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CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 1

MANGANESE DEPOSITS
OF THE WOODSTOCK AREA
NEW BRUNSWICK

By
F. D. Anderson



OTTAWA

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INTRODUCTION

General Statement

During the season of 1951 the writer undertook the detailed examination of the iron and manganese deposits of Woodstock map-area, New Brunswick, with particular attention to those to the northwest of Woodstock near the village of Jacksonville. A plane-table survey was made of these latter deposits, on a scale of 200 feet to 1 inch, and compass and pace surveys were made of the other smaller and less important occurrences.

The writer was ably assisted in the field by L. E. Swayne, J. I. MacDonald, M. F. Moore, R. J. Wallace, and J. M. Patterson.

Location

Woodstock map-area is in Carleton county, New Brunswick, about 60 miles northwest of Fredericton. The area lies between latitudes $46^{\circ}00'$ and $46^{\circ}15'$, and between longitude $67^{\circ}30'$ and the International Boundary.

The deposits of manganese lie to the west and northwest of Jacksonville, a village 4 miles northwest of Woodstock, and minor occurrences are known 1 mile west of McKenzie Corner, 2 miles west of Belleville on Meduxnekeag River, and 1 mile northeast of Union Corners. The deposits near Jacksonville are the most important, and are the only ones considered here.

Topography

The Woodstock area in general is a maturely dissected upland surface, having an average elevation of 400 feet. Drainage is well developed in the central and northern parts of the area, and these parts are extensively cultivated. The southern part of the area, which is underlain by intrusions and other resistant rocks, is poorly drained and heavily wooded; it supports only scattered farms and settlements.

The area has been extensively glaciated, and hills are elongated in a general southerly direction due to erosion by ice. Glacial till comprises about 85 per cent of the soil cover¹, and averages 3 to 4 feet thick, but may be as much as tens of feet thick.

History

The iron and manganese deposits near Jacksonville have been known for over 100 years, and were mined intermittently from 1848 to 1884. About 70,000 tons of ore were smelted², and the iron obtained was reportedly used for gunboats of the British navy³.

In 1868 the deposits were examined by H. Y. Hind⁴, and 6 years later by R. W. Ellis⁵. In 1884, the deposits were abandoned and no mining operations have since been undertaken.

In 1931, S. C. Perry and W. J. Wright, of the New Brunswick Department of Lands and Mines, made a plane-table survey of the area of the iron workings, showing the outlines of the old workings and indicating the zones of ferruginous rock⁶.

¹Stoobé, P. C., and Aalund, H.: Soil Survey of the Woodstock Area, N.B.; Dept. of Agriculture, Canada, Pub. 747, Tech. Bull. 48, March 1944.

²Lindeman, E., and Bolton, L. L.: Report on Iron Ore Occurrences in Canada; Dept. of Mines, Canada, Mines Branch, No. 217, vol. 2, p. 162 (1917).

³Hitchcock, C. H.: 2nd Annual Report, Natural History and Geology of the State of Maine, 1863.

⁴Hind, H. Y.: A Preliminary Report on the Geology of New Brunswick, Fredericton, 1868.

⁵Ellis, R. W.: Report on the Iron Ores of Carleton County, New Brunswick; Geol. Surv., Canada, Rept. of Prog. 1874-75, pt. vii, pp. 97-104.

⁶Wright, W. J., and Perry, S. C.: Manuscript map, New Brunswick Dept. Lands and Mines, Plate 32-1, 1932.

The presence of manganese in the ores was recognized from the time of the earliest operation, but no attempt was made to recover that metal.

GENERAL GEOLOGY

The greater part of the Woodstock area is underlain by steeply folded sedimentary rocks of Silurian and pre-Silurian age, cut by intrusions.

The pre-Silurian strata are composed mainly of greywacke and interbedded slate. The Silurian rocks are dominantly green-grey slate, dark grey calcareous slate, red slate with minor limestone, sandstone, grit, and conglomerate. A small part of the area is underlain by relatively flat-lying, coarse, clastic, Carboniferous beds.

The Silurian and older rocks are intruded by diabase sills and dykes, and by granite and associated rocks. The intrusions are probably of Devonian age.

Descriptions of Formations

Pre-Silurian. The oldest rocks of the area are of uncertain age, no fossils having been found in them by which strata could be more accurately dated. Lithologically they comprise green-grey greywackes, argillites, and grey and green slates. The beds vary in thickness from a few inches to several feet. The rocks have undergone varying degrees of deformation, which commonly has formed green chloritic schist.

The trend of these rocks is generally northeast, with local variations in strike. Dips are steep, generally about 80 degrees.

Silurian. The greater part of the Woodstock area is underlain by rocks that have been termed Silurian in age¹, and comprise red and green slates, grey-green slates and sandstones, dark grey calcareous slates, and minor amounts of grit, conglomerate, and greywacke.

¹Caley, J. F.: Geology of the Woodstock Area, Carleton and York Counties, New Brunswick; Geol. Surv., Canada, Mem. 198, 1936.

These rocks in common with those of pre-Silurian age trend northeasterly, but dip more gently than the latter. They also have been considerably deformed.

Devonian Intrusions. Intrusive rocks of probable Devonian age occur throughout the Woodstock area. They include large bodies of granite and syenite in the southeast part of the area, and diorite and diabase sills and dykes intrude both pre-Silurian and Silurian beds in other parts of the area. Only the minor intrusions occur in the area of the small map that accompanies this report.

Carboniferous. Carboniferous beds underlie a relatively small area on the west bank of Saint John River north of Woodstock. The rocks are dark brown and red conglomerate with interbeds of bright red sandstone and sandy shale, and unconformably overlie pre-Silurian and Silurian rocks. They dip gently, rarely more than 15 degrees, and trend northeasterly. They are referred to the Carboniferous mainly on the basis of their lithological similarity to rocks known elsewhere to be of that age.

DESCRIPTIONS OF THE MANGANESE DEPOSITS

General

The manganese deposits of the Woodstock area occur mainly in rocks of Silurian age. Minor occurrences of manganese oxides were noted in pre-Silurian strata, but because of their relatively low grade and limited extent they are not included in this report.

Four deposits of manganese were examined in detail. The two most important are those of Iron Ore and Moody Hills, which lie respectively about 1 mile northwest, and $\frac{1}{2}$ mile west, of Jacksonville. These deposits were mapped with a plano-table and are shown on the accompanying map as Area 3. The other two deposits are $2\frac{1}{2}$ miles north-northwest, and $3\frac{1}{2}$ miles north, of Jacksonville respectively; they were mapped by pace and compass,

and are designated as Areas 1 and 2, on the accompanying map.

The manganese deposits described in this report, in particular those of Iron Ore and Moody Hills, contain considerable iron, and at one time were mined for that metal.

Iron Ore Hill

General. Iron Ore Hill lies about 1 mile northwest of Jacksonville. The manganese is found in a highly contorted manganiferous iron formation, which outcrops along the crest of Iron Ore Hill. These deposits were worked at one time for the iron content of the rock. Exposures are rare except along the walls of the pits of the old workings. The lack of outcrop has rendered it difficult to determine, with any accuracy, the width of the manganiferous material, the grade, and the stratigraphy of the deposit. The deposit is readily accessible by road, and the land in the vicinity is cleared and under cultivation.

Geology. Low-grade manganiferous hematite interbedded with red and green slates comprise much of the rock of this deposit. These rocks have been folded into a series of steeply plunging anticlines and synclines. Small faults and slickensided surfaces were observed in several places, but major dislocations were not noted.

Due to the lack of exposures the writer was unable to observe all parts of the ferruginous zone, but an earlier report¹ mentions that the beds of hematite reach a thickness of 16 feet. The width of the zone in which the beds of hematite occur varies considerably; it was noted to be as much as 200 feet in places.

The folds plunge steeply towards the northwest; the dip of beds on the limbs of the folds are also steep, and overturning of the beds is

¹Ells, R. W.: op. cit., p. 2, No. 5.

frequent. The strikes of the beds vary considerably, but the over-all trend of the deposit is to the northeast.

Veinlets of quartz, carrying pyrite and chalcopyrite, cut the bedding of the hematite and slates along the crests of the numerous folds. The amount of sulphides with these quartz veins is insignificant, and should have little, if any, bearing on the development of the deposit for iron or manganese.

Beyond the limits of the old workings the structure of the hematite and slate beds is unknown, and there are no exposures of bedrock to indicate further extension of the deposit. Such information may be obtained only by an intensive exploration program involving diamond drilling and trenching.

Character of the 'Ore'. Hematite and interbedded slates are the host rocks for the manganese minerals. Although the cryptocrystalline character of the rock prevented the identification of manganese minerals in thin sections and polished sections, the presence of the metal is made evident by the assays (See Table I) and the dense black coating of manganese oxide on exposed surfaces.

The hematite occurs in a dark red, fine-grained, very finely laminated rock, containing detrital quartz, chlorite (daphnite?), calcite, and small amounts of magnetite. Paralleling the laminae of the low-grade hematite are bands, up to 1 centimetre thick, and elongated pods or 'wheatstones' of a light-coloured, fine-grained carbonate. The carbonate effervesces when treated with dilute acid, and has optical properties that lie between those of calcite and rhodochrosite. The weathered surfaces of the bands and pods are heavily coated with black manganese oxide.

The red and green slates are all heavily stained with a coating of manganese oxide on the weathered surfaces. In thin section detrital quartz was the only mineral identified, the other minerals in the slates

are too fine grained to be identified by conventional methods with a petrographic microscope.

Manganese ores of a similar character to those described above are found in an adjoining area in the State of Maine. The manganese minerals identified in these ores, some of them with the aid of X-ray studies, included braunite ($3(\text{Mn},\text{Fe})_2\text{O}_3 \cdot \text{MnSiO}_3$), bementite ($\text{MnO} \cdot 7\text{SiO}_2 \cdot 5\text{H}_2\text{O}$), and manganiferous carbonate¹. It is probable that these are also the minerals that contribute the manganese to the hematite deposits in the Woodstock area.

Metamorphism. The low-grade manganiferous hematite and interbedded slates have undergone considerable change along the crests of several folds. The bands and elongated pods of fine-grained carbonate have been recrystallized, but are still manganiferous, in that the exposed faces of the carbonate crystals are black, with a coating of manganese oxide. The bands in the metamorphosed rock are approximately half the width of those in the unaltered rock. The optical properties of the metamorphosed carbonate are approximately the same as those of the unaltered material -- between those of calcite and rhodochrosite.

The hematite of the metamorphosed areas contains minerals similar to those found in the unaltered parts of the deposit but in different proportions. The main difference appears to be in the relative amounts of magnetite, as the metamorphosed zones contain much more of that mineral. No manganese minerals were identified in thin sections made of the metamorphosed hematite or slate, although both are heavily stained with manganese oxide on exposed surfaces.

The fissile green slates, interbedded with the hematite, have been transformed into a dense, dark green, laminated rock. Study of thin sections

¹White, W. S.: Occurrence of Manganese in Eastern Aroostock County, Maine; U.S. Geol. Surv., Bull. 940E, 1943.

of this rock indicates that the original mineral constituents have been reconstituted and that the laminae of the rock are either quartz or chlorite rich. Considerable calcite and magnetite are also present in these rocks. The red slates do not appear to have undergone any noticeable change.

The hematite and slate beds are cut by many quartz and quartz-calcite veinlets; on exposed surfaces the latter are coated with a thin layer of manganese oxide. Small veinlets of pyrite were also noted cutting the laminae of the hematite.

There may have been an introduction of manganese from an outside source into the low-grade hematite of the metamorphic areas, as assays taken from several areas indicate. In Table I, sample 51-4 is from a channel taken across a succession of interbedded slate and hematitic beds on the limb of an anticline; sample 51-5 is taken from the crest or metamorphosed section of the same anticline, and from the same beds. The latter sample has 10 per cent more manganese than the former.

Moody Hill

General. Moody Hill is about $\frac{1}{2}$ mile southwest of Iron Ore Hill. The deposits of manganese and iron are located on the southward slope of the hill, and are readily accessible, as a road from Iron Ore Hill runs along its east side. The southern part of the hill may be reached by a road between Jacksonville and Hartford. The old workings are found in the open bush that covers a large part of the hill.

Bedrock exposures are relatively plentiful at and near the crest of the hill. Overburden is generally quite thin, commonly not more than 3 or 4 feet, except in the saddle between Iron Ore and Moody Hills, where it may be as much as 20 feet.

Geology. The manganese deposits of Moody Hill consist of several lenticular, manganiferous, ferruginous zones that are 10 to 100 feet in width and may be hundreds of feet in length. There are indications that many of these ferruginous zones are repeated by folding and faulting.

The rock assemblages of Moody Hill are similar to those of Iron Ore Hill. More outcrops were observed and the different rock types appear to have the following relationships:

Younger - green slate, red slate, red and green slates
with interbedded hematite

Older - dark grey calcareous slates

All the rock types listed above, with the exception of the calcareous slates, are heavily stained with manganese oxide. The manganese occurs largely in beds of low-grade manganiferous hematite, which vary in thickness from a fraction of an inch to 6 feet.

Although there are numerous outcrops at and near the crest of the hill, they are rare on the slopes, and in many cases the walls of the old pits offer the only sources of information as to the stratigraphy and structure of the deposits. It is apparent that the structure of the Moody Hill deposits is for the most part complex. On the accompanying map, trend lines are used to indicate the possible complexities of the deposits.

Locally the strikes of the bedding vary considerably, but the general trend of the beds is northeasterly. Dips are generally of a high order but may be as low as 30 degrees. Schistosity strikes northeast with almost vertical dips.

There are indications that faulting is important from a structural standpoint, but little direct evidence was obtained. The one fault shown on the accompanying map was located by a study of topography and of the distribution of rock types nearby. Topographic breaks, slickensided surfaces,

and minor displacement of beds were observed in other parts of Moody Hill, but the lack of continuity of these features did not permit accurate interpretation.

Character of the Ore. The ore of the Moody Hill deposits is a laminated, fine-grained, low-grade, manganiferous hematite with interbedded manganiferous slates, and is similar to that of Iron Ore Hill. Analyses of this material show the presence of considerable manganese, but in lesser amounts than found in similar material of Iron Ore Hill.

Pods and narrow bands of fine-grained manganiferous carbonate, which were noted in the hematite of Iron Ore Hill, also occur in the hematite of this deposit. The manganese occurs in much the same manner as in the unaltered parts of the Iron Ore Hill deposit. Metamorphosed areas, such as were found in the other deposit, were not noted here.

The manganese content of Moody Hill ores compares favourably with that of the ores of Iron Ore Hill, but in general the orebodies are narrower and lack the continuity displayed at Iron Ore Hill.

Assays of the material from the Moody Hill deposits are given in Table I.

Area 1

A small exposure of manganiferous hematite was found in a pit about $1\frac{1}{2}$ miles north of Iron Ore Hill (See map). The pit was dug in a ferruginous zone of indefinite width. The occurrence is in the middle of a small hardwood grove within a few hundred yards of a gravel road.

The exposed rocks comprise several thin beds of a fine-grained, low-grade hematite interbedded with red and green slates. Four of the largest hematite beds were up to 16 inches wide. Impure limestone was found in the vicinity but its relationship to the ferruginous zone is unknown. All the rocks are contorted and broken, with a strong northeasterly

schistosity. The strike of the bedding, where observed, is mainly conformable to that of the schistosity, and dips are all steep. A layer of black manganese oxide coats all the exposed rock. No data could be obtained on the stratigraphy, but it appears that the deposit pinches out a short distance to the south.

The manganese content of the material is considerably less than that found at Iron Ore and Moody Hills, but the mode of occurrence of the minerals appear to be the same.

Analyses of the ore from Area 1 is given in Table I.

About 500 feet east of Area 1 is a zone of ferruginous slates about 250 feet wide. This zone contains much red slate and numerous, narrow stringers of hematite. One-half mile south, along the extension of this zone, is another 10-foot ferruginous zone containing beds of hematite, the largest of which was 8 inches thick. The rocks in both of these localities were heavily stained with manganese oxide. It appears quite possible that these zones represent the northward extension of the Iron Ore Hill deposit.

Area 2

Ferruginous rocks outcrop at a point about 200 yards west of the highway about $3\frac{1}{2}$ miles north of Jacksonville (See map). A pit approximately 300 square feet in area and 15 feet deep was dug in iron formation, apparently for exploratory purposes. The land in the vicinity of the deposit is cleared, but due to the stony nature of the soil and the numerous outcrops it is not under cultivation.

The stratigraphy of the deposit has been determined to a limited extent and the various rock types appear to have the following relationship and thicknesses:

	Feet
(1) Dark grey calcareous slate	50 +
(2) Red slates	100
(3) Red slate with interbedded hematite	20
(4) Grey, sandy slate	2
(5) Conglomerate	150
(6) Red and greenish grey slates	60
(7) Thinly bedded limestone	20 +

The conglomerate is composed of fragments and pebbles of hematite, red and green slate, grey slate, chert, quartz, and fossil material, bound in a calcareous cement. The fossil material was examined by the Palaeontological Division of the Geological Survey and identified as crinoid stems and Favosites gothlandicus (Fought); the latter indicates a Silurian age. The conglomerate varies considerably in thickness and appears to be lenticular; interbedded with it are several bands of manganiferous hematite, measuring from a fraction of an inch to 10 inches in thickness.

The main deposit of manganiferous hematite is confined to a zone about 20 feet wide (bed No. 3, above). The deposit is composed of red slates and hematite. The hematite is in narrow beds up to 16 inches thick, and is similar to the manganiferous hematite described in the other deposits. Red slates comprise the greater part of this ferruginous zone. Light-coloured, fine-grained, manganiferous carbonate, first described in the Iron Ore Hill deposit, is also present in the hematite of this deposit in the form of elongated pods and bands.

The structure of the bedrock in this area does not appear to be complicated either by folding or faulting. The strike of the bedding

and the schistosity are approximately parallel and trend northeast. Dips of both bedding and schistosity are steep.

An assay of material from this deposit is given in Table I.

ASSUMED EXTENT OF THE MANGANESE DEPOSITS

The rock assemblages of each of the manganese occurrences in the Woodstock area are similar. The manganese-bearing rocks commonly outcrop in a definite pattern that follows the structure of the enclosing strata. There may be only one manganiferous horizon, but this is doubtful; it is more probable that there are a number of lenticular bodies of manganese-rich rock scattered through and along a belt about 2 miles wide and up to tens of miles long.

The manganiferous strata of Iron Ore Hill cannot conservatively be assumed to extend for more than a few hundred feet beyond the limits of the old workings. The contorted structure and the lack of outcrop in the vicinity make any forecasts of their continuity purely hypothetical. A southward extension towards Moody Hill and, in particular, a junction with these latter deposits, must be based on information gained from trenching or diamond drilling. The same remarks apply to a northward extension of the strata toward Area 1.

The Moody Hill deposit comprises several bodies of manganiferous rocks, none of which may be extended beyond the outcrop area with any accuracy. Information derived from the outcrops indicates that these deposits are contorted as much as, if not more than, those of Iron Ore Hill. A northward extension of manganiferous strata toward Iron Ore Hill must be proved by exposed rock or by diamond drill cores; as both of these are lacking, no attempt has been made to indicate on the map the continuity of the manganiferous beds between the two major occurrences.

The manganiferous beds of Moody Hill have been traced to within $\frac{1}{4}$ mile of Meduxnekeag River. Almost continuous outcrop along the river bank, and in railway cuts within 100 yards of the river, do not show the presence of such beds. The rocks along the river and railway are grey-green slates, dark grey calcareous slates, and limestone breccia.

The manganese horizon of Area 1 may be traced, by outcrops and soil fragments, to a small pit about 2,500 feet to the northeast. Between this pit and Area 2 there are no outcrops and the soil cover appears to be quite thick, so information of any extension of the manganiferous beds to the northeast must be based on further exploration. The writer believes, however, that a short distance north of the before-mentioned small pit the manganiferous zone pinches out, and that the deposits of Area 2 lie stratigraphically above it.

There is no evidence in the vicinity of Area 1 by which the manganiferous strata could be assumed to extend any distance southward toward Iron Ore Hill; it appears unlikely that the two deposits are in the same stratigraphic position, although the rock assemblages of each are very similar. About 500 feet to the east of Area 1 there is a zone of ferruginous rocks about 250 feet wide. About $\frac{1}{2}$ mile south of this zone there is an outcrop of manganiferous hematite, and it is possible that these two areas are related and that they represent the northward extension of the Iron Ore Hill deposit.

The manganese rocks of Area 2 appear to be lenticular, and, as mentioned earlier, are believed to lie stratigraphically above those of Area 1. No attempt has been made to assume an extension of the strata of ores between Areas 1 and 2.

Reports written on the occurrences of iron ore in this part of New Brunswick, and observations made in the field by the writer, indicate

that the belt of manganese and iron-rich rocks may extend for tens of miles northeasterly from Area 2, but little or no detailed information is available.

ORIGIN OF THE MANGANESE DEPOSITS

The manganese deposits of the Woodstock area are of sedimentary origin. The associated, thinly bedded, calcareous slates, limestones, and fossiliferous strata show that the manganiferous rocks were probably deposited as marine sediments, in shallow water a considerable distance from shore.

It has been suggested by Caley¹, that the iron and manganese concentrations in the rocks were the result of chemical precipitation accompanying volcanic activity. No volcanic rocks are directly associated with the deposits, but extrusive rocks occur in other parts of the region within a radius of 10 miles. These volcanic rocks are regarded as being in the same stratigraphic sequence as that of the manganese and iron-rich rocks.

White², and later Miller³, studying similar manganese deposits in Maine, are inclined towards the view that the manganese was derived from the subaerial weathering of an adjacent landmass, and deposited as geosynclinal sediments. Miller, however, does believe that volcanic activity during Silurian time played a role in the formation of the deposits.

Due to the limited amount of geological information available on the surrounding region, it is difficult to prove or disprove any one theory of genesis of these deposits. From various field observations the writer favours the suggestions put forward by Caley.

¹Caley, J. F.: op. cit., p. 19.

²White, W. S.: op. cit., pp. 142-144.

³Miller, R. L.: Manganese Deposits of Aroostock County, Maine; Maine Geol. Surv., Bull. 4, pp. 33-36 (1947).

RESERVES OF MANGANESE

The lack of subsurface data and the scarcity of bedrock exposures have been limiting factors in the estimation of manganese reserves in the Woodstock area. The reserves of the two larger deposits, that is, Iron Ore and Moody Hills, have, however, been calculated.

The manganese and iron deposits are sedimentary and may, therefore, be assumed to extend for a distance below the surface comparable to their lateral extent, but the complex structure and the apparent lenticular shape make it necessary to limit the assumed depth in estimations of reserves; this depth has been taken at 100 feet.

Assays of the manganese-rich rocks of Iron Ore and Moody Hills indicate that there is at least 10 per cent manganese across the width of the old iron workings; in places, this width may be as much as 200 feet. It is probable that further exploration of the deposits will reveal that the average grade is higher than 10 per cent.

Estimated reserves of possible 10 per cent manganese ore are as follows:

Iron Ore Hill 1,500,000 tons
 Moody Hill 800,000 tons¹

ASSAYS OF THE MANGANESE AND IRON DEPOSITS OF THE WOODSTOCK AREA

Table I
IRON ORE HILL

Sample	Iron %	Manganese %	Phosphorous %	Sulphur %	Width Feet
51-4	22.42	12.18	0.56	0.23	8
51-5	19.10	22.38	0.51	0.10	11
51-6	14.74	16.84	0.38	0.02	10
51-7	22.22	14.99	0.86	0.13	10
51-8	17.94	10.48	0.39	0.12	10
568	20.91	18.53	1.28	trace	10
569	15.05	14.10	0.56	0.25	8
570	30.00	9.30	1.02	0.02	12
571	27.47	10.80	0.89	0.03	11.5
579	25.48	14.69	0.96	0.09	28
581	24.95	10.28	0.86	0.13	7

MOODY HILL

51-3	26.06	12.26	0.69	0.02	11
583	31.51	12.15	1.08	0.02	5.5
584	26.97	14.84	1.09	0.02	4.5
584	24.85	11.10	0.87	0.03	4
586	26.06	11.25	0.88	0.03	5
587	23.63	14.25	1.25	0.04	5
588	22.02	12.08	0.87	0.05	5

AREA 1

51-1	13.88	6.97	0.28	0.02	7
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AREA 2

51-2	20.50	8.86	0.49	0.03	15
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Note: Numbers preceded by '51' are of samples assayed by the Mines Branch, Department of Mines and Technical Surveys, Ottawa; other numbers are of samples taken in 1939 by the Department of Lands and Mines, New Brunswick, and assayed by J. T. Donald & Co., Ltd., Montreal, Quebec.

¹Comprises the total of the estimated tonnages of the larger orebodies of Moody Hill.