 2 and 4, block A is actually a series of discontinuous sub-blocks, separated by erosional channels filled with glacial deposits. Overburden is thinner than in the other three areas, but the iron bed also tends to be thinner (5 to 10 feet) on the average. Block B, which straddles Swift Creek along the southern slopes of the Notikewin River valley, is less accessible than the deposits north of Worsley. However, it contains much larger "proven" resources of ore, owing to the fact that the iron bed is thicker (17 to 25 feet) and more continuous in areal extent.

Availability of Fuel and Other Raw Materials

Fuel accounts for a significant part of the total cost in producing pig iron or steel from iron ore. Fortunately, adequate supplies of coking coal and natural gas are available in Alberta, although fuel costs will depend to some extent on where the ore is beneficiated and smelted.

Coal

Good quality coking coal is mined at several localities in the Alberta Foothills. The nearest deposits to the Clear Hills district are at Grande Cache, approximately 160 air miles southwest of Hines Creek (Fig. 1), where McIntyre Mines Limited currently mines 1 to 2 million tons of coking coal annually for export to Japan. Alternatively, if the raw ore were shipped to Edmonton for beneficiation and smelting, coking coal is available from the Luscar area, about 160 miles west of Edmonton in the central Alberta Foothills.

Locally, some thin coal seams have been observed in the Wapiti Formation which caps the upper part of the Clear Hills (Fig. 3), about 300 to 500 feet above the iron formation. However, the coal is lignitic or subbituminous in quality, and the extent and mineability of the seams are unknown.

Natural Gas

Natural gas fields of moderate size are present along the southern margin of the Clear Hills, in close proximity to the iron deposits (Fig. 4). As of

R-N Process

The second and most thoroughly investigated conventional approach to processing the Peace River ore involved the R-N reduction process followed by magnetic separation (Samis and Gregory, 1962). This method was followed to make an iron briquet of 90 percent iron metal which could then be used in electric-arc furnace steelmaking.

Table 3. Composition of product resulting from R-N processing and magnetic separation of Peace River ore

Constituent	Percent
Total iron	90.00
Metallic iron	84.69
SiO_2	3.56
Al_2O_3	2.31
CaO	0.76
P	0.29
S	0.026
C	0.25

The R-N tests used coke as the reducing agent and natural gas as the heating source. The coke and ore were mixed and fed into a rotary kiln. Temperature of the kiln was kept below slagging temperature - about 900 to 1000°C - and closely controlled and measured by an array of multiple gas inlets and thermocouples placed along the length of the rotary kiln. The reduced ore was then put through a series of wet crushers and wet magnetic separators until a fairly enriched metallic iron fraction was obtained. The enriched and crushed ore was again put through a series of magnetic separators and finally yielded a product which, on filtration, had the analysis given in table 3. The iron recovery was actually 74.32 percent of the iron present in the ore, but due to spillage (which could have been prevented) the recovery was estimated to have been 83.17 percent of the initial iron.

The number of operational steps in the separation procedure is quite large, with 11 magnetic separators, 7 cyclones, and 6 ball mills involved in processing either all or part of the ore. In addition to these steps, there are settling ponds, filter, pumps, coolers, tabling and screening equipment, and if ferrous chloride is produced, or to a very high purity iron oxide if either ferric sulfate or ferric chloride salts are produced. The iron oxide can then be used to produce high purity sponge iron by conventional techniques.

One of the major drawbacks to the process is the loss of acid. Repeated washings were required to remove the residual acid retained by the gangue components or the undissolved pulp, and the residual acid is not recoverable. In addition to iron, Ca, Mg, Al, and Mn were dissolved by the acid to form various salts, and this acid is not economically recoverable. Phosphorus and sulfur, both of which are detrimental to high quality iron, also were dissolved during the solution trials.

The crystallization phase of the process did yield a pure iron salt in good quantities, with only minor silica and alumina impurities, but filtration presented some problems if large amounts of the opaline matrix of the ore (alumina-silicates) were dissolved during leaching. Therefore, steps were taken to reduce the amount of alumino-silicates dissolved and thereby alleviate the flocculent-type crystallization of the silica which caused filtration problems.

The leaching step, using HCl in 20 to 30 percent concentrations, dissolved from 85 to 95 percent of the iron present in the ore, depending on the reduction technique used. The filtration step recovered 85 to 95 percent of the iron as crystalline compounds; therefore, the overall efficiency of recovery of iron would be in the 80 percent range (0.90 x 0.87 x 100% = 78.3%). However, the iron product produced from the chloride salts is in the order of 99 percent Fe and therefore would demand a premium price for low-carbon steelmaking processes and for powder metallurgical applications.

Flotation Processes

An agglomeration or flotation process for upgrading the Peace River ore has been developed by the National Research Council (Puddington and Farnand, 1968). The process uses a ball mill with hydrophilic surfaces, an oil fraction,

Table 4. Results of reductive roasting of sized fractions of ore

Sample	Percent Iron in Concentrate	Reduction	Percent Iron Recovered	Percent Iron in Concentrate/ Percent Acid Insolubles in Concentrate
1	64.7	Strong	66	4.3
2	60	Strong	90	2.8
3	50.7	Mild	85	3.3

The use of high intensity magnetic separation on ore roasted under oxidative conditions yields a high recovery of iron but a low grade of product as compared to the reductive-roast experiments. A high intensity separation on straight ore, dried in air at ambient temperatures, yields little to no upgrading of the iron content.

Preliminary tests using an electrostatic separator give insignificant separation. The separations were attempted on ore from both an oxidative roast and a reductive roast. Also, ore dried at ambient temperature yields little or no separation. Highly classified ore fractions give slightly better beneficiations than do nonclassified material.

Leaching-type experiments using various mineral acids yield relatively high grade iron oxides. The technique is to leach the ore, or partially reduced ore, at high temperatures to yield as concentrated a solution of iron salts as possible. This concentrated solution is then separated from the gangue components by filtration or centrifugation and then evaporated to dryness. The dry salts are next roasted in air to yield iron oxides; a concentrate containing better than 60 percent iron and up to 6 percent alumina is obtained with sulfuric acid leaches. The possibilities of using this method should increase as the technology of steel mill pickle-liquor utilization develops (Conners and Butcher, 1971), although the high alumina content of the Peace River concentrates may present some problems during smelting.

The blast furnace uses high grade coke to ensure smooth flow of the burden through the stack. Usually, the ore is uniformly high grade and sized to approximately 1/2 to 1 inch; this ensures a smooth flow of materials and economical furnace-charging procedures. It has been found that removing gangue by mechanical means such as heavy-media separation, magnetic separation, electrostatic separation, or flotation is less expensive than removing it as slag in a blast furnace. One estimate is that the cost of simple mechanized removal of gangue is usually about 1/3 that of removing it as slag (United Nations, 1966). However, to take advantage of this cost differential, a crushing-beneficiation-sintering procedure must be added to the front end of the blast furnace operation to regain proper ore size.

The blast furnace is probably the least expensive method of processing medium grade and high grade ores. Self-fluxing agglomerates (sinter and pellets), properly sized, along with well-sized coke result in high production rates. Use of fuel injection with high-temperature blasts has aided in reducing the quantity of high grade coking coal required per ton of hot metal produced. If capital is a problem, but a cheap source of coking coal is available, non-byproduct-recovery coke ovens could save on capital requirements (Miller, 1966). Also, if high Btu-value gas (such as coke-oven gas or natural gas) is available for firing the stoves, economies in the size and number of stoves required may aid in reducing the overall capital cost of a blast furnace and its ancillary equipment. Single smaller-size blast furnaces are in operation for producing iron from medium grade ore, especially where the ore and coal are readily available (Konig, 1970, MacManus, 1972).

Direct Reduction Methods

Direct reduction methods now available produce a metal product which is about 90 to 95 percent iron. This iron is usually produced in the solid form so that subsequent melting is required for steel production. The several methods available for direct reduction can be put into various classes: rotary kiln processes, static and fluidized bed processes, moving

The *Midland-Ross (Midrex) process* is similar to the Wiberg process in that a countercurrent flow of hot reducing gases and iron ore occurs in a stack. The ore must be sized and of high grade to yield good quality sponge iron. The Midland-Ross process also is in commercial production.

Electric furnace reduction of ores produces a molten product of iron and slag. Ore and the coke used for reduction can be charged directly to the furnace, either cold or preheated and prereduced. Electrical energy requirements for cold-charging are in the order of 2,000 to 3,000 kwh; hot and prereduced-charging reduces the energy requirements to slightly more than 1,000 kwh. For melting of additional slag, it is estimated that 40 kwh of extra electrical energy are required for each 100 pounds of slag formed; thus, an ore of 50 percent iron and 15 percent SiO_2 requires a minimum of 500 kwh just to melt the slag components. If high grade reactive coke is not used, electrical consumption can increase greatly. The coke requirement changes only if prereduced ore is fed to the furnace, and then only if no coke is used in the prereduction step. The burden must have physical characteristics about equal to those required for the blast furnace, since the basic reduction and smelting operations are the same. Many problems have arisen from trying to feed preheated and prereduced ore directly to the electric steelmaking furnace. Most of the originally designed units have been abandoned, and straight feeding of cold ore and coke to the electric furnace is preferred (B. R. Nijhawan, pers. comm.).

The electric furnace produces molten slag and iron which can be tapped occasionally to allow for continuous processing. The molten iron can be formed into cold pig iron or directly charged to a steelmaking furnace, thus saving on remelting costs. The off-gases from the electric furnace should be used to take advantage of their high carbon monoxide content. A logical place to use off-gases is in the prereduction step. Experimental and commercial processes which incorporate the prereduction and preheating steps in electric smelting of iron ore are the *Strategic-Udy, McDowell DLM,* and *Elektrokemisk processes.* The *Lubatti* and *Tysland-Hole electric furnace procedures* do not incorporate these steps.

(A) a high grade hematite, 67% Fe,

(B) a medium grade concentrate obtainable from the Peace River iron deposit, 60% Fe, 20% SiO_2, 0.3% P, and 2% CaO,

(C) crude Peace River iron material, 35% Fe, 30% SiO_2, 0.3% P, and 4% CaO.

The relative values using the Polish formula for C, B and A are 1:5.0:8.5, respectively, and the ratios using the Czechoslovakian formula are 1:6.0:9.2, respectively. A formula developed by Swedish interests is available, but sufficient production data to calculate the relative values are not. Russia did not supply a base formula, but did supply the relative values of various ores produced in Russia, together with mineral analyses. Table 5 gives the relative values of several ores produced in Russia; these may be compared to the selected ores, A, B and C.

Table 5. Relative values of several ores produced in Russia

Ore	% Fe	% SiO_2	% CaO + MgO	Relative Value
(1)	47	30	0.2	0.126
(2)	56	18	0.2	1.042
(3)	58	17	1.0	1.183
(4)	68	3	0.16	2.039

Ratio of relative Fe values = 1 :8.26 :9.39 : 16.2

Another method of estimating the value of iron ore involves the coking consumption. French and British formulas for such estimates are available; they yield the following consumptions in kg of coke per ton of iron produced:

French: C, 1,038 kg/ton; B, 662 kg/ton; A, 540 kg/ton
British: C, 1,094 kg/ton; B, 654 kg/ton; A, 507 kg/ton

The following values for coke consumption taken from a graph produced by Konig (1970) show a similar trend in coke requirements for the three ores:

German: C, 900 kg/ton; B, 650 kg/ton; A, 600 kg/ton.

Table 6. Relative values of A, B, and C ores in different countries

Ore	Polish	Czechoslovakian	U.S.S.R.	U.S.A.	German
C	1	1	1	1	N.A.*
B	6.0	5.1	9.4	3.0	2
A	9.2	8.5	16.2	3.5	3

*Not available.

From the series of relative values in table 6, the medium grade concentrate (B) is worth roughly 1/2 to 2/3 the value of the high grade concentrate (A) for smelting under blast furnace conditions. These relative values also should apply to some degree to electric smelting and direct reduction processes. The above calculations are only rough estimates and ignore other values such as reduceability, texture and physical properties of the ore, undesirable impurities, moisture content, and varying energy costs.

If an offshore or domestic high grade iron ore concentrate were available in Edmonton at $23 per ton (unpublished economic survey, 1973), then a medium grade concentrate should be worth between $11.50 and $17 per ton. A 5 percent reduction in the silica content - from 20 percent to 15 percent - would increase the ore value by greater than 10 percent. It has been suggested in a previous section of this report that a concentrate of 60 percent iron and 15 to 20 percent silica conceivably could be obtained by beneficiating raw Peace River ore.

It must be emphasized that the actual value of an iron ore can be determined only by use. The value of the ore also will vary with the process used. The cost of removing molten slag is usually less on a high-tonnage basis in a blast furnace than it is in direct reduction and electric smelting processes, especially if coking coal is readily available.

Cost Estimates for Iron- and Steel-making

A suggested procedure for utilizing the Peace River iron deposits involves the following steps:

In addition to operating costs, capital outlay in the order of \$24 to \$40 per annual ton of iron metal is required. Capital outlay could increase to \$50 per annual ton iron metal, if the SL/RN prereduction-electric furnace technique were used.

The Japanese estimate for iron production is \$38 per ton hot metal (Lounie, 1971). Raw materials (ore and fuel) are \$28, labor \$2, and fixed charges \$7. Capital costs for a blast furnace are estimated to range from \$20 per annual ton pig iron (6,000 ton per day plant) to \$60 per annual ton pig iron (2,000 ton per day plant)(Konig, 1970).

These estimates can be applied to the Peace River iron ore as shown in table 7, if one assumes the ore to be available in the form of a self-fluxing pellet grading 52 percent Fe.

Table 7. Estimate of costs to process Peace River iron ore

	Costs/ton of iron	
Item	Large-scale plant	Small-scale plant
(1) Iron pellets (52% Fe)*	\$17	\$27
(2) Fuel (coke, average value)	\$20	\$20
(3) Labor and fixed charges**	\$12	\$18
TOTAL	\$49	\$65

*Costs are based on estimated pellet values of \$9.95/ton and \$15.80/ton, respectively, converted to costs/ton of iron metal.

**Based on one-third the cost of pellets and fuel.

Other estimates are available for comparison of costs for various processes of converting iron ore to steel. For example, Cartwright (1971) shows a graph in which, at prevailing rates of energy, the estimated costs for the SL/RN/arc furnace and B.F./BOS processes "cross" at \$52 per ton and at a capacity of about 1.5 million tons per year. The cost per ton increases less rapidly for the SL/RN/arc furnace as the annual capacity decreases. The minimum capacity of the blast furnace is estimated at about 1 million tons per year. As the price of electricity decreases with respect to coking coal, the cost of steelmaking by the SL/RN/arc furnace is again favored.

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Appendix

Peace River Iron Deposits: History

In the 1950s, Alberta was in the grip of oil fever, but for a brief period during that decade, oil was not the only resource in the limelight.

In 1953, petroleum exploration activities in the Clear Hills area of Alberta, about 300 miles northwest of Edmonton, turned up traces of iron ore and news of the find sparked a wave of excitement that has periodically rippled through the province ever since.

It appeared that the interest and enthusiasm which greeted word of the discovery was well-founded, particularly when subsequent drilling, sampling and testing revealed several major deposits in the Peace River area containing millions of tons of low-grade iron ore.

For a province forced to rely on scrap iron to feed its modest steel industry, the prospect of a vast source of raw material within its borders was enough to produce heady visions of massive mining and smelting operations and speculation that a significant integrated steel industry could eventually emerge in Alberta.

Perhaps nowhere was the news more favourably received than in northwestern Alberta communities such as Peace River, Hines Creek and Fairview -- centers that stood to profit from any major iron mining and processing developments in the area. But to some residents of Fairview, it came as no surprise to hear that vast deposits of iron ore lay beneath the tree-covered slopes of the Clear Hills and along the banks of the winding creeks that emptied into the Peace River. They had been part of a similar discovery some 30 years earlier.

The early discoverers were Cliff Chalmers, a farmer from the Waterhole District, about 10 miles south of Fairview; Rod Redfern, a pioneer horse rancher in the Hines Creek area; and John Lundstrom (better known as John the Swede), a trapper who also homesteaded near Eureka River.

Like others in this remote area (often there were only two or three people to a township), the three turned their hand to a variety of jobs in order to make a living. In addition to farming, Chalmers worked in his father's

PLATE 3. *Cliff and Bea Chalmers and Rod Redfern on their way to stake claims, July 1925.*

PLATE 4. *Mrs. Chalmers and Mrs. Redfern relaxing in camp.*

As well as five riding horses, the tiny procession included 15 packhorses loaded with supplies for their own expedition and for Lundstrom's traplines. Bringing up the rear was Peggy, a small spotted dog belonging to Mrs. Redfern.

Bea Chalmers, the only member of the group still living, recalls that they were away from home for about 60 days -- a period in which they saw no one but the members of their own party. Despite the fact that they had to cover miles of burnt-over muskeg, follow narrow trappers' trails through heavy bush, negotiate a variety of streams, rivers and hills, and put up with the constant onslaughts of hungry mosquitoes, she recalls the trip as primarily a pleasant experience.

She explains that she and Mrs. Redfern were simply "along for the ride".

"We didn't make a meal or wash a dish. John the Swede made breakfast, Rod wrangled the horses and Cliff helped with the packing and made the supper."

She admits that, before the trip, friends warned her that she would likely regret her decision to go along. "Once or twice I wanted to get away by myself and have a cry. The worst part was the heat. But then I'd get over it. I remember we had a lot of laughs. I wouldn't want to go through it again, but when you're young, that sort of thing can be fun."

Once at the deposit, the women fished or read and played cards at camp while the men were busy staking their claims. John the Swede went on to cache his supplies along his trapline.

The men were careful to stake their claims according to regulations, Bea recalls. Pine posts were squared and pointed, then set in rock at the prescribed intervals.

"Great thought went into the choice of names for the claim markers," she says. "I chose 'Elk Horn' for the name of the town in Wisconsin where I was born. Mrs. Redfern chose 'Onyx' meaning 'unexpected'." No record was kept of the names chosen by the men but Bob Bieraugle, a farmer at Notikewin who trapped in the Swift Creek area during the '20s, recalls seeing the stakes in 1926, one of which bore the name "Coyote".

But that day became more remote as the men became involved in other pursuits and no move was made to register the claims for almost three decades.

Eventually Rod Redfern and his wife left the area. He worked as a brand reader in Calgary; then they moved to Saskatchewan, where Mrs. Redfern died. Redfern continued to be interested in the iron ore, however. In 1939, he wrote from Moose Jaw to Alberta's Minister of Mines to inquire about the analysis of samples shipped to Edmonton by Chalmers about 1925. Although the department queried the provincial analyst on the matter, no reply was kept on file and it appears the matter was dropped. In his letter to the provincial analyst, the Deputy Minister of Mines asked for a copy of the analysis, adding: "it would mean a great deal to the Province if an iron deposit were to be discovered in Alberta."

It's not known if Redfern ever received a reply to his letter. He returned to Alberta and took up residence at Longview. According to the Chalmers family, it's unlikely that he ever lost his prospector's interest in the iron ore "find", but he died before events of the '50s focussed attention on the resource.

In the late '20s, Cliff and Bea Chalmers, along with other residents of Waterhole, moved north to form a new settlement at Fairview, on the route of the Northern Alberta Railway. Cliff farmed there until his death in 1970 and his wife continues to live there. The couple had three children -- Rod and Jack who both farm at Fairview, and Glee, a daughter who is married and lives at Crystal Springs, Alberta.

John Lundstrom worked on his homestead at Eureka River -- but his first love remained trapping and he was considered one of the most successful trappers in the area. Jack Chalmers recalls making visits to several of John the Swede's "spotless" cabins strung along his traplines north of Eureka River. Lundstrom died in 1958.

Iron ore was probably the last thing on the mind of drilling crews working for Phillips Petroleum Company in the Swift Creek area in 1953; but traces of "oolitic hematite" were noted in Phil C No. 1 well that year, and deposit in the '50s. Travelling on horseback, he was accompanied by Harris Davis, a prospector from Hines Creek -- a man always intrigued by word of a "strike". Although the two were apparently unsuccessful in locating the iron deposit, Harris was later involved in trying to help Chalmers find financial backing for development. Later still, he was to find his own fortune in the form of a rich copper deposit in northwestern B.C. Now the owner of Davis Keeys Mine, Harris spends much of his time in Fort Nelson.

Lambert, now a parks official in the Yukon, was involved in four of the trips. He recalls attempts to relocate the site were made by parties on foot, on horseback, on snowshoes and with the help of snow vehicles. The various expeditions approached the site from different directions -- some travelling north from Eureka River and others heading west from the Mackenzie Highway. The aim was to make a definite location of the site, restake the claim and bring out samples.

Conrad Rudd, a farmer and trapper now retired to his cabin north of Worsley, was a member of a party which was successful in reaching the site, probably in 1954. "Lambert, Chalmers and I drove to Hotchkiss, north of Manning, in the truck, then we rode west on horseback for two days to reach the spot," he says. "I saw the old stakes all rotted down -- squared old jackpines that had been used to stake claims." According to Rudd, about 15 pounds of ore were brought out and sent to Edmonton. He claims the samples graded about 37 percent iron.

Jack Chalmers recalls accompanying his father to the site in 1954. Also on this expedition were Lambert and Jack Cheshire, a trapper from Eureka River. For the young Chalmers, then 20, the trip was "a real adventure". The party hired a bombardier at Manning and headed almost straight west toward "the iron ore mountain". When the snow got too deep for the machine, they took to snowshoes. The men reached the Third Battle (Notikewin), followed the river for a short distance, then turned south and west.

"We had to snowshoe for 25 miles or so. I had never been on snowshoes before and I spent quite a bit of the time flat on my face."

The men didn't give up, however. There was still a remote chance a mining company might be persuaded to finance further work on the claims, and perhaps even put up the money for a full scale development of the ore. By this time, Chalmers, a diabetic, was in failing health, and it was Lambert and Olstad who continued to try to generate some interest in the deposit. In 1955 Lambert guided a geologist from Premier Steel to the site, but by this time it was apparent the discoverers of the iron were not likely to benefit from its development.

In 1956 the Research Council of Alberta assigned Dr. Donald Kidd, a geologist, to study the iron ore deposits of the Clear Hills and Swift Creek areas. He spent two summers in the area and later reported that the deposit north of Worsley along the southern slopes of the Clear Hills contained well over 25 million tons of ore while the Swift Creek deposit contained more than 200 million tons.

Dr. Robert Green of the Research Council accompanied Kidd on a trip to the Swift Creek deposit. He notes that in their contacts with several area residents, no mention of the earlier find was made and it was believed by Research Council personnel that the discoveries made by the seismic crews in the '50s were the first in the area.

Although pioneer residents claim they were always vaguely aware of the presence of iron in the rocky outcropping and had noticed the rusty color of water in the bogs and muskeg patches, no one appears to have realized either the extent or the significance of the deposits until the late '50s.

One oldtimer comments: "We always knew there was iron there but we just didn't get very excited about it."

Further studies of the iron ore were undertaken by Premier Steel Mills Limited. Overburden was stripped from the Worsley deposit and in 1957 Premier Steel took a 50-ton sample out of the pit. Kidd was believed to have brought the first large sample out of the Swift Creek deposit in 1956 -- a 120-pound load which was carried out by packhorses.

Then came the '70s -- and worldwide shortages of steel. Once more attention focussed on the desirability of a western Canadian steel industry fed by iron ore from the province's healthy deposits. In addition to the Peace River ore, deposits were known to exist in the Crowsnest area. According to R. Green of the Alberta Research Council, the Peace River iron offered the more attractive alternative because ore from the Crowsnest area lay in deposits which were unpredictable, faulted and potentially difficult to develop.

In 1973, Fred Peacock, then Minister of Industry and Commerce, announced that development of the Peace River iron ore deposits was now considered economically viable. He promised that the province would have "either a sponge (pig) iron or steel plant within the next five years."

Renewed interest in the iron, he said, was the result of continuously increasing demand for steel and a U.S. embargo on scrap metal. He noted that a Japanese firm was interested in establishing a steel plant in Alberta with a capacity of 350,000 to 400,000 tons a year and the Peace River deposits represented the logical feedstock.

A brief item in the Edmonton Journal, noting Peacock's announcement, stated that the iron ore had been discovered two decades earlier by seismic crews working in the area. That comment brought an immediate response from Fairview's Gib Oliver. Then he was 88 but alert and in good health. He vividly recalled events surrounding the earlier find -- and wasted no time in giving the government the details. Gib pointed out that he, personally, had seen samples of iron ore from the Swift Creek area some three decades earlier.

"I felt that the men who made the discovery back in the '20s should at least receive some credit for their part in this."

A two-year federal-provincial study by the Alberta Research Council and Canmet in Ottawa is currently under way to determine the economic feasibility of developing the deposits. If a decision is reached to proceed with development, the implications for residents of the area will have to be determined.

There is a possibility that a processing plant could be located in the Peace country; ore of the Swift Creek deposit would be most easily accessible from the east, by a rail spur from the Slave Lake Railway.

However, answers to the questions surrounding the possible development of this abundant and long undisturbed resource will have to await the outcome of the current study and others that will likely follow.

Meanwhile, in the Fairview area, a small group of people associated with the original discovery watches with more than casual interest as the story of Alberta's iron ore unfolds.

For Chalmers, Redfern and Lundstrom, their discovery brought nothing in the way of fame or riches -- but perhaps it should ensure them a place in Alberta's history.

Bea Chalmers sums it up this way: "I think some day there will be a big development. I feel Cliff and the others should have some recognition -- but I certainly don't feel bitter that I won't get rich over it. The years passed so quickly. We were all keyed up again in the '50s, but by then it was too late. We'd just like our grandchildren to know about it."