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THE JULIENNE LAKE DEPOSIT

A REPORT OF STUDIES CONDUCTED DURING 1959 - 1960

DAVID M. KNOWLES JUNE 1960

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JUNE 1960

CANADIAN JAVELIN LIMITED

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ABSTRACT

An examination and study of over 270 outcrops and the core from 9 drill holes in the Julienne Lake deposit has led to a reasonable understanding of the geology of the deposit.

Two mineralogic varieties of the iron formation constitute nearly all of the material in the deposit, quartz-specular hematite and quartz-granular hematite. Other varieties occurring in minor amounts are: ferruginous quartzite, siliceous goethite, altered silicate material, blue colored hematite, and sponge like material. The distribution and proportions of these varieties define seven recognizable stratigraphic submembers of the oxide member of the Wabush Lake Iron Formation.

The stratigraphic succession, from youngest to oldest, is as follows: Submember A, ferruginous quartzite; B, quartz-granular and specular hematite; C, quartz-specular hematite; D, quartz-granular and specular hematite; E, quartz-granular hematite; F, quartz-granular and specular hematite with leached "silicate" casts; G, siliceous goethite; muscovite schist or granulite; quartzite.

These layers have been folded into an overturned syncline which was later cross folded. Foliation is strong throughout the deposit, it is parallel with the stratigraphy along the north limb of the syncline, but is across the bedding in the south limb. Nearly all exposures of the iron formation exhibit a mineralogic lineation on the foliation surface which is

parallel with the axes of secondary folding.

The detailed structural studies conducted suggest that depths to the bottom of the deposit are in the order of 500-700 feet at least.

The deposit has undergone more leaching and oxidation than the Wabush Lake deposit, but for all practical purposes the ore is essentially similar and readily amenable to concentration.

THE JULIENNE LAKE DEPOSIT

1959

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MAPS (separate) 1" = 200 feet

Base Map

Geologic Plan

Geologic Sections AA, BB, CC, DD, EE, FF

INTRODUCTION

The first systematic examination of the Julienne Lake deposit was made during a 10-day period in August 1956 by the field party of Canadian Javelin Limited. The work was of a preliminary nature in an effort to gain an appreciation of the geology of the deposit, its mineralogic character, its probable extent, and indicated grade. The results of this work are embodied in a report by G. Gastil, dated December 13, 1956.

The need for a comprehensive study of the deposit became apparent during the years following the 1956 examination as a better appreciation of the geologic complexity of the iron ore deposits in the Wabush Lake area was gained, and it was realized that an understanding of the geology of the Julienne deposit had not been reached.

The present report covers the studies conducted during the summer of 1959 by the Javelin geologic staff. Approximately six weeks were devoted to the study by D. Knowles, J. Soles and W. MacPherson or W. Blakeman.

The purpose of the work was to study the geology of the deposit until comprehension of its geologic makeup had been achieved. That this goal would, or could be achieved, was doubted at times during the course of the work, but by persistent efforts during the field and later office study, a degree of understanding which cannot be increased without further data was finally achieved.

This report may seem to be academic to the reader. This is necessarily so because understanding of the deposit is a mental state and is extremely hard to adequately portray on maps.

This report, then, shall attempt to bridge the gap between understanding and the illustrations so that the information presented shall have meaning and be of value to the reader in his efforts to appreciate the deposit.

This report will not attempt to cover the reserve-grade picture which will be the subject of a later report.

PHYSIOGRAPHY

The Julienne Lake Deposit occupies the conspicuous hill which forms the peninsula at the north end of Wabush Lake. The northernmost part of the property lies within a couple hundred feet of the north shore of Wabush Lake, thus forming the Julienne narrows which separates Wabush Lake from Julienne Lake.

The peninsula is joined to the mainland by a swamp beginning just south of the map area. The deposit is 10 miles northwest of mile 25 on the Wabush Lake Railway.

The hill itself rises 225 feet above the level of the lake throughout all but the northeastern corner of the property. The very existence of the hill is due to the resistance of the iron formation to glacial scower, although the iron formation has been scowered and removed to below lake level on the west and east sides. The hill is conspicuously steep on its northwestern flank and more gently sloped on its southeastern side.

A thin veneer of glacial debris, sand, gravel and boulders, covers the deposit above elevation 1810. This marks the former level of a glacial lake as evidenced by the prominent bench which rings the entire hill. Above the bench, outcrops occur as humps of rock sticking above the veneer. In many cases, the rock is covered only with a layer of cariboo moss and tree roots, which, when stripped off, provide beautifully clean exposures.

At the bench line, where wave action was erosional, many exposures are found. Beautiful exposures are thus found on the NE side of the property at this level, where about 90-95% exposure is seen for over 2000 feet. Below the bench, no exposures are found except near the NE corner of the hill. The lakeside edge of the bench consists of sand and/or rounded pebbles of iron formation.

Above the bench, the trends of the rock structure are subtly discernable in the topography, but not below the bench because the overburden gets very thick, reaching 138 feet in hole 9.

The base map shows the location of all surface features, including outcrops, roads and lines cut or marked through the woods. The lettered 1959 magnetic transverses across the north and south contacts were not blazed. They will not be found on the ground but are shown in order to reference the magnetic profiles.

REGIONAL GEOLOGIC SETTING

The general geology of the region and the various geologic factors which control the nature of the iron ore deposits in the Wabush Lake area have been previously described in company reports and published articles and need not be detailed here. It will be sufficient to state that the deposit exhibits conformity with the regional geologic habit and the geology of the deposit is a small scale version of the regional geology.

The Duley marble and Wapussakatoo quartzite in the Julienne Lake area lie upon the gneissic basement complex. The quartzite occurs directly under the iron formation in the deposit while the marble occupies a belt to the south along the east side of Wabush Lake immediately west and north of the area of basement complex exposure.

In this part of the Wabush Lake area, the iron formation overlying the quartzite consists primarily of oxide facies iron formation and the silicate and carbonate facies are of minor importance. No silicate or carbonate members have been definitely recognized in the Julienne deposit.

The general trend of the iron formation and other rock units is north-south along and west of Wabush Lake. At the north end of the lake, these rocks curve in an arc towards the east and finally trend north-east. The rock units are isoclinally interfolded and overturned towards the outer (north and west) edge of this arc. While the outcrop trend of these units would suggest superposed synclinal deformation about axes trending approximately N 45 degrees W, a statistical analysis of the geometry of all known rock attitudes within a four mile radius of the Julienne Lake deposit shows that the superposed deformation axes trend N 30 degrees W and plunge southeast at 20-30 degrees. The western fold limbs strike N 15 to 45 degrees E and dip 35-50 degrees to the east and the northern limbs strike EW to S 75 degrees E and dip southerly at 10-40 degrees. The stereographic representation of the geometry of the superposed regional structure is shown on the outer edge of the stereographic nets on the Julienne Lake geologic map.

The regional stratigraphic - structural environment is a sequence of marble, quartzite and iron formation which has been isoclinally interfolded and overturned towards the northwest, and which has been refolded about axes trending N 30 degrees W such that the limbs outcrop in an arc.

Because the events which have produced this regional picture are regional in scope, it is to be expected that the Julienne Lake deposit will be in stratigraphic and structural harmony with this habit, but on a smaller scale.

SOURCES OF INFORMATION

This study of the Julienne Lake deposit is based solely upon information gathered during 1959 except for the regional setting.

The location of the north and south contacts had previously been indicated by the 1956 work. Baselines were cut and chained parallel to these contacts and magnetometer lines run across the contact at 200 foot intervals and along the shore of Julienne Lake to delimit the contacts. As shown on the profiles, most contacts are fairly clear except west of holes 1 and 3, where complex relations are found.

By far, most of the information came from outcrops. Approximately 275 outcrops were found, extended or exposed by pulling back the trees and moss. While many of these are concentrated on the eastern or southern side of the deposit, enough exist throughout the central parts to give a reasonable amount of information. Specimens from each outcrop or small cluster of outcrops were taken. The core from the nine drill holes was obtained, thoroughly studied and representative samples taken.

As is the case throughout the Wabush Lake area, word descriptions of individual outcrops or samples are a hindrance rather than a help. This is due to the fact that words cannot adequately describe all the various combinations of features of mineralogy, texture, structure, alteration, iron occurrence and changeability in matter of inches which, together, form a particular variety of the oxide facies iron formation.

The method of classification which was used during the course of the work was a color scheme, whereby the varieties of iron formation were designated by a particular color and so recorded on the field maps along with the structural observations.

EVOLUTION OF THE STUDY

Upon first examination of the deposit, the only thing which is fairly clear is that there is quartz-iron oxide rock everywhere within the deposit and that its gross shape in section is synclinal. That there are several varieties of ore material in the deposit is clear, but the relationships between these are obscure. Many features may be observed which have no meaning except to indicate that the geology is probably quite complicated.

FIRST STAGE

After surveying all outcrops and examining the drill core, it was recognized that the several varieties of iron formation could be used for classification. These varieties are recognized on the basis of mineralogy and general physical appearance of hand or core specimens. The varieties are considered to be the end member of varietie , so to speak, and are the smallest recognizable units within the iron formation. A single variety may form the entire specimen or outcrop, or two or more varieties may be seen in a single specimen or outcrop. It all depends upon the scale at which varieties of iron formation change into one another and upon the scale of observation.

Table 1. Varieties of Iron Formation

1. "Silicate". Cream colored bands in coarse grained quartz-specular hematite, sometimes with visible altered, fibrous silicate minerals, strongly foliated (Figure 6).

2. "Blue Hematite". Aphanitic (fine grained) mixtures of chert-quartz and bluish colored hematite, dense and hard, occurs in layers up to about a foot thick, or as discrete bands about 1 inch thick in other types, sometimes containing large euhedral plates of hematite, occasionally with pyrolucite, upper left (Figure 5).

3. "Specular Hematite". Friable, coarse grained, quartz-micaceous specular hematite, sparkles, rich appearance, massive to well foliated (Figure 3).

4. "Granular Hematite". Coarse to medium grained, quartz-granular hematite, generally hard, massive to banded (Figure 2, left; Figure 4).

5. "Sponge". Sponge-like textured material; a mixture of quartz-granular hematite shot through with veinlets and alteration zones of coarse grained quartz and hematite in a matrix of goethite and limonite (Figure 8).

6. "Ferruginous Quartzite". Mottle gray, medium grained quartzite containing a small amount of granular hematite distributed in patches or layers such as to appear as a stain, lean iron formation (Figure 1).

7. "Siliceous Goethite". Yellow-brown, goethite and limonite, completely altered material, occasionally with large casts of former silicate minerals (Figure 7).

Quantitatively speaking, the granular hematite and specular hematite varieties predominate in the deposit and occur nearly everywhere and usually intermixed. The "silicate" variety and the blue hematite variety are found in restricted horizons with granular-specular material. The "sponge-like" variety occurs locally within other types. The ferruginous quartzite forms a particular stratigraphic unit as does the "siliceous goethite" material. These varieties may be recognized in spite of variations in texture and secondary alteration.

SECOND STAGE

A second examination of the outcrops along the northeast bench indicated that there might be stratigraphic order within the deposit because it was observed that the combinations and proportions of the several varieties of iron formation, as observed on a scale measurable in ten's of feet or greater, appeared to define distinctly different zones having gradational boundaries.

This formed the basis for the concept of the stratigraphic makeup of the deposit, involving at least seven sub-members, each characterized by a particular summation of varieties and other features of iron formation, and occurring in a definite sequence, A to G. Within this sequence, only two varieties appeared to be distinctive horizon markers; one is the presence of the cream colored laminated, foliated, quartz-specular hematite-"silicate" material occurring towards the north edge of the area at (F9N), and the other is the presence of the ferruginous quartzite in the center of the deposit at (A 10). Other distinctive features which might be of value for correlation, if their relative positions prove to be constant, are the rich quartz-specular hematite material (CN 3) and the fine grained, "blue hematite" layers at (EN 8). The test of this concept was whether or not these members could be traced across the deposit and at depth in the drill holes, while maintaining the same characteristics and relative positions as shown in the type locality.

All outcrops and drill core were re-examined objectively as a test of this hypothesis. Continuing southward from locality A-10, along the bench line, by allowing for incomplete exposure, it was found that outcrop areas BS 10, 11, CS 6 and 7, were essentially identical with BN 7, 8, and CN 3. (Note: outcrop numbers were assigned after the stratigraphy had been worked out.) This suggested that "A" was the uppermost sub-member in the deposit and marks the fold axis of the syncline. After diligent search, the "silicate" material was found sporadically in FS 7 in a zone about one foot thick. Proceeding westerly across the deposit, the "silicate" material was found at FN 6, FN 5, FN 3, FN 2, FS 6, FS 5, FS 4, FS 3, and FS 1, all lying somewhat within the magnetic contact and essentially parallel to it. The ferruginous quartzite was found continuously from A 10 to A 4, then at A 3 and finally at A 1 on the western side. Within the synclinal framework, it then became practical to examine the remaining outcrops in search for a distribution pattern of material which could be correlated with the type locality. No one outcrop or group of outcrops by themselves were diagnostic, but with the recognition that sub-members B and D are essentially identical, separated by sub-member C, it became reasonable to correlate CN 1 with CN 2-3 and CS 1, 2, 3, 4 with CS 6-7. The "C" sub-member is extremely friable and thus could not be expected to outcrop very often.

With the recognition of sub-member A in drill holes 2 and 8, the "silicate" material in the lower parts only of holes 3, 1, 2, 5, 6 and 7 (sub-member F), and with the remaining members falling into the observed sequence, it became convincingly clear that there was stratigraphic order within the deposit from one end to the other and at depth, and that the body is synclinally folded so that all sub-members except "A" appear on the surface twice.

The stratigraphic sequence is shown in Table 2 from youngest to oldest and occurring from the center of the deposit outwards. All contacts are gradational.

Table 2. Stratigraphic Sequence

Wabush Lake Iron Formation
Quartz-iron Oxide Member

Sub-member	A	Ferruginous quartzite.
	B	Quartz-granular hematite, some specular hematite towards C.
	C	Specular hematite, foliated, quartz-specular hematite, well foliated.
	D	Quartz-granular hematite, increasing specular hematite towards E.
	E	Quartz-granular and specular hematite with thin seams of blue hematite.
	F	Predominantly quartz-specular hematite including a zone or zones of "silicate" variety laminae.
	G	Completely altered goethite, limonite and silica.
Muscovite Schist		Muscovite, sericite, quartz.
Wapussakatoo Quartzite		White quartzite.

During the course of the initial examination, the impression gained of the structure of the deposit was that of an isoclinally folded syncline overturned towards the north with all units dipping about 30 degrees to the south. Upon second examination, with the stratigraphic picture in mind, it became apparent that the structure of the deposit was more complex. A more critical examination of observable structural details indicated that most observed planar attitudes were actually foliation surfaces, which in many places cut through the deposit irrespective of the stratigraphy. With the discovery, in a few outcrops and drill core specimens of intricately folded rocks, it was realized that instead of a simple body isoclinally folded conformably with the stratigraphy, that the body may locally be foliated irrespective of the stratigraphy so intensely that virtually all traces of the synclinal folding had been obliterated, and that the folds which were found were either remnants of earlier folding or later superposed folds.

This explained how the south edge of the deposit has a foliation dip of 30-40 degrees south, yet the stratigraphy appears to be essentially vertical as required by the relationships indicated from the magnetic survey, drill hole 4 and the outcrops along the south side; but at the same time, with the discovery of several other conflicting structural details, such as foliation surfaces trending E-W and NE-SW, N-S lineation, and fold axes in several attitudes, it was indicated that the structure might be too complicated to unravel. Certainly two, and possibly three, generations of deformation were indicated.

THIRD STAGE

When it became apparent that we could not unravel and understand the geology of the deposit while in the field (due to time and other considerations), it was decided to collect specimens from every possible source for office study. By organizing these specimens, it was possible to reduce the deposit to a scale where comparative study of the entire deposit was possible at one observation, something which is not possible in the field because of the size of the deposit. This study confirmed the ideas developed in the field and are reported in this work.

PRESENTATION

The methods of presentation used for this report are the standard geologic maps and cross-sections. These are drawn through the drill holes in spite of the fact that a section may show a longitudinal view rather than a true cross-section. Because of the size of the deposit, the results are presented at 1"=200'. While this scale is consistent with the underlying purposes for the work, the complexity of the deposit would require maps in the order of 1" to a few feet for presentation of details rather than generalizations. We have reconciled these problems by including photographs and sketches of specimens illustrative of stratigraphy and structure.

We feel quite confident regarding the representation of the geology at and near the sources of information. Interpretation of the geology between outcrops is reasonably accurate, but interpretations between drill holes is necessarily generalized and, to an extent, diagrammatic. The depth extent of the body has been shown as a reasonable minimum, the reason for which will become clear later.

STRATIGRAPHY

Wabush Lake Iron Formation

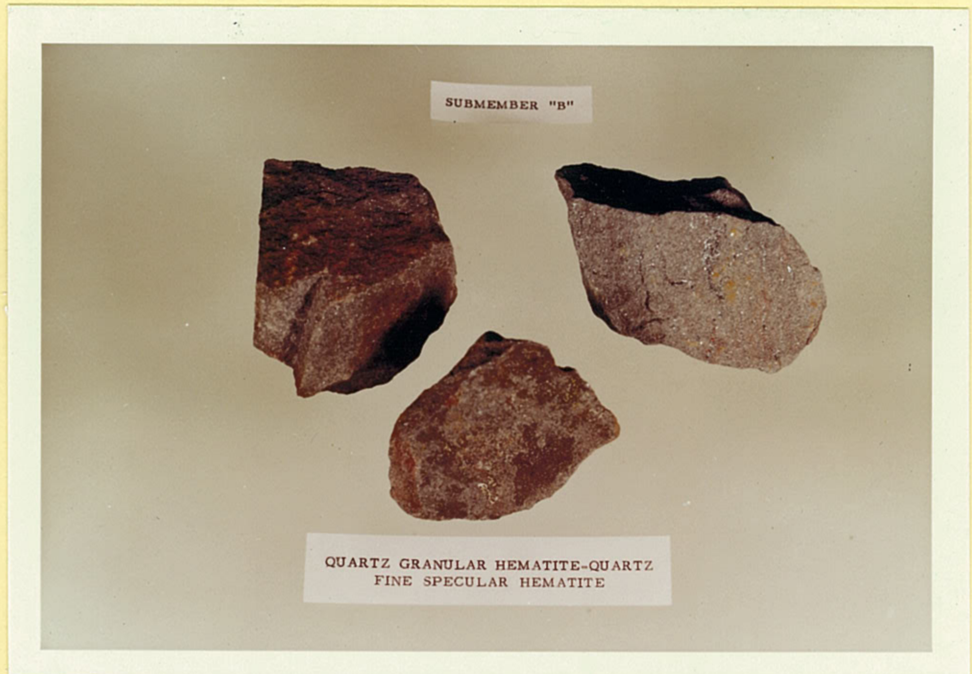
The oxide member of the Wabush Lake Iron Formation consists of seven sub-members in the Julienne Lake deposit. These sub-members are recognized on the basis of mineralogy and physical character.

Sub-member A. The ferruginous quartzite sub-member occupies the central position within the deposit. Excellent exposures occur along the eastern bench near the road from hole 8, and for about 700 feet along trend to the west. Typical material is found in hole 8 (107-147), outcrop A-3, hole 2 (60-69, 84-118) and outcrops A-2, and A-1.

The typical material, fig. 1, consists of granular quartz containing irregularly distributed zones, layers and patches of ferruginous material. The ferruginous material in the quartzite consists of fine-grained, granular, dark hematite with or without secondary goethitic replacement, staining and fracture filling. The material is typically a mottled white-gray to brownish color, locally becoming quite dark where the iron content increases. The ferruginous quartzite clearly is basically the same material as the other sub-members; it is only the iron content which is sub-normal. The indicated grade of this material is less than 20% iron. This material is similar in many respects to the quartzose material discovered in the upper parts of the Wabush Lake deposit. It grades sharply into sub-member B and is about 50 feet thick.

Sub-member B. The B sub-member does not show any obvious diagnostic features and, therefore, its identification depends upon its


SUBMEMBER "A"
FERRUGINOUS QUARTZITE


SUBMEMBER "B"
QUARTZ GRANULAR HEMATITE-QUARTZ
FINE SPECULAR HEMATITE


SUBMEMBER "C"
COARSE QUARTZ-SPECULAR HEMATITE


SUBMEMBER "D"
QUARTZ GRANULAR HEMATITE


SUBMEMBER "E"
QUARTZ GRANULAR HEMATITE QUARTZ-FINE
SPECULAR HEMATITE BLUE HEMATITE MATERIAL


SUBMEMBER "F"
QUARTZ-SPECULAR HEMATITE
ALTERED "SILICATE MATERIAL


SUBMEN SUBMEMBER " G "
ALTERED QUARTZ-GRANULAR HEMATITE
SILICEOUS GOETHITE


SPONGE LIKE MATERIAL
ALTERED QUARTZ-GRANULAR HEMATITE
AND INTRODUCED QUARTZ HEMATITE

position as well as its character. It is readily identifiable in the type locality area (BN 7, 8, BS 10, 11) where it sharply grades from the "A" sub-member. Both to the north and south of "A", the material consists of predominantly quartz-granular hematite (fig. 2, left) which gradually changes into a quartz-granular and specular hematite material (fig. 2, right) towards "C".

The south limb of "B" is recognized in hole 8 down to 107', in outcrop from BS 11 to BS 2 (excluding BS 1, BS 1A, BS 2 and parts of BS 3 and 4) and in hole 2 (69-84 and above 60'). No direct evidence of it has been found farther west. The north limb is found in hole 8 (147-260), BN 8 to BN 1, and in hole 2 (118-160). These locations are quite reasonable except for the lower contact in hole 8.

As stated above, the predominating presence of granular hematite is the characteristic feature of "B". A three-foot zone in BS 11 contains numerous 1-2" seams of the hard "blue hematite" variety material, similar material is also found at BN 7. In the hole 2-1 area, many outcrops of sub-member B consist of the granular hematite material and/or the "sponge-like" variety. Leached silicate mineral casts can be observed in BS 9.

The thickness of "B" appears to be on the order of a minimum of 100 feet and a maximum in the order of 175 feet. The rock is generally weakly foliated and is massive to weakly banded.

<u>Sub-member C</u>. Sub-member "C" occurs next towards the outside from "B"; it is found in hole 7 above 40', in four outcrops of the north

limit, CN 1-4, in hole 2 (160-190), in hole 8 (260-317) and in seven groups of outcrops on the south limb, CS 1-6, DS 12. Due to the scarcity of outcrops at regular intervals, and because this sub-member appears to be one of the more intensely folded, the position shown between CN 1 and CN 2 is at best approximate, likewise between CS 4 and CS 6-7. Further, due to the intense deformation south of hole 2, its identification in this area is questionable; it may have simply been folded out of existence as a recognizable unit.

The material characteristically consists of friable, coarse-grained, strongly foliated quartz-specular hematite, with a sparkly black and rich appearance (fig. 3). It may be massively disseminated, banded or laminated. The gradation from sub-member "B" occurs within a few feet (distance between CN 3 - BN 8, CS 6 - BS 11, CS 2 - DS 2), but it grades smoothly into sub-member D such that a contact is difficult to determine. It probably locally includes zones containing considerable granular hematite as well, as shown by CN 2, CN 4. A few silicate mineral casts may occasionally be observed.

A strong planar foliation with a pronounced lineation is characteristic of this material. In a few places (CN 3, CS 7, hole 2-160) it is observed that the uniformity of this foliation has been disturbed, such that the foliation surfaces have been bent so as to form small discreet folds with the axis parallel to the lineation (CN 3, hole 2-160), or the material is permeated by two foliation planes as at CS 7.

The thickness of "C" appears to be in the order of 30-50 feet. In spite of the rich appearance of this material, due to the coarse grain size, it is not of appreciably above average grade.

Sub-member D. This member begins by the virtual complete disappearance of specular hematite at the bottom of "C". The massive, hard quartz-granular hematite rock (fig. 4) remains quite uniform in character until about the middle of the unit, where some fine to medium grained specular hematite is found, which gradually increases in amount such that near "E" the content of the specular hematite variety is much greater than the granular hematite variety. This gradation is beautifully shown by DN 11-12, and DN 1-2-3. On the southern limb, many of the outcrops consist wholly or in part of the "sponge-like" material. This sub-member is remarkably like "B", but is a distinct unit.

The north limb is to be found in hole 7 (40-175), hole 2 (190-240), in outcrop, and hole 6 above 245. The south limb is seen in essentially continuous outcrop from DS-1 to the DS-10 area and again at DS-12. Its indicated thickness is in the order of 100 to 200 feet.

Sub-member E. The upper edge of sub-member "E" is denoted by a rapid decrease in the specular hematite content in "D", such that the predominating material within "E" is quartz-granular hematite, generally massive (fig. 5). The one distinguishing feature contained within the unit is the presence of a zone containing seams or layers of the "blue hematite" variety (fig. 5, upper left). The layers typically consist of a dense, fine graomed "blue hematite" matrix locally containing 1/4 - 1/2 inch plates of euhedral crystalline hematite. In other forms, it may contain a little quartz or granular hematite which may substitute for some of the blue hematite. It may be stated that the common features which mark these seams are the "blue" hematite and high iron content. Quartz is rarely observed, but manganese oxides are noted. These seams are unusual, but only form a small part of the normal quartz-granular hematite rock in "E".

Unit "E" is recognized in hole 7 (175-260, "blue" variety at 200 and 235), hole 1 (0-60, 90-125, 175-300, "blue" variety at 20, 114, 198, manganiferous), hole 2 (240-280, "blue" variety at 260), hole 5 (above 50, "blue" variety at 22), hole 6 (245-295, "blue" variety at 266). The north limb outcrops several times between hole 1 and the type locality at EN 8-12, also at EN 1 on the west side. On the south side, the unit is found in eight outcrops. Good examples of the blue variety may be observed at EN 8-9, EN 1, ES 1 and ES 8. Its indicated thickness is in the order of 50-100 feet.

Sub-member F. This unit is the most readily recognizable unit in the deposit because of the presence of the cream-colored "silicate" variety in part of the quartz-specular hematite rock. In most specimens, it can be observed that the laminations consist of quartz strung out in the lineation direction and permeated with the cream-colored stain and also alteration products or vugs of former fibrous silicate minerals (fig. 6). Occasionally, definite and well defined fibrous silicates can be observed. The impression is strong that the rock at one time contained abundant silicates in well defined layers, but that they have been pretty well destroyed through shearing and later secondary alteration. The cream coloration is probably due to the redistribution of the residual remains of the silicates after alteration.

Unweathered silicate-bearing quartz-specular hematite iron formation has been found west of Wabush Lake. The material is similar to the "silicate" zone at Julienne, except for the unweathered state. The silicates have been reported to be anthophyllite, a magnesia, iron, aluminum silicate. Upon weathering the aluminum has formed clay-like material responsible for the coloration.

Where the "silicates" occur in distinct layers, the remaining layers consist of foliated quartz-specular hematite. Otherwise, quartz-specular hematite and "silicates or cream-colored material" are all intermixed.

The "silicates" are found in a zone occurring near the top of unit F. The zone is several tens of feet thick along the north side of the deposit (FN 9), but is only a foot or so thick along the south side (FS 8). While the former presence of silicates can be occasionally seen in other sub-members of the deposit, it is only in unit F that they were abundant enough to have produced a distinctive rock material.

Below the "silicate zone," the sub-member consists of quartz-specular and granular hematite not unlike that found throughout the deposit. The lower part of the sub-member appears to contain a fair to large proportion of the specular hematite variety.

Sub-member "F" can be identified in hole 7 (260-EOH), hole 3 (47-250), hole 1 (60-90, 125-175, 300-EOH), hole 2 (280-EOH), hole 5 (50-142), hole 6 (295-EOH) and in outcrop along the north side. The "silicate" horizon can be seen in all of these occurrences except in outcrop FN 4. On the south side of the deposit, it is seen in outcrop from

FS 1 to FS 7 and in hole 4 (17-124, 160-265). The "silicate" seam is quite thin along the south limb, but may be observed at FS 1, FS 3, FS 4, FS 5 and FS 7; probably did not produce core in hole 4.

The "silicate" variety has been the most helpful material found as far as the structure of the deposit is concerned. While the material is characteristically strongly foliated and lineated, it often exhibits beautiful folds. Of the observed folds in the deposit, about 60% occur in this material, expressed as two foliation directions or as actual folds. This is probably because the material was relatively incompetent and also because the thin and contrastive layering permits observation of small scale folds which would not be seen were the material less contrastively marked. The indicated stratigraphic thickness of unit "F" is in the order of 100 feet.

Sub-member G. Unit "G" is the lowest stratigraphic unit of the iron formation. Typical of the Wabush Lake area, it consists of a virtually indescribable mixture of altered and leached iron formation; the most appropriate descriptive term would be siliceous goethite. It consists of remnants of quartz-granular hematite in a matrix of brown, cherty goethite with vugs and voids; the colors include black, brown and yellow. Pre-alteration features are sometimes seen; these indicate that the material consisted, at least in part, of banded quartz-granular hematite and also contained some proportion of silicate minerals. These silicates are believed not to be the same as those found in the unit above because they are considerably larger in size and some distinctly occur within the iron-rich layers. In general, this unit exhibits features suggestive of material similar to the magnetite-silicate and silicate-carbonate material from the Wabush Lake deposit, both in the primary and altered physical state and its stratigraphic position. Just as at Wabush Lake, this material occurs at the bottom of the iron formation.

Unit "G" has been found in hole 3 in the lower parts around 300 (boundaries indefinite because of lack of core), in hole 5 (142-155) and outcrop GN 1 on the north limb. The south limb is seen in outcrops GS 1-5 and in hole 4 (124-160, 265-300). It appears to have a thickness in the order of less than 50 feet.

MUSCOVITE SCHIST

A variable rock unit directly underlies the iron formation throughout most of the Wabush Lake area. Muscovite mica is ubiquitous in the rock, but it often contains variable amounts of quartz and biotite. The rock underlying the Julienne deposit has been found as a few fragments of core and micaceous sludge in hole 3 below 300', hole 5 (155-200), and hole 4 below 300.

The material is expressed as mica-bearing quartzite in hole 4, as micaceous, sericitic and talcose clay in hole 3, and micaceous, sericitic and talcose clay, quartzite and schist in hole 5. No outcrops of this material are known, but it probably lies near the surface on the south side of the deposit in the shallow depression south of the iron formation and north of the quartzite ridge. No estimate of thickness would be reliable because during deformation it probably has been squeezed such that in some areas it may be virtually absent and in other places it may be extremely thick.

WAPUSSAKATOO QUARTZITE

The Wapussakatoo quartzite underlies the iron formation and muscovite rock throughout the Wabush Lake area. The typical material consists of white, coarsely crystalline quartz with no other constituents except occasional flakes of muscovite near the top. This is the type of material observed in outcrop 400 feet south of the deposit. None of the drill holes has penetrated deep into the quartzite, but its upper micaceous transitional phase is probably represented by the material recovered in hole 4 (302-328), hole 5 at 203 and possibly at the bottom of hole 3.

STRATIGRAPHIC REVIEW

Seven stratigraphic sub-members are recognized within the Julienne deposit on the basis of mineralogy, physical nature, and sequence. These sub-members total about 600 feet in stratigraphic thickness.

The entire deposit consists of metamorphosed oxide facies iron formation with only the lowest sub-member representing in part silicate or carbonate facies. The hematite occurs in two basic forms, either as fine to medium grained granular hematite, or as medium to coarse grained specular hematite. These two basic varieties occur individually or mixed and it is the relative proportions of these two which, with other considerations, define zones or thicknesses of iron formation which can be recognized as sub-members. All sub-members grade into each other. The descriptions given for these sub-members are at best general and apply to the unit as a whole rather than on a small scale.

METAMORPHISM

The present basic mi[illegible]logy and texture of the iron formation are the result of prolonged amphibolite grade regional metamorphism of primary oxide facies iron formation. The thermal-chemical metamorphic environment resulted in the recrystallization of the constituents of the iron formation such that the iron formation consisted of a mixture of crystalline quartz-granular hematite, specular hematite and probably magnetite, prior to later alteration. Magnetite is known to occur in the deposit because of the anomalous magnetic field over the deposit, but most of the former magnetite has been oxidized by secondary alteration. It is suspected that much of the granular hematite within the iron formation is martite (magnetite oxidized to hematite), but as yet no reliable criteria have been recognized which might demonstrate this. The reasons for suspecting that granular hematite may, in part at least, be martite are that the granular hematite rocks are somewhat finer grained than specular hematite rock (quartz magnetite sub-members in the Wabush Lake area are generally finer grained) and also because the rock shows more evidence of secondary alteration products, i.e., goethite and limonitic stains.

In hole 5 (87 and 102) are 1/8-1/4 inch holes or earthy hematitic masses in quartz-specular hematite-granular hematite material. The slightly angular shape of these masses is not unlike those produced by garnet. Garnets have been seen in a few places in the Wabush Lake deposit also.

In the area north of hole 4, many outcrops exhibit contrastive mineralogic-physical features of a veinlet-like character, suggestive of the introduction and replacement of the host rock by other ferruginous materials. Outcrops BS 1 and CS 4 particularly show introduced masses, stringers and veins of coarse specular hematite, which were either irregularly introduced or complexly deformed after introduction. In the area north of hole 4, and occasionally in other places, the "sponge-like" material is found, consisting of brownish, medium grained quartz-granular hematite shot full of irregularly distributed blobs, patches, lenses, veins, layers or 'what have you' of very coarsely crystalline quartz, irregularly shaped hematite and a few hematite octohedrons (former magnetite), all of which have been partially altered, such that the hematite crystals are surrounded by a halo of goethite. The conclusion that the deposit locally contains a suite of late metamorphic introduced ferruginous materials seems inescapable.

The presence of the "silicates" in sub-member F is most probably stratigraphically controlled. While no precise identification of the silicates is possible from the weathered material, it seems most likely that the silicates were alumina rich. This is supported by the fact that they alter differently than grunerite and unweathered material near Wabush Lake is aluminous. No explanation is known at this time for the "blue" hematite material except to say that it appears that this material did not recrystallize to the normal grain size during metamorphism, probably because of some physio-chemical characteristic inherited from the time of primary deposition.

The stress-strain environment during metamorphism resulted in the observed textural-structural relationships. The foliation ard sometimes the lineation is caused by the dimensional and spacial attitudes of individual crystals which crystallized in preferred orientation in response to the stress field at the time of deformation. Specular hematite, because of its inherent platey crystalline habit, is strongly preferentially oriented such that the plates lie parallel to each other, resulting in a well developed foliation. In many cases (particularly in the "silicate" material) the specular hematite, quartz and silicates within the foliation surface are dimensionally preferentially oriented in direction, resulting in a strong lineation on the foliation surface.

In addition to the obvious external preferred orientation of specular hematite, it is suspected that a preferred internal orientation (orientation of crystal axes rather than external shape) of quartz would be found if universal stage studies were undertaken. The textural evidence suggests that deformation proceeded through the mechanisms of flow folding with essentially plastic behaviour.

STRUCTURE

The ferreting out, from the mass of structural features, those features of significance, and of understanding what has taken place during deformation and the resultant structural geology of the deposit has been a most challenging task.

SCALE

Structural evidence on all scales is observed. Small scale features observed are planar, bent, or bi-planar foliation surfaces, lineation, micro-folds and single or multiple foliation, crenulations and folds in hand specimens or outcrop. Medium scaled structural features consist of folds, changes of attitudes, positions and shapes of stratigraphic units over distances up to several hundred feet. The largest scaled features are those concerned with the shape of the deposit as a whole and involve the length, width, depth, and direction of the body.

The general structural characteristics of the body are:

1. A syncline overturned to the north and trending NE-SW as evidenced from stratigraphic relationships.

2. The body is composed of three blocks exhibiting essentially rectalinear geometry.

3. The rocks in the end blocks strike EW and dip south, the middle block strikes N 15 degrees E and dips SE.

4. The attitudes exhibited by the rocks are foliation surfaces which may or may not be parallel with the stratigraphy.

5. Many rocks exhibit a southerly lineation on the foliation surface.

6. Folds actually seen are rare. Those observed vary from open bends to tightly oppressed folds with the axes in several directions.

7. Repetition of beds several times at depth in holes 1 and 2, and strong S folds near hole 3.

8. Occasional features striking NW.

9. Suggestion of strong shearing in some places.

GEOMETRY

The geometry of the observed attitudes was investigated through the use of statistical stereographic projection techniques, which permit the plotting of a multiplicity of attitudes on one diagram in the search for regularity.

All attitudes lying west of a line between GN 2, hole 1 and ES 8 were plotted as one field. The synoptic diagram of this field (see geologic plan map) shows a well defined concentration of poles of the foliation surfaces (S). This may reasonably be interpreted as shown on the cyclographic representation of the foliation surfaces. It can be seen that statistically there are two foliation planes. One (S_1') strikes N25° E and dips SE at 30-50 degrees, the other (S_1) strikes EW and dips south at 25-45 degrees. The S_1 and S_1' surfaces intersect in axes: B' which trend S 35° and plunge 25-45 degrees SE. Note that the geometry of the southwestern part of the deposit is essentially the same as the regional geometry shown on the outside of the diagram.

All attitudes from east of the line between GN 2, hole 1, hole 2 and FS 7 were plotted as the northeastern field, overlapping the western field only in outcrops BS 6, 7, ES 8 and FS 7. The synoptic diagram from this field exhibits a grouping of the poles to foliation attitudes strung out between three clusters. This field may reasonably be interpreted as is shown on the cyclographic representation. The (S_1') plane (same plane as in the southwestern) field strikes N 26° E and dips SE at 30°-50°. The other foliation surfaces (S_1 and S_2) strike S 80° E and dip southerly at either 10°-20° (S_2) or 35°-55° (S_1). These foliation surfaces intersect in an axis which trends S 30° E (B_1'), and plunges 30°-50°, or NS (B_2') and plunges 10°-20° SE. Note that the geometry of this field corresponds closely with regional geometry. Note that S_1, S_1' and B_1' as determined separately from three different areas (regional, western and eastern) are essentially identical in space and that the remaining statistically shown preferred attitude of foliation (S_2) strikes parallel with S_1 .

The degree of regularity of the geometry of these fields and the presence of common surfaces and axes would strongly suggest that deformation about axes trending and plunging SE was responsible for most of the observed foliation attitudes. The intersection of S_1' and S_2' in a horizontal EW axis might suggest that there was deformation about such an axis as well as the SE axis. Thus we have indications of two deformations from the stereographic analysis alone.

Examination of the structural features shown in outcrops in view of the geometry reveals several lines of evidence which support the geometric statistical analysis.

1. The stratigraphy and direction of the segments forming the deposit closely follow one or the other of the foliation directions, EW or N 25 E.

2. Southeasterly trending structures and fold axes plunging SE are found which conform with the indicated deformation axes; those features are found particularily at FN 7, EN 7, DN 10, CN 3, A 7, B 2, BS 9, CS 7, DS 12 and BS 4.

3. It is also observed that the lineation throughout the deposit trends NS to S ' E.

SOUTHEAST AXES

These points and other features from the surface data strongly support the concept of deformation about NW-SE axes plunging SE, with similarily directed lineation, and with the limbs of the folds striking EW or NE. Such a deformation is consistent with the evidence from all scales, the regional habit, the deposit itself, and small folds seen in outcrop. The gross pattern of this folding is not unlike that of a book opened about 140° with the binding plunging SE at 30°-40°. This type of folding would appear to be responsible for the rectilinear segments of the deposit, with anticlinal (book binding up) axes predominating in the hole 5 to hole 4 zone and synclinal (book binding down) axes predominating in the hole 3 to CS 7 zone.

Examination of the drill core discloses further evidence for the SE folding in the form of small folds which, when oriented NW-SE by the use of the lineation, geometrically fit the pattern. Numerous such folds were observed, some of which are sketched on sections CC' and FF'. Folds in hole 1 at 82, 308, and hole 2 at 602 illustrate the nature of the folding whereby foliation surfaces striking EW (S_1) and dipping south at 30 degrees are bent downwards east of the axes (B') such that the foliation surface (S_1') dips around 60 degrees or greater and strikes NE. Note that the east limb has been rotated 60° to over 90° relative to the west limb, that the plane (P') containing adjoining fold axes approximately bisects the angle between the limbs and dips westerly at steep angles, and that lineation is parallel to the fold axes regardless of the attitude of the limbs.

EAST-WEST AXES

The folding about SE trending and plunging axes cannot be responsible for the synclinal nature of the deposit because the axis of deformation is NW-SE and the syncline trends northeasterly. The NW-SE folding must be a superimposed modification of earlier structures; it is the geometry of the earlier folding which may control the gross shape of the body at depth and the overall distribution of stratigraphic units. With the geometry and character of the second folding in mind, it is possible to examine the deposit for evidence of earlier structure.

Evidence for the nature of the earlier structure is found mainly in the large scale features, such as the position of stratigraphic units in plan and at depth. In the examination of outcrop and core for structural evidence, all features which fit the geometry of the NW-SE folding are considered secondary; those which do not fit probably are remnants of the earlier deformation. Specific cases of earlier folds are so few in number and important in analyzing the structure that these are listed and discussed below.

BS 4, northern outcrop - foliation at 250, dip 40° south, overturned drag folds, horizontal axes (B) striking 250.

BS 3, northern outcrop - east of road, 1 inch layer of specular hematite in quartzite folded about horizontal axes (B) striking 240, axial plane (P) 60° south - see sketch on section CC.

ES 6, eastern outcrop - drag folds about axes plunging 30° northeasterly.

FS 1 - in a 1 foot seam crossing outcrop - is seen intensely folded "silicate" material. The foliation surfaces are parallel to the limbs of the fold, dipping 30° (S_1) and 65° (S_2) south, strike 250. The fold axes (B) are horizontal at 250, the axial plane (P) dips 45-50° S. The rock is slightly crenulated and strongly lineated in the NS direction. (See sketch on geologic plan map.)

The evidence from these outcrops and the geometry of the northeastern field for foliation surfaces and folds which are folded about EW axes such that the limbs are 30-40° apart, suggests that in actual fact there may be two preferred attitudes of early foliation within the body, that only one attitude exists in most outcrops, or if they both are present, only the lower dip one may be easily observed. In any case, several instances of anomalous attitudes are explainable by deformation about EW axes resulting in two preferred attitudes but a few attitudes out of the normal: EN 1, foliation dipping south and north; BS 2 (northern outcrop) northward dipping foliation; DS 6, north and south dipping foliation; FS 3, south foliation at 30-60°; GS 5, 80° north; DN 12 (north end), foliation 60-90° north; and FN 9, where the foliation curves from 20 to 50°. In addition to the local variations just listed, there is a tendency towards low dip (10°-20°) attitudes to occur along the north side of the deposit, high dip (50°-60°) attitudes along the south side, with the normal 25-35° attitudes in the central areas.

To review the concept of deformation up to this point, we have recognized (from the geometry) the strong suggestion of two deformations, an older, large scale fold pattern, and a younger smaller scale fold pattern. The older pattern is recognized as foliation surfaces (S_1) within the rock which had a relatively constant attitude parallel to the stratigraphy and presently dips 30° south when the strike is 250°. This surface occurs so often that it probably represents one limb of the older deformation. In those places (north and south edges of the deposit, and locally elsewhere) where the other limb exists, divergent foliation attitudes (S_2) or actual folds with foliation parallel to the limbs and about 30° to 40° apart are recognized. The axes (B) of the older deformation appear to be essentially horizontal and parallel to the stratigraphy.

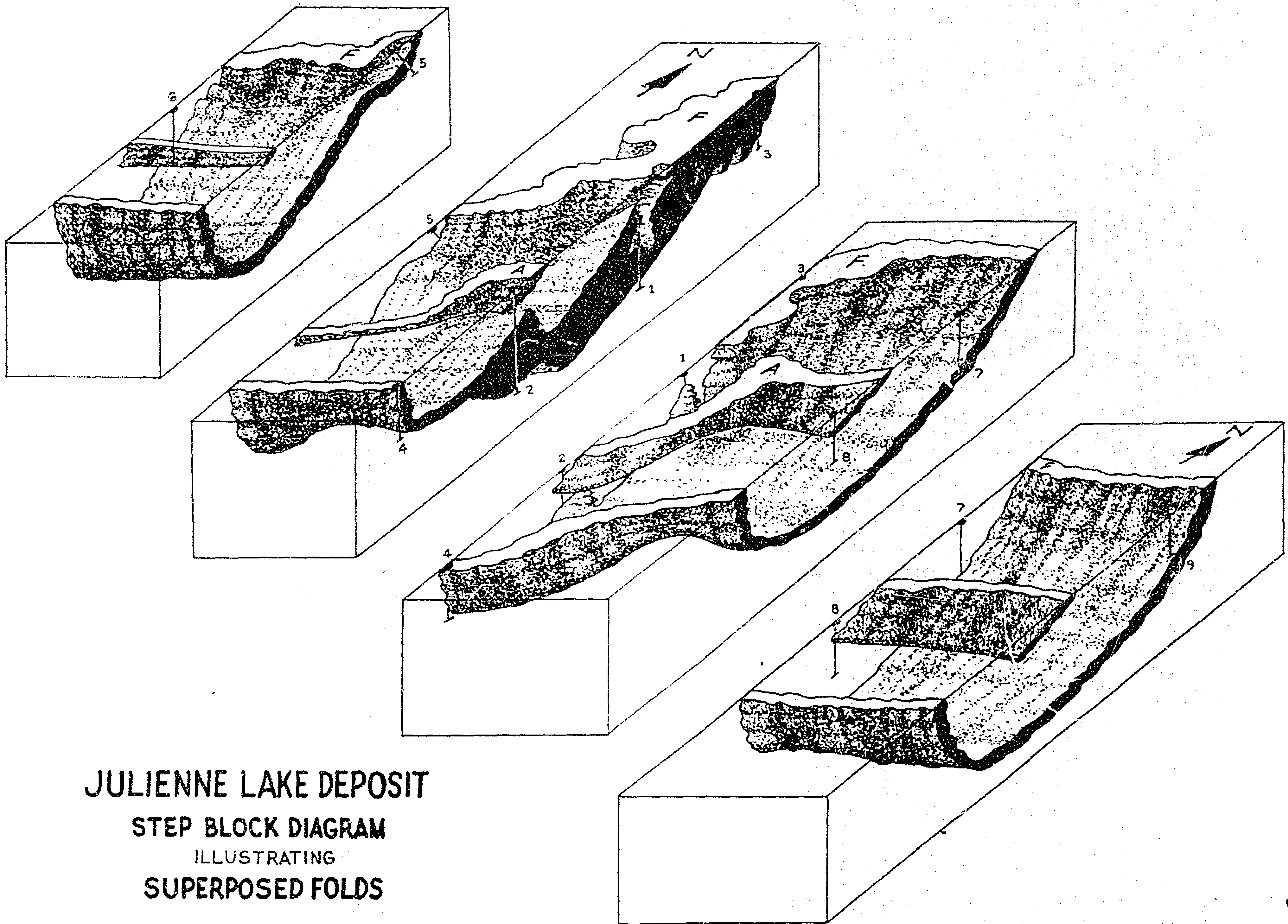
Older (B) folds axes (which in the western segment are horizontal) plunge to the northeast in the central segment between the younger anticlinial and synclinal hinge (B) zones, and are again horizontal in the eastern segment.

The early folding was most probably largely isoclinal and on a large scale such that the entire body is planal foliated (S_1) except for a few places where double foliation (S_1 and S_2) or folds may be observed.

The secondary folding is on a smaller scale, such that it is expressed as a modification of the earlier structures and its effects are readily observed in small scale features.

SUPERPOSED FOLDS

The specimens from outcrops FS 1 show earlier deformation on a



JULIENNE LAKE DEPOSIT

STEP BLOCK DIAGRAM

ILLUSTRATING

SUPERPOSED FOLDS

Fig. 9

scale small enough to be directly observed and even smaller scaled later deformation, the lineation. The two specimens from hole 4 are a case in which the scale of deformations are above equal and are both directly observable. The specimen from 49 feet shows the common lineated foliation surface (S_1) at the top, oriented 250 and dipping 40° south; this planar foliation exists for a depth of about ½ inch. The center of the specimen shows a fold, the axis (B) is at 225 and plunges 20° SW. The axial plane strikes 315 and dips west 20°. The top limb of the fold is the (S_1) foliation surface while the bottom limb is an (S_2) surface which strikes 340 and dips 40° west and is lineated in the same direction as the top foliation surface.

The specimen from 49 feet 6 inches has as its top surface the same foliation surface (S_1) as the top of the upper specimen. When this surface is oriented such that the lineation parallels that above, the fold axis (B_1') lies at 130 and plunges 40°SE, the axial plane (P') strikes 040. The upper limb of the fold is parallel to the S_1 surface (250°, 40° south), and the lower limb strikes NS, dips 45° east, and is lineated parallel to the fold in the specimen from 49, with discordant relationship in between. If one attempts to match the fold axes and planes of the large folds in these two specimens, the fold limbs can be matched, but the small fold at the bottom of 49'6" and the lineation are discordant. In view of the other evidence from the deposit, it seems reasonable to interpret that the fold axes at 225, 20° W (B) in (49) and the one in 49'6" at 130, 40 SE (B') represent two generations of folds.

The other specimens sketched from J1 (308), J 2 (602), J 4 (164), J 1 (82) and J 1 (308) serve to illustrate folds related to B' axis on a scale small enough to be observed but which is too small in scale to show any sign of the synclinal folds.

STRUCTURE OF THE DEPOSIT

With the foregoing concepts of the two deformations and their respective geometry in mind, the evidence within the deposit can be interpreted so as to develop a reasonable representation of the internal structure of the deposit.

SECTION AA Units D, E and F outcrop north of hole 6 and are cut by hole 6 as shown in Section AA. Definite correlations between EN 1 and 6-266 and DN 2, 6-86 and 102 are found. As the foliation has the same average dip as the stratigraphy, it is reasonable to assume that this corner of the deposit is foliated parallel to the bedding. Secondary deformation is weak in this area and is expressed only by the lineation. Variation in primary foliation attitudes is seen in EN 1, DN 1, and the observed early fold at FS 1. Section AA lies nearly at right angles to the axes of early deformation and affords a true perspective of the synclinal fold.

The structure shown south of hole 6 on Section AA is probably fairly accurate down dip until the axial plane of the syncline is reached, marked by unit A. The stratigraphic dip of the body is probably vertical or steep to the north as determined from the magnetics and drill hole 4. The only direct clue as to the dip of the axial plane comes from the early fold observed at FS 1 where the dip of the axial plane is 50°. Assuming that the early deformation is responsible for the syncline, if the plane actually dips 50°, then the body probably has a shape similar to that shown. At any rate, the deepest part of the body should be south of unit A, and all the rock near the axial plane and in the overturned south limb of the syncline will be foliated at about 30° or 65° degrees to the south; in other words, foliated across the stratigraphy.

<u>SECTION BB</u> In Section BB is seen the effects of both deformations. The early deformation as seen in the area lying south of A is a true section and shows the effects of the synclinal fold and foliation essentially parallel to bedding in the north limb and across the bedding south of the axial plane of the syncline.

From A north, the section shows the effects of the secondary folding. Anticlinal B' axes trending 130 and plunging SE from ES of hole 5 cut through the section such that from A to S the rocks strike essentially parallel to the section and dip eastward. This series of SE plunging anticlinal rolls is effective all the way across the deposit to hole 4, although not as a unique and traceable single fold.

Cutting through hole 5 are complimentary synclinal rolls effective to at least unit A west of hole 2. East of the synclinal zone, the rock resumes the normal 250° - 30° S (S_1) attitude. The nature of the secondary deformation may better be seen in Section FF near hole 5, in that the units take a sharp downward dip to the east. West of A to hole 6 is an oblique section.

<u>SECTION CC</u> Secondary structures are responsible for the shape of the body as shown in Section CC. This is because the section lies entirely within the central segment where practically every attitude of

foliation and stratigraphy are due to strong folding about the SE plunging axes (B') such that the general strike is NS to slightly NE and dips are steeply east to vertical or even westerly, underturned. The section lies nearly parallel to the fold axes so that the section is largely longitudinal. A better appreciation of the structure is seen in Section FF at hole 1 where a true perspective is seen.

Immediately west of hole 1 foliations and units strike 250 and dip 40° south, but in hole 1 these units go straight down the hole after having been bent about the anticlinal (B') axes plunging SE. The gross structure is not unlike that seen in specimen scale sizes in hole 1 at 82 and 308 feet. This secondary deformation has proceeded to the point where the rock has been locally underturned such that it dips westerly. The extreme of this type of underturning is seen in plan at A 3 - S 3. This westerly bulge in the iron formation is not a synclinal fold plunging east as might at first be expected; rather it is a doubled up tight S fold, the axis of which proceeds from the surface southeasterly at about 25° and emerges in hole 1 at the 200-300 foot depth. Eventually the fold disappears and becomes lost in the multiplicity of other secondary folds. This fold, and others of smaller scale but similar type, are responsible for the repetition of the sub-members about the B' axes, especially in holes 1 and 2. These secondary folds are seen longitudinally in Section CC and more truly in Section FF.

In Section CC, the structure in the immediate vicinity of hole 3 is probably in true perspective because the rocks trend essentially at right angles to the section. They are early structures only modified by the secondary. The entire length of hole 1 and hole 2 below 300 intersect underturned secondary structures such that sub-members E and F are repeated several times. The upper parts of hole 2 and the area to hole 4 are also folded about B', but not to the point that the gross shape from the earlier folding has been destroyed. The specimen from 164'6" in hole 4 shows compositional banding running EW and standing vertically, yet the foliation surface is bent about the B' axes.

It is this later folding which is responsible for the NE trend of the stratigraphic units in the central segment, in a more or less straight line habit south of sub-member "A".

The secondary folds predominate the structure from the anticlinal (hole 5 to 4) zone to the complimentary synclinal zone, extending from just east of hole 3 towards the CS 7 area. East of this zone, the earlier structures predominate and are only modified by the later. The later syncline is especially well marked by the outcrop pattern of "A" from A 4 to A 10. A minor later anticlinal axes zone lies about 500 feet east of the major synclinal axes as evidenced by the more westerly trend of the BS 10-11 area.

SECTION FF The axial plane of the secondary folds is indicated to dip westerly and roughly bisect the angle between the two limbs, as shown by the specimens from hole 1 at 82 and 308. This plane may steepen towards the center of the syncline because the plane dips about 75° in the lower part of hole 1.

The later folding is seen to be on a small scale from hole 5 to near hole 1. At hole 1 and until about halfway to hole 7, the later folding is seen to be on a large scale, it has dropped sub-members down something like 500 feet. East of the syncline the sub-members stay at considerable depths because the later folds are again only on a minor scale.

SECTION DD On Section DD, later folding is of minor importance and the gross shape of the body is a result of the earlier synclinal folding with only modification by the later. Bedding foliation of the north limb is indicated by the close correspondence between foliation and the attitude of "C" as cut by holes 7 and 8. The essentially straight line trend of the north magnetic contact between the hole 7-9 area would suggest that secondary folding east of holes 7 and 8 is of minor importance. The lack of dips steeper than 40° in these holes might suggest that the body has a shallower average dip than the west end of the deposit, but this may not be true due to the lack of evidence from the south limb.

SECTION EE Hole 9 did not go deep enough to reach the marker horizon, sub-member F. Therefore the units cut by hole 9 are somewhat tentative and the section is drawn on the basis of average dip, distance from the north contact and that hole 9 probably stopped somewhere above sub-member F. Secondary folding is probably of little importance in this part of the deposit.

SYNCLINE

The synclinal seen at Julienne Lake is merely a part of the long fold containing this iron formation which extends through the middle of Wabush Lake, through Julienne and northeasterly towards Shabogamo Lake. Thus the body extends under the lake on both ends of the Julienne deposit.

The evidence suggests that the bottom of the deposit may lie somewhere around elevation 1200 near hole 6 based upon dip of bedding foliation, outcrop hole correlations, dip of axial plane as taken from bisecting foliation attitudes and inconclusive evidence that the stratigraph in the south limb is steeply dipping and across the foliation.

If this indicated elevation of the bottom near hole 6 is correct, then the elevation may be expected to rise going east perhaps around elevation 1400 between sections BB and CC. East of the superposed folding (hole 5 to 2) ridge, the bottom elevation can be expected to decrease, perhaps to somewhere around 1000 between sections CC and DD. This is indicated by the increased surface width of the deposit as well as of structural evidence. East of Section DD the deposit may become a little shallower but it apparently remains deeper than at the west end of the deposit.

Wherever there is a kink or bend in the direction of a sub-member, that is where the deformation about the SE axes has been strong enough to modify or change the shape of the body. Figure 9 is a three-dimensional representation of the shape of the body.

There apparently is no continuous plane or surface containing the later SE fold axes. The later folds seem to be more or less distributed through the body in the central segment and are of limited extent and confined to a relatively small volume of rocks lying at some distance from the next later fold. Because they are structures superimposed upon pre-existing structures, they were to some extent controlled by the pre-existing structures and types. Thus their random distribution and somewhat irregular attitudes.

Only in the central segment of the body has the sum effect of the later folding been enough to seriously change the shape of the body.

STRUCTURAL SUMMARY

The structural evidence observed can be explained by the following concept of the sequence of structural events.

1. Folding of the iron formation into a syncline overturned to the northwest. The deposit is located on the hinge of this large fold such that we have part of the lower limb and the hinge, none of the overturned limb. Foliation tends to be parallel to the stratigraphy of the lower limb, but is steeper and probably across the stratigraphy in the hinge.

2. Modification of the syncline by bending about axes which plunge southeasterly. The shape of the deposit is determined by the magnitude and geometry of the events at various places in the deposit. The internal variations within the deposit are probably largely the result of the later folding, but the depth extent and shape of the deposit are predominately controlled by the synclinal folding. In that the foliation is not parallel with the stratigraphy in the south limb, there is at present no direct evidence regarding the depth extent of the deposit. The sections show the minimum depth and shape as interpreted from the evidence.

ALTERATION

The entire deposit shows evidence of alteration. This is evidenced by the presence of holes or vugs within the material, the friable nature of the material, the leached silicate casts and the secondary iron oxides.

Oxidation of magnetite to martite is another of the alteration effects Magnetite cannot generally be identified within the material. While the magnetic survey indicates that some magnetite is present throughout the deposit, the only place where a magnetic deflection of the compass is known is near CS 3, where within a 50 foot circle the compass points to a particular spot. Less than 1% magnetite was found during metallurgical testing of the 1957 drill core.

In some cases, the alteration has been virtually complete as in the case of sub-member "G". In general, three types of alteration are found: (1) leached material, friable to semi-friable but free of appreciable secondary iron oxides; (2) leached or unleached but exhibiting a brownish color due to the presence of goethite and/or limonite as a stain or in appreciable amounts; (3) completely altered material, usually expressed by a brown to red sludge and mud instead of drill core.

While alteration can be seen in outcrop, particularly in the "sponge-like" material, the "silicate" material and in other places, it is better shown in the core where limonite and goethic iron formation is common. It would appear that there is little order in the distribution of alteration. It is found in all holes and at any depth, even to 700 feet as in hole 2.

No quantitative estimate of the amount of alteration can be given because there are no quantities related to alteration which can be measured in the field. The slime produced in grinding tests would be partly contributed to by the inherent goethite-limonite content. Qualitatively estimated, it is believed that the Julienne Lake deposit contains perhaps

10-20% more secondary iron oxides than the Wabush Lake deposit.

FUTURE EXPLORATION

In view of the knowledge gained about the body from this study, it seems appropriate to consider the matter of continued exploration of the deposit.

Considering the nature of the stratigraphy and the degree of folding, drill holes at 1000 feet centers staggered on alternate 500 sections would be the absolute minimum to finalize the structure and sample the deposit. In order to prevent a reoccurrence of a hole staying in the same unit as in hole 4, the holes testing the south limb should be angled to the south and collared north of the contact.

It is suggested that the present grid system be maintained in as much as no new grid would adequately solve the problem of oblique sections. It is better to have at least part or some of the sections in true perspective than none.

Representative bulk samples could quite easily be obtained of all stratigraphic units in their plan proportion by trenching across the deposit. This could best be done along the good exposure area on the northeast corner of the deposit as one continuous trench from A 10 to EN 9 and a small separate trench through the EN 7-9 area. The old beach alongside of this area would serve as an excellent and ready-made roadway.

DEVELOPMENT CONSIDERATIONS

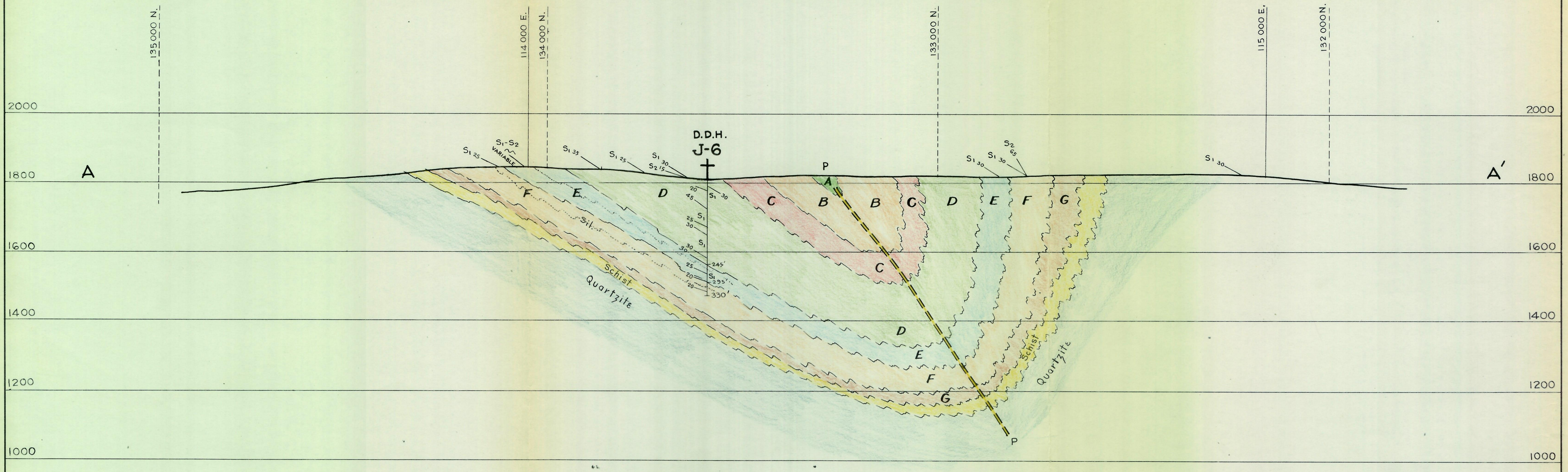
This work has served to demonstrate beyond any reasonable doubt the presence of a body of concentrating type, metamorphased iron formation, which for all practical purposes is not unlike that found in the Wabush Lake area and which is currently in development. Seven stratigraphic sub-members of the oxide iron formation are systematically folded in a synclinal fashion such that the entire volume of the deposit is iron formation. Of the seven sub-members within the body, units "A" and "G" are not likely to be economic, "A" because of its inherent low iron content, and "G" because the iron is not in a form suitable for concentration, but "G" would not have to be mined anyway and would form the footwall of the open pit.

No unusual features inherent in the body would interfere with the normal processes of concentration. Any variation in result with concentration processes used at Wabush Lake would only be a matter of degree. It is entirely possible that a slightly finer grind might be required because the slightly lower metamorphic grade of the Julienne area may have resulted in a somewhat smaller average grain size. Similarily it is believed that the slightly greater goethite-limonite content of the body may cause a somewhat greater slime content.

Uniformity of plant feed can be maintained by keeping benches in a northwest direction such that they cross the stratigraphy. As the benches proceed longitudionally and with depth, this uniformity can be maintained with ease.

CROSS-SECTION A-A′

LOOKING NORTH EAST



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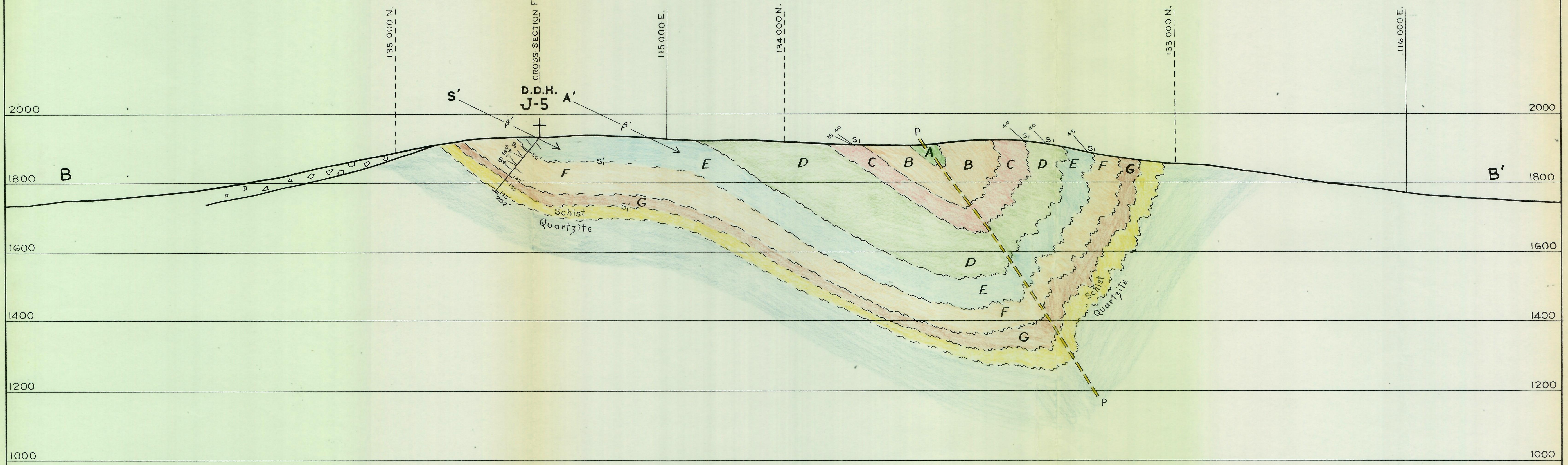
CROSS-SECTION
A-A′
LOOKING NORTH EAST

SCALE 1″-200′	DATE 1960	FILE
DWG Leo D.	APP	NO

CROSS-SECTION B-B′

LOOKING NORTH EAST



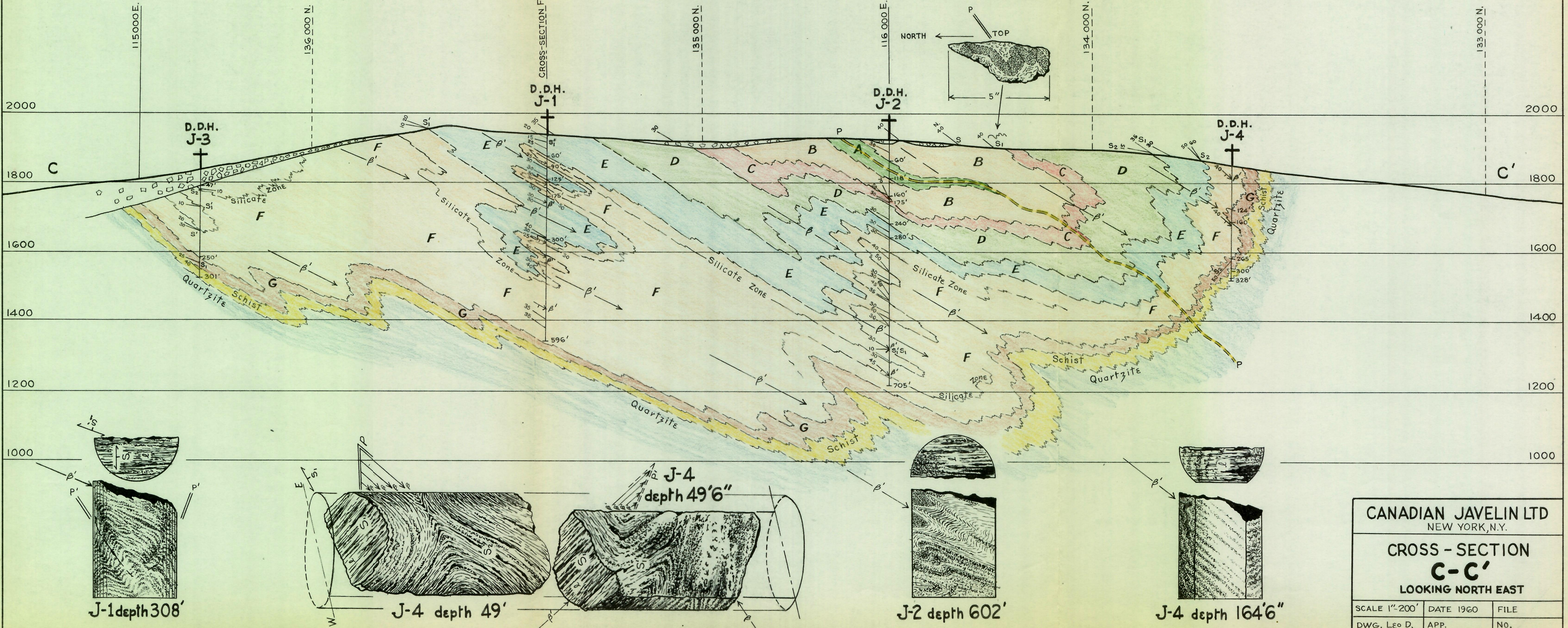
CANADIAN JAVELIN LTD
NEW YORK, N.Y.

CROSS-SECTION
B-B′
LOOKING NORTH EAST

SCALE 1″-200′	DATE 1960	FILE
DWG Leo D.	APP.	NO.

CROSS-SECTION C-C'

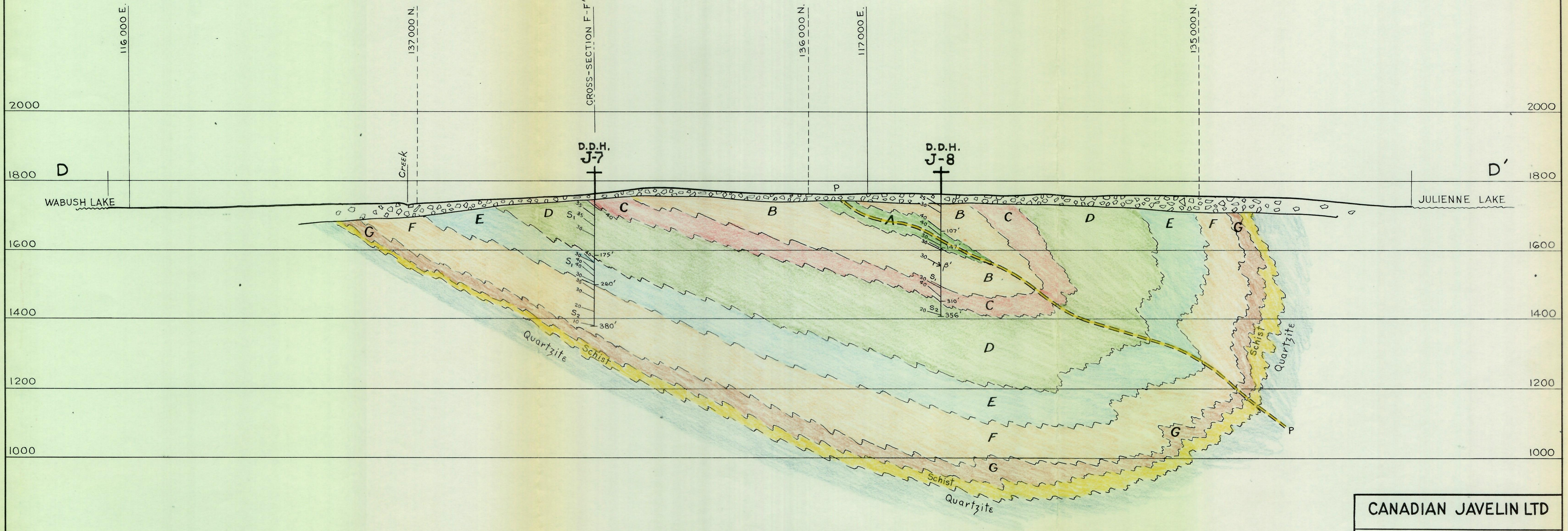
LOOKING NORTH EAST



CANADIAN JAVELIN LTD NEW YORK, N.Y.		
CROSS-SECTION C-C' LOOKING NORTH EAST		
SCALE 1"-200'	DATE 1960	FILE
DWG. LEO D.	APP.	NO.

CROSS-SECTION D-D'

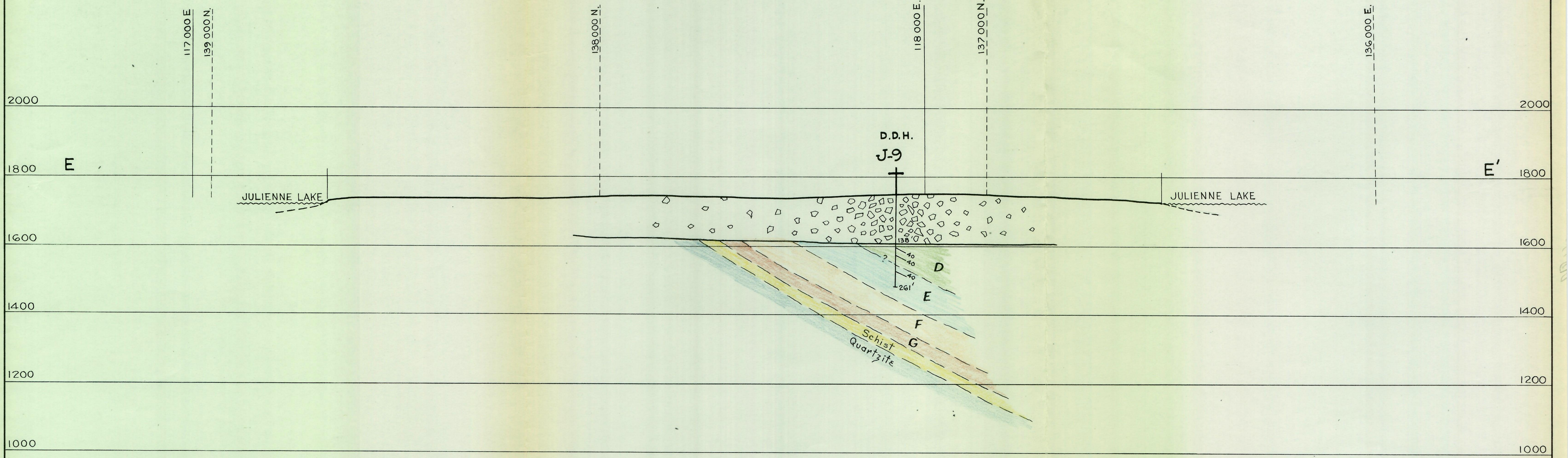
LOOKING NORTH EAST



CANADIAN JAVELIN LTD		
CROSS-SECTION **D-D'** LOOKING NORTH EAST		
SCALE 1"=200'	DATE 1960	FILE
DWG Leo D.	APP.	NO.

CROSS-SECTION E-E′

LOOKING NORTH EAST



CANADIAN JAVELIN LTD
NEW YORK, N.Y.

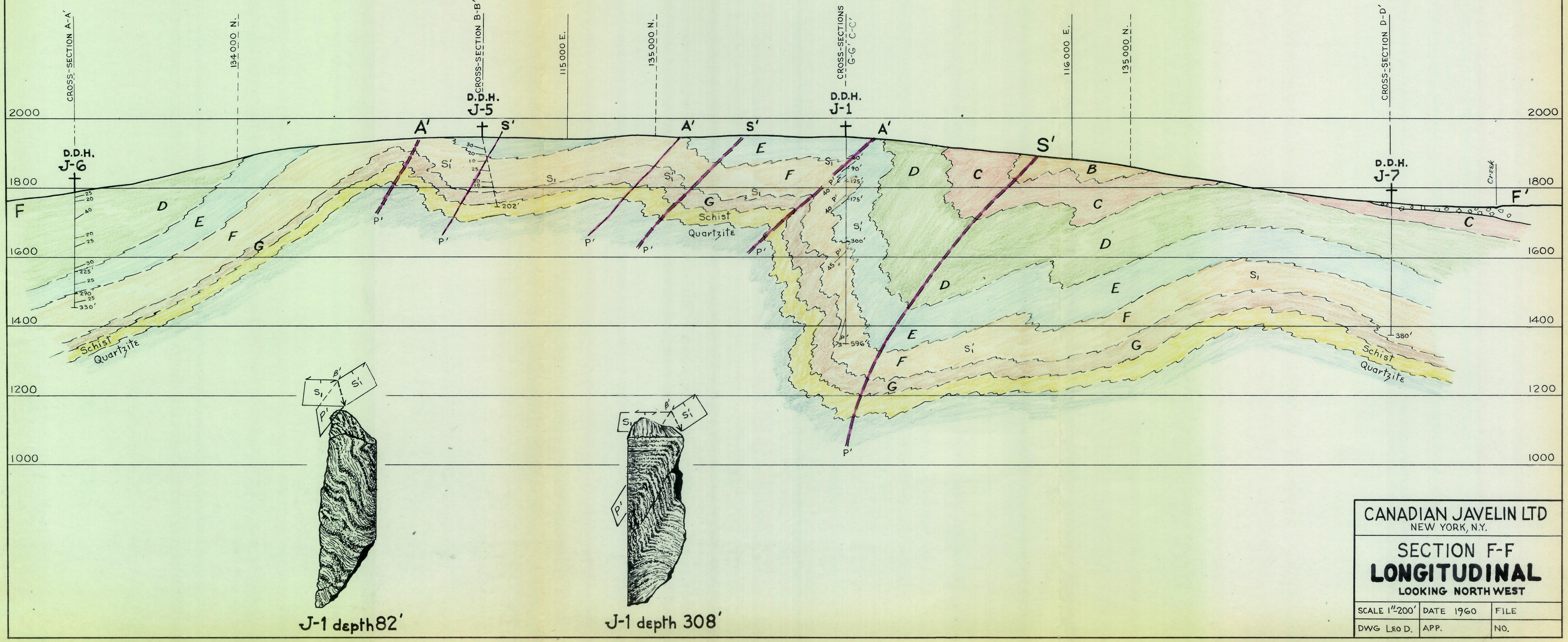
CROSS - SECTION
E - E′
LOOKING NORTH EAST

SCALE 1″=200′	DATE 1960	FILE
DWG.	APP.	NO.

LONGITUDINAL

CROSS-SECTION F - F′

LOOKING NORTH WEST



CANADIAN JAVELIN LTD
NEW YORK, N.Y.

SECTION F-F
LONGITUDINAL
LOOKING NORTH WEST

SCALE 1″=200′	DATE 1960	FILE
DWG LEO D.	APP.	NO.