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The Julian Deposit, A Geologic Summary Report

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JULIAN IRON CORPORATION

THE JULIAN DEPOSIT

A GEOLOGIC SUMMARY REPORT

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RESUME

Exploration examinations of the Julian Deposit of metamorphosed iron formation conducted by Canadian Javelin have served to indicate the presence of a large reserve of concentrating type iron ore quite similar to other deposits in the Wabush Lake District of Labrador - Newfoundland.

The deposit is a cross folded syncline composed of numerous stratigraphic members, sub-members and individual horizons distinguishable on a mineralogic and textural basis, quartz-specular hematite and martite account for about 90% of the material. The mean of the log normal distribution iron content is indicated to be 35% iron.

The exploration stage has been completed; all future work on the deposit should be of a development stage nature. The remaining problem is to relate geology and metallurgy so as to volumetrically prove the metallurgical characteristics of the ore deposit.

INTRODUCTION

PURPOSE

The detailed exploration information concerning the Julian Deposit of concentrating type iron ore is to be found in the numerous reports covering the various programs that have been conducted. This report summarizes the information of a geologic nature about the deposit.

HISTORY

The existence of iron formation in the Wabush Lake District has been known since about 1914. Basic geologic information dates from the 1930's, but systematic exploration for iron ore deposits began only in the 1950's. The Julian Deposit was examined by NALCO geologists in 1953, Canadian Javelin's examinations date from 1954.

The deposit was investigated in 1956. This initial work suggested the presence of a deposit of concentrating type iron ore extending some 6000 feet across the peninsula and varying from 1800 to 3400 feet wide. Four holes were drilled in 1957, followed by 5 more holes in 1958. These holes were drilled under the supervision of Pickands-Mather & Co. who were then acting as agents for Canadian Javelin. Javelin conducted geologic surveys in 1959, test pitting in 1960, trenching, engineering surveys and opened a road to the property in 1962. More geologic-geophysical and engineering surveys were conducted in 1963 as well as bulk sampling.

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LOCATION

The deposit is situated at the north end of Wabush Lake, Labrador, Newfoundland, about 20 road miles from the towns of Wabush and Labrador City. A natural railway route about 8 miles long exists between the deposit and the Wabush Lake Railway. The deposit forms the core of a hill some 200 feet high in the peninsula separating Wabush and Julienne Lakes.

GEOLOGIC SETTING

The iron deposits in the Wabush Lake District are a part of the southern extension of the Labrador Trough. This Proterozoic belt of sedimentary rocks extends over 700 miles through the heart of the eastern Canadian shield and is one of the largest and best preserved pre Cambrian mobile belts in the world. The western part of the trough is composed of micgeo-synclinal formations and contains a widespread Lake Superior type iron formation of great economic importance as one of its principal formations.

The northern edge of the younger Grenville Province cuts across the trough a few miles north of the Wabush Lake District, and all trough formations south of the Grenville Front have been completely recrystallized through processes of regional metamorphism. Cherty hematite-magnetite iron formation north of the Grenville Front is represented by coarse grained quartz-specular hematite-magnetite iron formation south of the front. The iron content remains about the same, it is the great increase in crystal size which permits the separation of the iron oxides by gravity concentration methods. This feature has led to the establishment of two multi million ton iron ore operations in the district in the past few years.

There are three basic types of iron formation in the district, quartz-iron oxide, iron silicate, and iron carbonate. These metamorphic types reflect differences in the composition of the iron formation as it was deposited in the form of chemical percipitates. The composition varied systematically in space and time in response to shifts in the physio-chemical environment. These variations are represented by the presence of systematically arranged oxide, silicate, and carbonate facies of the iron formation.

Oxide facies is generally found in the upper part of the iron formation and towards the west. The reducing environment facies typically occur in the lower part of the iron formation and predominate towards the east. The facies-types grade into each other and intermixed subfacies is common, particularily in the oxide where changes in the ferric-ferrous iron ratio has led to intermixed specular hematite and magnetite on all scales. The oxide facies-type is the only one of economic importance because the iron in the othertypes is non recoverable grunerite or ankerite.

The relative proportions, thickness, and mineralogy of the types is variable throughout the district. The character of any particular deposit depends not only upon the facies within it, but also upon its location with respect to the regional metamorphism and deformation effects of the Grenville Event. In general, metamorphic rank increases southeastward of the front, and as rank increases, metamorphic effects range from virtually nil through partially recrystallized to completely recrystallized. This is also expressed by an increase in grain size, which in some high rank areas may reach the 1/8-1/4 inch range. The Julian Deposit lies just south of the area of partial recrystallization, and there are a few small seams or lenses in the deposit which still have a cherty texture. The order of recrystallization was quartz followed by the iron oxides.

There have been two episodes of deformation in the Wabush Lake District. The miogeosynclinal Trough formations were folded and thrusted towards the west during the rise of the eugeosynclinal zone. These folds are well shown in the Knob Lake area in the central part of the Labrador Trough. They trend parallel with the trough, have sub horizontal axes and consist of repeated overturned anticlines and synclines with sub isoclinal limbs dipping easterly.

These folds, within the Grenville Province, have been refolded to various degrees about axes which plunge to the south-east on the limbs of the earlier folds. Surface expressions of the formations are typically accurate and the internal con-struction of the deposits is usually a combination of both periods of deformation. The size of individual deposits is to a large extent dependent upon the structural and topographic relationships. Post metamorphic erosion has removed most of the early anticlines so that synclinal troughs are the loci of large deposits.

Tertiary age oxidation and leaching affected the deposits, but because of the large grain size the effects were much less severe than in the Knob Lake area where soft ores formed. Leaching removed the carbonate content and some of the intergrain cement to produce the friability so common in the district. Concurrent oxidation converted magnetite to martite and distributed secondary iron oxides and hydroxides within the iron formation. Glacial erosion removed the leached-oxidized capping in some parts of the district so that both altered and unaltered deposits occur. One mine is operating on unaltered ore, the other on altered ore.

There are tremendous reserves of this concentrating type of iron ore in the district. The selection of which ore to mine is more a matter of the internal nature and size of the body in relation to accessibility and concentration plant sites than anything else.

The Julian Deposit is the only exposed part of the belt of iron formation which extends through the center of Wabush Lake, across the peninsula and into Julienne Lake to the east. The hill was an island in the glacial lake, and above the old shore line at about elevation 1800 feet there is only a thin skin of overburden measurable in inches to a few feet.

GEOLOGIC-GEOPHYSICAL SURVEYS

The initial mapping and magnetic surveys of 1956 were the basis for the 1957 and 1958 drilling programs. The 1959 geologic study related the surface and drill hole data and produced the first appreciation of the internal nature of the deposit. The trench exposure in the late fall of 1962 showed that there was more internal variation than had been expected. This led to the more comprehensive geologic-magnetic investigations conducted in 1963.

In this last investigation, the deposit was magnetically surveyed at 25 foot stations on lines 125 feet apart, and locally on 62 foot lines, in order to obtain a saturation magnetic survey. The object was to locate, identify, and follow specific magnetic highs and lows along the deposit. This was accomplished and was of great value in correlating the mineralogic varieties between outcrops, which in turn helped identify stratigraphic horizons and members which can be traced along the length of the deposit.

The 1-400 foot maps accompanying this report are simplified versions of the 1-100 foot interpretation based upon these latest investigations. The interpretation is naturally subject to revision when more data becomes available.

DIAMOND DRILLING

The four holes drilled in 1957 followed the previous

Wabush Lake practice of keeping the casing to within 5-10 feet of the bottom of the hole as much as possible in order to insure correlation of core and sludge samples in the very friable ground. This practice was not followed in the 1958 program because the results did not justify the great effort involved. Core recovery has always been a problem in the oxidized-leached iron formation, but the Wabush experience has shown that the recovered, harder core does yield a fairly representative indication of the type of material penetrated as was demonstrated by the rotary precussion air lift drilling performed at Wabush following diamond drilling.

Condensed logs of the holes are included wherein descriptive remarks and assay averages are grouped as near as possible with the geologic interpretation. The nine holes presently on the property total 3477 feet.

GEOLOGY OF THE JULIAN DEPOSIT

MINERALOGY

The post metamorphic mineralogy of the deposit was basically a trimineralogic mixture of crystaline quartz, specular hematite and magnetite with subordinate and sometimes localized amounts of carbonate, anthophyllite, grunerite, and fine grained hematite-manganiferous seams. Post metamorphic leaching removed the carbonate and anthophyllite. Oxidation converted magnetite to martite, spread a certain amount of red hematite and limonite within the deposit and converted the grunerite schist to siliceous goethite.

The iron oxides occur in three forms:

a) Coarse grained, platey and bright specular hematite
b) Medium grained, dull granular hematite, martite
c) Fine grained, earthy hematite-limonite, or crystaline goethite-hematite.

These fundamental forms, when occurring with the ubiquitous quartz and other textural features, permits the visual recognition of nine basic mineralogic varieties of the iron formation which occur in mappable units reflecting internal stratigraphy and original composition. These varieties are:

1) Quartz-specular hematite, clean, massive or banded.
2) Quartz-specular hematite intermixed with quartz-granular hematite, often thinly banded but massive in bulk, usually accompanied by red hematite or limonite.
3) Quartz-granular hematite (martite), often massive and accompanied by red hematite or limonite-goethite.
4) Quartz-specular hematite with leached anthophyllite remains or casts, generally schistose and pinkish.
5) Ferruginous quartzite, lean iron formation, the oxides are generally granular hematite.
6) Blue hematite, hard, nearly aphanitic, banded, brittle.
7) Manganiferous, black variation of the blue hematite above, may be accompanied by secondary pyrolucite etc.
8) Siliceous goethite, a mixture of silica and secondary material (largely goethite), brown in color.
9) Introduced, small veinlets of intermixed quartz, hematite and limonite-goethite, represents metamorphically migrated material.

The first three varieties probably account for about 90% of the material in the deposit, somewhat over 90% including the fourth variety and probably about 5% is composed of the remaining varieties. The distribution of these varieties in bands along and across the deposit leaves little room for doubt that they are stratigraphic horizons.

STRATIGRAPHY

The regional stratigraphy in the Wabush Lake District is readily correlatable with the type locality at Knob Lake in spite of the regional metamorphism.

KATSAO. The Katsao is a thick sequence of garnetiferous, biotite-feldspar gneiss derived from argillaceous sediments. It occupies a large area north of the Julian Deposit and also tothe south of the overlying marble.

DULEY MARBLE: The Duly marble is a coarse grained, quartzose meta-dolomite which occupies a belt immediately south of the Julienne peninsula. It pinches out northward and no exposures are known north or west of Wabush-Julienne Lakes.

WAPUSSAKATOO QUARTZITE. The Wapussakatoo quartzite is a thick, massive, white quartzite. It outcrops on both sides of the Julian Deposit and is some of the evidence for the synclinal interpretation of the deposit.

MUSCOVITE SCHIST. There is a thin but persistent muscovite schist in the district which typically lies between the iron formation and the quartzite. This unnamed formation is the equivalent of the Ruth Slate at Knob Lake. It has been found in holes 3 and 5, and undoubtedly accounts for the little valley along the south side of the deposit.

<u>WABUSH LAKE IRON FORMATION</u>. The iron formation is the youngest trough formation present at Julian. The overlying Nault does not occur due to the level of erosion of the syncline. The iron formation has a stratigraphic thickness of 600 feet or more, and is composed of numberous members, sub members and horizons of metamorphosed oxide facies overlying a thin basal silicate facies.

For convenience it can be divided into lower, middle, and upper units generally recognizable on the basis of mineralogic varieties and other evidence. However, the general lack of unique and distinctive horizon markers makes the present interpretation somewhat tentative, though there is little doubt about the fundamental nature of the deposit.

The magnetic contacts on both sides of the deposit generally do <u>not</u> mark the geologic contact of the iron formation with the muscovite schist. The reason is that a basal siliceous goethite is so completely oxidized that there is no susceptibility contrast. The magnetic contact generally lies within the iron formation and roughly corresponds with the bottom of the first specular hematite bearing member where the overburden is shallow. Where the overburden is deeper, the magnetic response from the edge is weak and the contact shifts further inward. The specular hematite itself is para magnetic and the evidence on hand indicates that it is the specular hematite content of the iron formation that is largely responsible for the magnetic response rather than the 1% or less magnetite content.

LOWER IRON FORMATION. The lower I.F. is composed of two principal members, the basal siliceous goethite member overlain by a quartz-spec member characterized by the localized presence of the leached anthophyllite, herein called spec-silicate.

The siliceous goethite is found in several brown and irregularly textured outcrops on the south side and in hole 4. On the north side, it is found in the far northern end of the trench exposure and in holes 3 and 5. It appears to be around 50 feet thick. This material is not considered to be suitable plant feed.

The qtz-spec-silicate lies immediately above the siliceous goethite. The change of facies from silicate to oxide represents a shift in the depositional environment, one manifestation of which may have been the presence of magnesia and perhaps alumina which were deposited in the second member and which upon metamorphism yielded the anthophyllite which is used to identify this member. Similar anthophyllite bearing qtz-spec horizons appear near the base of the oxide facies elsewhere in the Wabush Lake District. In the unaltered state they present a mining problem, but at Julian the anthophyllite is all leached away and only a pinkish-white discoloration marks their former presence.

The leached anthophyllite occurs in irregularly distributed bands or lenses and is quite schistose. Otherwise, the member is a typical banded qtz-spec with subordinate amounts of granular hematite. The unit is 100 or more feet thick and in addition to numerous outcrops is found in all drill holes except 8 and 9.

The qtz-spec-sil exhibits more evidence of deformation than any other variety or member for some reason. It apparently was more ductile during folding, perhaps due to its mineralogic composition and also perhaps due to its position near the base of the fold.

MIDDLE IRON FORMATION. To the middle I.F. is arbritarily assigned the material above the lower upwards until the appearance of an appreciable number of the ferruginous quartzite bands. In general, it exhibits a gradual change from predominately qtz-spec near its base to qtz-spec-gran towards the top, but local changes in the mineralogic varieties make attempts to accurately subdivide it quite difficult. Two to five members and numerous horizons are apparent depending upon location.

A thin band of blue hematite marks its base along the north side, this band is manganiferous in the trench exposure, part of it is manganiferous in hole 5 where it accounts for some extremely high assays. There is some intermixed spec and spec-gran above this, followed by a clean qtz-spec horizon in the northeast part of the deposit which appears to pinch out west of the trench exposure.

Blue hematite and locally manganiferous varieties appear in the middle part of the unit, again associated with spec and spec-gran horizons which form the upper part. On the south side, qtz-spec predominates west of 9500 E, but east of here, qtz-gran varieties predominate and contain a few ferruginous quartzite seams as well.

The middle I.F. appears to have a minimum thickness of around 300 feet, but in the eastern parts of the deposit, the present interpretation suggests somewhere around 600 feet, though part of this may be due to some unrecognized folds. It has been cut by all holes except 3 and 4.

UPPER IRON FORMATION. The upper iron formation is more or less similar to the middle except for the presence of a greater percentage of the ferruginous quartzite seams and associated granular hematite bearing horizons, though qtz-spec is prominent locally and there are a few blue hematite horizons as well.

Qtz-gran and spec-gran with ferruginous quartzite horizons mark the bottom of the upper I.F. These are followed by a predominately spec-gran member with only a few lean bands.

East of the trench area, a predominately qtz-spec horizon appears along the axial trace of the syncline. This is likely an expression of the easterly plunge of the syncline towards the cross fold. The upper I.F. is probably 200 or more feet thick, it has been cut only in holes 2 and 8.

The trench exposure across 2250 feet of the I.F. shows that the seven basic varieties (spec-sil, spec, spec-gran, gran ferruginous quartzite, blue hematite, and manganiferous) occur in 76 different bands. Twenty five of these are 3-12 feet wide, 27 are 12-27 feet wide, 14 are 27-52 feet, 6 are 52-67, and 4 are over 100 feet wide. While 68% of the number the bands are less than 27 feet wide, 70% of the total distance across the exposure consists of horizons greater than 27 feet wide.

The qtz-spec silicate variety accounts for about 10% of the distance, qtz-spec about 24%, qtz-spec-gran about 40%, qtz-gran about 14%, ferruginous quartzite about 6%, and about 6% is composed of the blue and/or manganiferous.varieties. This would suggest that somewhere around 90% of the total material in the deposit consits of quartz-specular hematite and granular hematite bearing material.

STRUCTURE

The synclinal fold responsible for the Julian Deposit is a result of the first period of deformation during which all trough formations were folded towards the northwest more or less isoclinally and with one overturned limb. Later folding associated with the Grenville Event produced folds whose axial traces run northwest-southeast. The plunge of the axes of the secondary folds was determined by the dip of the earlier folds. At Julian, the early syncline trends about N60E and the cross folds plunge southeast.

Recrystallization foliation is essentially parallel with bedding-stratigraphy, but mineralogic lineations on the foliation surfaces parallel the axes of the cross folds, whose intensity varies from place to place within the deposit. The change in exposure width of the deposit from around 1800 feet on the west to over 3000 feet on the east side is one expression of the cross folding. It not only thickened the iron formation along the cross fold, it also lowered the keel of the syncline on the eastern side so that more of the syncline is preserved than further west.

The north limb of the syncline dips about 20-30 degrees southerly (Mine grid system), then curves around the hinge of the fold to come upward as the approximately vertically standing south limb. The south limb is overturned in part and is clearly constructed of several large scaled drag folds in which the bottom limb is normal and parallels the north limb, but the upper limb of these drag folds is completely overturned and dips southerly at a much steeper angle. Thus both limbs of the drag folds dip southerly, one at about 30 degrees, the upper at about 55 degrees. Thus, nearly all outcrops exhibit southerly dips, but because the drag folds face both north and south, it is seen that the stratigraphic members stand about vertically or even dip northerly towards the keel of the syncline when the local dip of the drag folds are ignored. There is no evidence to support an interpretation which would place iron formation under the quartzite along the south limb.

The sinuous character of the members along the length of the deposit is largely due to and reflects the cross folding. The secondary anticlinal fold plunges down the north limb of the syncline from around the area near the north end of the trench exposure, its axial trace closely parallels the trench exposure. The complimentary secondary synclinal depression enters the north limb near hole 3 and its axial trace can easily be followed southerly.

These secondary folds lie almost exclusively within the north limb and represent a roll of over 300 feet amplitude in the north limb. These folds die out at depth and do not seriously affect the south limb other than shift the south contact about 400 feet northward between 10 and 11000E. Note that the axial traces of the secondary folds can be followed only to about the axial trace of the syncline.

The secondary folding was accomplished largely by movement from east to west within the north limb. Left lateral movement, accomplished by flow folding and probably some strike slip faulting, producted underfolding in the basal parts of the north limb. There is evidence indicating that the axial surfaces of these secondary folds are curved surfaces which tend to flatten at depth and perhaps become parallel with the stratigraphy in those areas where secondary folding was extreme and near to the point of being isoclinal. The gross effects of these two periods of folding and the resulting interpretation of the shape of the deposit are illustrated on the sections.

SECTIONS

Section 8000E is a cross section of the syncline as interpreted from the available evidence. The keel or bottom of the fold is reasonably believed to lie at around elevation 1200 in this part of the deposit. The axial surface of the syncline dips south at about 45 degrees.

Section 9000 has been interpreted laregly from sections 8000E and 10000E, there being no subsurface data available except from hole 5 which was laid out to explore the north contact.

Section 10000E is roughly at right angles to the trend of the syncline only in the upper parts of holes 1 and 2 and in the south limb. In the lower parts of the north limb however, the section is not representative because it nearly parallels the axes of the major sized secondary cross folds. Repeated intersections of the spec-silicate member in holes 1, 2 and 3 are interpreted to be the down plunge extensions of the severe folding shown on the plan. A more representative view of these folds is shown on the longitudinal section.

Section 11500 E lies east of the secondary syncline and is fairly representative of the primary syncline. However, the lack of outcrop data close at hand leaves room for some doubt in this area as to the internal construction. It is felt however that the concept shown of a greater depth to the keel of the syncline is valid. Other than the width of the body, there is little to go on reference interpretation for section 13000E.

The interpretations shown from the surface and drill hole evidence are admittedly tentative because of the general lack of sufficient horizon markers within the body and such widely spaced holes. It is therefore expected that these sections will change when more information becomes available, but it is believed that the general, overall interpretation shown will withstand the tests of further investigation.

There is no evidence anywhere in the deposit or surrounding area of intrusive dikes or other geologic features which would distract from the basic assumption that the entire body of the iron formation constitutes a large volumetric reserve of iron formation suitable for concentration plant feed.

Previous estimates of the volume of the material available within the landward portion yield reserves in the order of 500 million tons of crude ore down to elevation 1200 feet. About 125 million tons lie above lake level.

EXTENSIONS

The lakeward extensions of the Julian Deposit were outlined in the winter 1963 lake sounding and magnetic surveying program. This work showed that the iron formation was magnetically recognizable from around 3000E to at least 19000E, a distance of about 3 miles. Widths remain approximately the same as near shore for about 13000 feet. Part of these extensions are shown on the accompanying geologic plan, including the principal magnetic highs and lows reflecting trends under the overburden.

A study of ground and aerial magnetic information, plus known depths of water and overburden, indicates that the top of the body of iron formation has a local relief of more than 400 feet. The hill was an island in glacial Lake Wabush and is surrounded on all sides by a shelf of glacial debris. The relatively flat top of this shelf lies between elevations 1700 and 1750, the lake is at 1730. This shelf is quite wide and extends from around 3000E to about 16000E, the depths of water are, for the most part, less than 20 feet.

Unfortunately, the iron formation under the overburden does not follow this shelf but becomes progressively deeper lakeward from the outcropping body. The iron formation was encountered at about elevation 1660 in hole 58L11 on the west side. Hole 9 has 138 feet of overburden, hole 58L12 has at least 98 feet and 58L13 at least 110 feet, neither of these L.M.&E. holes encountered bedrock.

The western slope seems to deepen westward to around elevation 1600 near 5000E. On the east side, there appears to be a plateau on the top of the iron formation at about elevation 1620 or so, and it probably extends from around 12500E to the vicinity of 16000E before further increases of depth occur.

There is no reason why the iron formation underlying the lake and glacial debris should be significantly different from that exposed on the hill. The amount of this material which could be included in potential reserves is a matter of mining feasibility and the economics of overburden removal. There is no information available at this time on any water problems which could accompany efforts to mine this material.

GRADE

While a discussion of grade is a phase often excluded from geologic reports, the crude ore grade of the iron formation is entirely a geologic phenomena and as such is given attention here.

A determination of the iron content of the deposit is a cumulative process wherein the order of magnitude is easily determined, but a figure accurate to within 1 per cent is only approached statistically as the number of samples increases and also only after due consideration is given to volumetric distribution. At the present time, the information indicates that the average grade is within 2 pointsof 35% iron.

SAMPLES

The twenty eight composite area, outcrop samples collected in 1956 gave the following:

Iron	37.15%
Manganese	0.18%
Phosphorus	0.012%
Sulphur	0.004%

The drill core, when weighted according to sample length, gives 35.2% iron, a straight arithmetic average is 34.2% iron, 0.32 manganese. A sludge-core comparison suggests that core samples are some 3.7% lower than comparable sludge samples, indicating that core samples may represent minimum values.

The forty ton sample from 5 pits taken in 1960 gave the following:

Iron	36.75 %
Manganese	0.09 %
Silica	46.16 %
Sulphur	trace
Phosphorus	0.009%
Titania	0.21 %

It was later learned that the bags used in shipment had been previously used in a titania test and as a result there was titania contamination, see 1963 test pits for subsequent check.

The trench exposure was completely (i.e. every exposure) sampled in 100 ft. intervals, but excluding the few thin manganiferous bands. The iron assay ranged from 29.82 to 44.56%, the average is:

Iron	35.71 %
Phosphorus	0.008 %
Manganese	0.32 %
Sulphur	0.0035%
Insoluble	47.52 %

One hundred anf fifty tons were removed from 12 pits in November 1963 for metallurgical tests. They were spotted in the trench exposure and one other place so as to hopefully be representative of the deposit as a whole. One pit was deliberately placed on a manganiferous horizon. This pit ran 29.66% iron, 15.74% manganese with low silica, suggesting that manganese may occur in addition to iron and as a substitute of silica. The average of the other eleven pits, based only on random samples collected during bagging, is as follows:

Iron	32.55 %
Phosphorus	0.195 %
Manganese	0.12 %
Silica	50.91 %
Titania	Nil
Sulphur	0.0046%

The samples, when ranked in order of inclusiveness, is as follows:

Drill Core	35.2 %
Trench 1962	35.71 %
Surface, 1956	37.12 %
12 Pits 1963	32.55 %
5 Pits 1960	36.75 %

This would indicate that the greater reliance should be placed upon the more inclusive samples, and that a figure around the 35% iron mark could be expected for an average.

DISTRIBUTION

An examination of the evidence concerning the distribution of the iron within the body shows several interesting features. A comparison of grade versus estimated percentage of the principal mineralogic varieties from the core and trench exposure shows the following general relationships.

Variety		Per cent of Total Sample	Average Grade
Qtz, spec-sil,	Core	27 %	34.5% iron
	Trench	9 %	32.5%
Qtz-spec,	Core	14 %	36.0%
	Trench	23 %	34.5%
Qtz-spec-gran,	Core	37 %	37.0%
	Trench	42 %	36.0%
Qtz-gran,	Core	17 %	38.0%
	Trench	15 %	38.0%

This table suggests the order of magnitude of the relative proportions of the principal varieties (excluding ferruginous quartzite, blue, and manganiferous varieties), and also suggests that there is a grade rank by varieties, that is that as granular hematite content increases so does average grade. The frequency distribution plot on which the above is based shows that the grade range is from about 29% to 46% iron, with the 68% normal distribution limits falling at about 34 and 38% iron in the core, and 32 and 40% iron in the trench samples. Both curves are somewhat skewed towards the higher end, but the mean of each lies very close to 35% iron.

A study of assays versus sample length was made as another measure of iron distribution. As expected, grade variation does decrease with increasing sample length, but the convergency is much less than one would expect.

Sample Length	% Iron Range
20 feet	27-46% iron
60 feet	28.5-43% iron
100 feet	30.-40% iron

It is generally accepted that many natural phenomena are best described by a log normal distribution. The evidence so far available strongly indicates that this is proba' ly the case in the Julian Deposit. It would appear that 35-36% iron represents the mean and that the standard deviation is likely plus and minus about 3 per cent. This would mean that a grade range of between about 32-39% iron should account for 2/3 rds. of the material. The other 1/3 rd. would average either less or greater than these limits. The evidence also indicates that these variations exist in widths approaching 100 feet. Thus, they become quite significant and would affect recovery ratios in the plant.

An examination of the available recovery data versus the grade of its feed indicates that about 80% of the data falls in a field roughly described by 33% Fe-40% weight recovery and 40%Fe-52% recovery. In general, as per cent iron increases, the corresponding increase in recovery becomes less and less. The % weight recovery increase per one per cent iron increase ratio decreases from about 4 to 1 around 30% iron to about 2.6 to 1 around 34% iron to about 1 to 1 around 38% iron.

This non linear relationship is probably a reflection of the increased granular hematite content in the higher grades with its associated finer grain size and increased secondary iron oxide content. These mineralogic features would likely contribute to greater recovery losses in the higher grade brackets.

In that an average grade for the deposit must take volume into account, an examination of grade variation between the Lower, Middle, and Upper parts of the iron formation was made.

Based upon weighted core samples, the 35.2% iron average is composedof:

41.1% of all samples at 34.5% iron in Lower I.F.
47.9% of all samples at 36.9% iron in Middle I.F.
11% of all samples at 30.0% iron in Upper I.F.

Similarily, from the trench exposure:

16% of all samples at 31.91% Fe in Lower I.F.
53% of all samples at 34.67% Fe in Middle I.F.
31% of all samples at 37.74% Fe in Upper I.F.

Note that the rank of the three major subdivisions of the iron formation does not agree between the core and trench samples. However, the core samples are deficient in the Upper I.F. and the trench samples are deficient in the Lower I.F. If these two sources of information are combined in proportion to their respective lengths, and averaged, the following distribution appears.

Lower I.F.	30.3% of samples	33.95% iron
Middle I.F.	50.1% of samples	35.89% iron
Upper I.F.	19.6% of samples	35.27% iron

Measurement of sections suggests that the relative proportions of the 3 units by volume between 7500E and 12250E is about as follows:

Lower I.F.	41%
Middle I.F.	48%
Upper I.F.	11%

Combining the volumetric proportions with the indicated grade for each of the major subdivisions should yield a reasonable estimate for the average grade of the deposit as a whole. The combination follows:

Unit	% Volume	Grade %	Product
Lower I.F.	41	33.9	1389.9
Middle I.F.	48	35.9	1723.2
Upper I.F.	11	35.3	388.3
	100	35.014	3501.4

Thus, when considered volumetrically, the figures again suggest 35% iron as a reasonable working average.

These figures for grade, distribution, and recovery patterns are, of course, only indications of the results to be expected when sufficient sample information becomes available so as to be statistically significant on a volumetric basis. However, there appears to be sufficient evidence to show that these patterns are real features, and therefore that mining operations will have to be conducted in such a way as to account for them to help insure uniformity of concentration plant feed.

SUMMARY

The Julian Deposit of concentrating type iron ore was deposited through the accumulation of siliceous and ferruginous chemical percipitates in a shallow water, oxidizing environment as a part of the extensive iron formation in the Labrador Trough. After diagenesis it was a typical Lake Superior Type cherty hematite-magnetite iron formation 600 or more feet thick overlying shale and quartz sandstone.

These formations were later folded into a synclinal trough, and still later subjected to regional metamorphism and deformation during Grenville times. Metamorphic recrystallization, essentially isochemically, produced the coarse grained mixture of quartz-specular hematite and magnetite. This was accompanied by cross folding which significantly affected parts of the deposit.

Post metamorphic erosion exposed the deposit to the Tertiary leaching, oxidizing, meteoric water environment which is responsible for the leached and oxidized nature of the deposit to depths below present levels of drilling. Glaciation removed some of the upper parts of the body on both sides of the hill and dumped glacial debris around its flanks.

The body can be subdivided into several members, sub-members, horizons, etc. on a mineralogic-textural basis. Each unit is composed of one or more of the 9 varieties that can be recognized, though quartz-specular hematite and granular hematite seems to account for about 90% of the material.

Samples collected to date are sufficient to strongly indicate that 35% iron is a good working average for the deposit. Manganese is present, but it is apparently confined to a few specific horizons, and is quite low in the rest of the ore. No other deleterious elements are present in objectional amounts. The grade appears to increase with granular hematite content, this is accompanied by a general decrease in grain size and increase in secondary oxide content, all of which combine to decrease proportionate recovery in the higher grade material.

The grade apparently follows a log normal distribution with a standard deviation of about 3 per cent. The grade variations to be expected from this large deviation appears to occur over significant widths, so that metallurgically balanced mining should be utilized to help insure uniformity of plant feed.

Accessible, crude reserves, measured within the peninsula, are indicated to be in the order of around 500 million tons. The lakeward extensions could provide additional reserves. The reserve is presently classed as probable, for there is only a geologic outline of the internal nature of the deposit and considerable more work needs to be accomplished to volumetrically demonstrate metallurgical characteristics.

The reserves do exist in the geologic sense however, and past performance in the district has shown that similar material can successfully support long term, large scale mining and concentration facilities.

APPENDIX

? Geologic Plan	1-400 ft.
? Geologic Sections	1-400 ft.
Drill Hole Logs - Holes	1-9

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-1	Depth 596 ft. Inclination vertical Direction		Location N 10504N E 10006E

Footage Interval	Member	Grade	Description
0-3			Overburden
3-65	Middle	3-60 34.98	3-12, mainly spec, some granular hematite, 12-42, granular with several seams of blue variety, manganiferous 15-21, 42-65, Spec-gran, weakly banded Dip 15-25 degrees
65-93	Lower	60-100 35.87	Banded spec with leached silicates Dip 35-40 degrees
93-132	Middle	100-136 35.75	Qtz-spec (93-100), granular with blue variety seams (100-120), manganiferous (104-111) Spec-gran (120-132)
132-160	Lower	136-157 27.82	Qtz-spec, friable, some leached silicate seams. Dip 30 degrees
160-213	Middle	157-213 39.27	Intermixed spec & spec gran layers. Blue variety seam at 198, manganiferous 185-188. Dip 30 degrees
213-275	Lower	213-280	Thinly banded spec-silicate
275-298	Lower	37.42	Spec-granular
298-390	Lower	290-377 31.82	Spec-silicate, thinly banded, dip 30 degrees
390-400	Lower	377-418	Massive granular
400-415	Lower	31.05	Ferruginous quartzite
415-423	Lower	418-479	Sericitic schist seams
423-479	Lower	31.81	Spec-granular in variable proportions Dip 35-40 degrees
479-596	Lower	479-596 36.42	Fairly uniform spec-silicate variety some spec granular horizons. Dip 25-35 degrees. Breccia Zone 535-543

Remarks: No core 280' - 290' - Average sludge analysis, 15-310, 34.82% Fe.
Average core analysis, 3-596, 34.7 Fe, 51.6% recovery.

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-2		Depth 705' Inclination vertical Direction	Location N 9500 - 9497N E 1000 - 9995E
Footage Interval	**Member**	**Grade**	**Description**
0-18			Overburden
18-61	Upper	20-61 43.23	Massive qtz-granular, considerable goethite & limonite, also introduced variety. Dip 30 degrees.
61-118	Upper	61-118 23.06	Ferruginous quartize to 61-69, granular & oxidized 69-84, Ferruginous quartzite 84-118
118-160	Middle	118-180 34.37	Quartz granular plus limonte-goethite & some introduced variety. Dip 30 degrees.
160-245	Middle	180-242 39.40	Mainly qtz-spec, some granular, spec rich below 215 medium grained, local steep limb fold.
245-300	Middle	242-300 35.24	Banded, mainly qtz granular with some spec layers, locally limonitic, lean zone 247-252, spec 258-263, blue variety at 260. Dip 30 degrees.
300-343	Middle	300-343 36.20	Mainly qtz-spec, dip about 40 degrees
343-369	Middle	343-379 34.60	Mainly qtz-gran, dip 40-50 degrees locally
369-390	Middle	379-409 42.40	Mainly qtz-spec, dip 30 degrees
390-484	Lower	409-489 34.39	Spec-leached silicate except for spec granular 400-430 Dips 30-60 degrees, folded.
484-645	Lower	489-625 39.11	Intermixed qtz-spec & qtz gran horizons some oxidation products, Dips 30-50 degrees, folded, fractures in 566-590 interval.
645-705	Lower	625-705 39.06	Spec silicate variety, thinly banded some silicate free sections. Dips become irregular below 625

Remarks: Average core analysis 20-705, 36.5% Fe. Recovery 54.2%
Average sludge analysis 20-360, 37.50% Fe.

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-3		Depth 318' Inclination vertical Direction	Location N 11500 - 11494N E 10000 - 9993E
Footage Interval	**Member**	**Grade**	**Description**
0-42			Overburden
42-75	Lower	47-60 38.74	Spec-silicate variety, dip 10-25 degrees.
75-109	Lower	60-108 31.67	Mainly qtz-spec, seam of blue variety at 85, dip 20 degrees
109-170	Middle	108-190 35.43	Mainly qtz-spec-granular, banded, some oxidized sections
170-300	Lower	190-301 32.79	Predominately spec-leached silicate, some spec intervals. Becoming highly goethitic & oxidized below about 270 & probably represents silicous goethite Dip about 25 degrees.
300-318			Sericitic mud, mica schist, clay

Remarks: Average core analysis 47-301, 33.7% Fe, Recovery 37.6
Average sludge analysis 30-300, 41.13% Fe.

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-4	Depth 328' Inclination vertical Direction	Location N 8500 - 8502N E 10000- 9994E

Footage Interval	Member	Grade	Description
0-16			Overburden
16-125	Lower	16-99 32.54	Intermixed spec and spec-gran horizons no leached silicates seen in hole. Locally leached & oxidized, also introduced variety
125-163	Lower	99- .190	Qtz-granular, oxidized
163-186	Lower	35.71	Qtz-spec
186-238	Lower	190-256 29.22	Qtz-granular, oxidized
238-255	Lower		Ferruginous quartzite
255-280	Lower	256-281 27.92	Qtz-granular, oxidized
280-302	Lower	281-302 21.43	Siliceous goethite, limonitic & sericitic
302-328			Sericitic & micaceous schist with micaceous quartzite near bottom

Remarks: Average core analysis 16-302, 31.5% Fe. Recovery 49%
Average 20-255, 37.49% Fe. (sludge analysis)

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-5		Depth 203' Inclination 50° Direction N	Location N 10161 - 10172N E 9000 - 9001 E
Footage Interval	**Member**	**Grade**	**Description**
0-12			Overburden
12-32	Middle	12-37 64.04	Mainly blue variety, some coarse spec, manganiferous. Dips about 55 degrees
32-72	Middle	37-71 36.10	Mainly qtz-spec
72-144	Lower	71-145 32.89	Spec-silicate (leached) variety schistose, manganiferous band at 98
144-154	Lower	145-154 35.17	Red hematite mud
154-199	Schist		Serecitic & talcose clay - altered muscovite schist
199-203			Quartzite

Remarks: Average core analysis 12-154, 39.3% Fe.

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-6		Depth 330' Inclination vertical Direction	Location N 9500 - 9519 N E 8000 - 7974 E
Footage Interval	**Member**	**Grade**	**Description**
0-10			Overburden
10-56	Middle	10-56 44.41	Mainly qtz-spec variety, some granular material, broken core, friable, some red hematite in seams Dips 20-30 degrees
56-153	Middle	56-153 37.87	Intermixed qtz-spec & qtz gran horizons, banded, some what fractured leached, red hematite oxidation products. Dips 25-45 degrees.
153-300	Middle	153-284 40.96	Mainly coarse grained qtz-spec, friable & leached, some granular horizons. Blue variety seam at base. Dips 20-30 degrees
300-330	Lower	295-323 36.85	Qtz spec, banded, leached silicates 316-319. Dip 20 degrees.

Remarks: No core: 295'-308' - Average core analysis
10-323', 40.1% Fe.

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-7		Depth 380' Inclination vertical Direction	Location N 11000 - 10989 N E 11500 - 11525 E
Footage Interval	**Member**	**Grade**	**Description**
0-12			Overburden
12-42	Middle	12-32.5 38.82	Mainly coarse qtz-spec, some granular layers Dip 35 degrees. Sericite mud seam 41-43
42-108	Middle	32.5-110 30.29	Banded, mainly granular hematite, some spec layers, friable & leached with considerable red hematite stain. Dip about 35 degrees.
108-160	Middle	110-157 30.88	Qtz spec with subordinate granular hematite, granular only 150-160. Dip 30
160-210	Middle	157-212 36.80	Intermixed qtz spec & qtz granular varieties Dip 30-40 degrees
210-261	Middle	212-245 43.55	Intermixed, qtz spec, spec-gran & granular varieties with granular predominating. Dip 30-40 degrees.
261-330	Lower	245-319 37.90	Qtz spec-leached silicate 261-283, mainly granular 283-304, red hematite mud in seams. Spec-leached silicate 304-330, also with red hematite seams, all friable & leached. Dips 20-35 degrees. Sericite mud at 308.
330-380	Middle	321-379 36.27	Intermixed spec-gran & spec varieties, leached & oxidized. Seam of blue variety at 350.

Remarks: No core: 245'-257', 278'-297', 321'-342'
Average core analysis 12-379, 35.5%Fe

SCANNED IMAGE

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-8		Depth Inclination vertical Direction	Location N 10000 - 9993 N E 11500 - 11509E
Footage Interval	**Member**	**Grade**	**Description**
0-26			Overburden
26-86	Upper	26-86 34.57	Banded qtz spec & qtz gran varieties with spec increasing near bottom Dip 30 degrees
86-150	Upper	86-145 21.18	Ferruginous quartzite to leached & oxidized with scattered layers of granular hematite. Dip 30-40 degrees.
150-275	Upper	145-265 30.96	Predominately spec-gran, occasional friable qtz-spec bands, secondary oxides below 164. Sericite seams at 150 & 272. Breccia 205-218. Dip 30 degrees.
275-356	Middle	265-356 33.84	Banded qtz-spec, slightly limonitic, some granular hematite appears below 320. Dips 20-40 degrees.

Remarks: No core: 26'-46', 66'-105', 125'-165', 185'-225', 245'-265' 285'-322'
Average core analysis 26-356', 30.6% Fe.

SCANNED IMAGE

CANADIAN JAVELIN LIMITED
Summary of Diamond Drill Hole Log
JULIAN DEPOSIT

Hole No. J-9		Depth 261' Inclination vertical Direction	Location N 11000 E 13000
Footage Interval	**Member**	**Grade**	**Description**
0-138			Overburden
138-210	Middle	138-208 34.76	Banded qtz-granular, limonitic & stain common. Specular horizon 145-168 Dips 35-40 degrees.
210-261	Middle	208-261 38.37	Mainly qtz spec variety, leached & oxidized zones around 226 & 251, friable. Dips 35-40 degrees.

Remarks: Average core analysis, 138 -261, 36.3 % Fe.