ONTARIO DEPARTMENT OF MINES

Geological Report No. 36

Casey and Harris Townships

By

R. THOMSON

1965

ONTARIO
DEPARTMENT OF MINES

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Geology of
Casey and Harris Townships
District of Temiskaming

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TABLE OF CONTENTS

Geological Report No. 36

Tables

Photographs

Figures

Geological Map
(back pocket)

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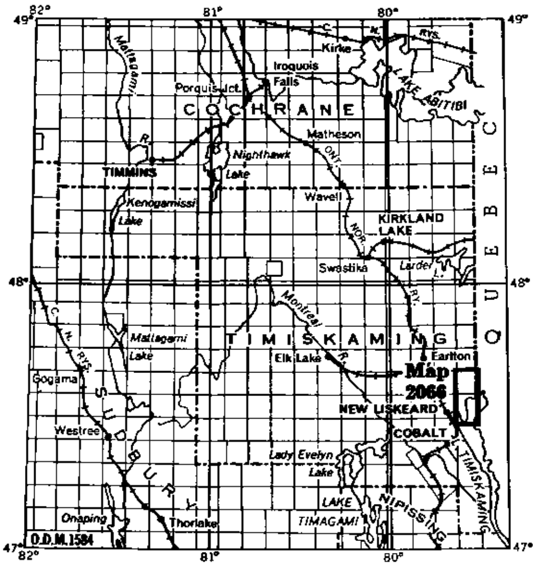
ABSTRACT



Key map showing location of map area. Scale 1 inch to 50 miles.

This report deals with the general, structural, and economic geology of Casey and Harris townships, situated about 20 miles northeast of Cobalt in the District of Timiskaming. The field work was carried out in 1962.

The townships lie within the Timiskaming silver-cobalt area, which contains one producing silver-cobalt mine known as the Langis mine.

The bedrock in the area comprises Precambrian and Paleozoic rocks. The Precambrian consists of Keewatin metavolcanics and metasediments cut by pre-Algoman, Algoman, and post-Algoman intrusive rocks, overlain by Cobalt Group sedimentary rocks, which are intruded by a sill of Nipissing Diabase. The Cobalt Group rocks have a thickness greater than 772 feet. Only the lower part of the Nipissing Diabase sill has escaped erosion in the map-area.

The Paleozoic rocks are Ordovician and Silurian shales, sandstones, limestone, and dolomite.

Prospecting for silver and cobalt deposits in unexplored parts of Casey and Harris townships depends to a large extent on two factors: the presence and depth of the Cobalt Group–Keewatin contact; the depth of overburden. The mapping showed that much of the area is not amenable to surface prospecting owing to the depth of overburden. Other parts seem to offer exploration possibilities.

Geology of Casey and Harris Townships

District of Timiskaming

By

R. Thomson[1]

Introduction

Casey and Harris townships are at the north end of Lake Timiskaming, about 8 miles northeast of New Liskeard.

Rich silver-cobalt deposits were discovered at Cobalt in 1903, and about three years later a similar type of deposit was discovered in Casey township. From 1906 to the present, prospecting and mining have been carried out intermittently. Production of silver and cobalt has been obtained at only one mine, at present known as the Langis mine; it is the only operating mine.

In 1962 the two townships were remapped by the Department to facilitate prospecting, and in November 1962 two uncoloured preliminary geological maps by the author were issued: P.162—Casey township, scale, 1 inch to ¼ mile, contour interval 50 feet; P.163—Harris township, scale, 1 inch to ¼ mile, contour interval 50 feet. At the same time a 500-word description of the geology was contained in Preliminary Report 1962-4, which is a summary of the Department's field work for 1962.

Basemaps used were compiled by the Cartographic Unit of the Ontario Department of Mines from maps of the Ontario Department of Lands and Forests (Forest Resources Inventory Map-sheets Nos. 474793, 475793, 476793) and Canada Department of Mines and Technical Surveys (National Topographic System Map-sheet No. 31 M/12E). On the basemaps was set down information obtained by the author prior to 1962 in the course of routine work as Resident Geologist at Cobalt for the Department, and additional information obtained during the 1962 field season. Air photographs on the scale of 1 inch to ¼ mile, obtainable from Ontario Department of Lands and Forests, were also used in the field mapping.

Acknowledgments

During the 1962 field season C. A. Giovanella was the senior geological assistant, and Vincent Kennedy the junior assistant; B. E. MacKean assisted in the drafting. Their assistance is gratefully acknowledged.

All the companies and individuals engaged in mining and prospecting were co-operative and helpful; acknowledgments are made in the descriptions of the individual properties.

Certain results of studies by B. E. Lowes (1963), covering not only the Langis mine but also other parts of the map-area, are incorporated in the present report, and the author is indebted to Mr. Lowes for making these results available.

Means of Access

New Liskeard, in Dymond township, situated on old Highway No. 11 and on the Ontario Northland Railway, is the centre from which access to the town-

[1] Resident Geologist, Ontario Dept. Mines, Cobalt.

ships is most convenient. The village of Belle Vallée, in the northwestern part of Casey township, is the largest centre within the map-area; others, much smaller, are Pearson, and Judge. Highway No. 65 passes through New Liskeard and, after traversing Harris and Casey townships, connects with the Province of Quebec system of highways.

The two townships are well supplied with secondary roads to service the extensive farmland areas. Almost every point in the township is less than a half-mile walk from either a road or highway.

Previous Geological Work

The first geological exploration in the map-area appears to have been undertaken by Alexander Murray (1846), under the direction of Sir William Logan who was the founder and first director of the Geological Survey of Canada.

Logan (1863, p. 336) mentioned the presence of Huronian sedimentary rocks in what is now Harris township.

Burrows and Hopkins (1922) mapped and described a large area including the two townships. Their map and report have been widely used in prospecting; nearly all the information in it dealing with the two townships is contained in the present report.

Hume (1917; 1925) investigated an area including Casey and Harris townships particularly with reference to the Paleozoic rocks.

Aeromagnetic Series Maps Nos. 511G and 514G, published in 1957 by the Geological Survey of Canada, were compiled from surveys made in 1947, 1948, and 1949, and these maps include Casey and Harris townships.

Ollerenshaw and MacQueen (1960) wrote of certain formational relationships in the Paleozoic.

A thesis by Lowes (1963) contains the results of his studies (dealing particularly with the structural geology) of the Langis mine and its vicinity.

Topography, Overburden, Drainage

About two thirds of the surface of the Casey-Harris map-area is a plain whose altitude is approximately 600 feet above sea-level; the other third is upland occurring in two separated areas.

For some purposes it may be convenient to determine altitudes in the map-area by utilizing the water-level of Lake Timiskaming. The normal water-level of Lake Timiskaming is about 585 feet above sea-level. (Forest Resources Inventory maps of Ontario Dept. Lands and Forests show a high water-level of 589 feet, and a low water-level of 579 feet.) A convenient bench mark for determining the water-level of Lake Timiskaming is near the west end of the concrete pier (approximately in line with Main Street) at Haileybury which is about 10 miles by road from New Liskeard. The altitude of this bench mark is 593.24 feet above sea-level.

The highest altitude in the two townships is in the southern part of Harris township and is slightly above the 850-foot contour.

An upland area in the southern part of Harris township and the southwest corner of Casey township has as its easterly limit an east-facing escarpment. From the crest of the escarpment the surface slopes gently westward. For about 1½ miles west of the crest, outcrops are abundant and bedrock is near the surface. This escarpment is a marked topographic feature; on the east side of the

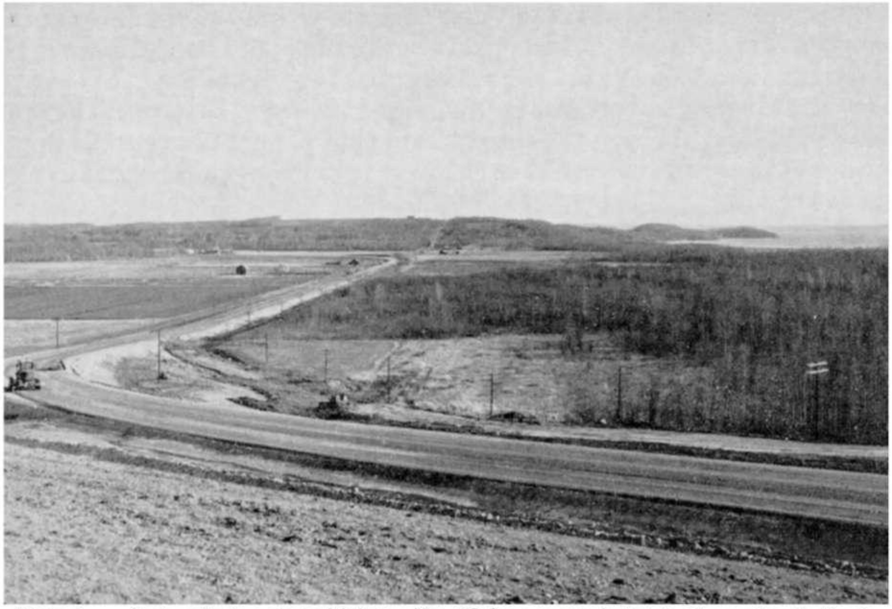


Photo 1 — Eastward view along Highway No. 65 from cuesta in Lot 3, Concession V, Harris township, showing the nearly level plain, and the southwest part of Casey Mountain; Lake Timiskaming is in right background.

peninsula ending in Dawson Point (formerly known as Wabi Point) it rises precipitously, in many places as rock cliffs, to a height of 140–200 feet above Lake Timiskaming; north of the lake the slope is gentler, and rock is not generally exposed along it.

Another upland area, known as Casey Mountain, extends from the hill in Lots 5 and 6, Concession II, Casey township, south to Lake Timiskaming. Casey Mountain has, in places, abundant rock outcrops; this "mountain" is mainly a gently southeastward-sloping clay plain, and is about 200 feet above a surrounding plain of about 600-foot altitude.

The lowland plain in Concessions V and VI of Harris township and the Casey Mountain upland area are shown in the accompanying photograph.

The lowland plain occupies almost the entire northern part of Casey township and extends to Lake Timiskaming as tongues along the Blanche River and Sutton Creek. The surface of the plain is almost entirely bedded (varved) clay deposited in extinct Lake Barlow-Ojibway, which existed at the close of Pleistocene glaciation. It is part of the great clay belt that extends many miles to the north. The overburden in the map-area is made up mostly of this clay.

On file in the office of the Resident Geologist at Cobalt are records (location, depths, drill logs) of more than 120 water wells in Casey and Harris townships.

Information on the depths of overburden in much of the farmland in the map-area was obtained mostly from local residents, but some data were taken from water-well records in the files and publications of the Ontario Water Resources Commission, and from previous reports by Watt (1953, p. 291; 1957, p. 229) and by Hume (1925, p. 54). The depths of overburden are shown on Map No. 2066 accompanying this report.

Depths of overburden at certain points in the vicinity of the Dolphin-Miller and Langis shafts are given in accompanying Figure 5 and on the Benner-Harris Group (Harris twp., Con. V, Lot 8) in accompanying Figure 6.

The only river of importance in the map-area is the Blanche; it flows with very gentle gradient through the nearly level clay plain. Water wells drilled in the vicinity of the river indicate that the river is much more than 200 feet above bedrock in the area.

Geological Control of Topography

The lowland clay plain as previously mentioned is a surface of deposition, and was once occupied by the extinct glacial Lake Barlow-Ojibway.

The upland area in the southern part of Harris township and extending into the southwestern part of Casey township is an example of the land form known as a cuesta; its origin and nature are explained in a previous report (Hume 1925, p. 4). The top part of the west-dipping Paleozoic rocks in this upland area is of resistant dolomite; below are less resistant limestones and shales. Differential erosion of this assemblage produced the east-facing escarpment. Possibly this preglacial cuesta was modified to some extent by glaciation.

The origin of the topography shown by the Casey Mountain upland area is somewhat complex. Although the position of the bedrock surface is the most important factor controlling the topography, the deposition and later erosion of the Lake Barlow-Ojibway clays also played their part. Prior to deposition of the Paleozoic rocks, there appears to have been a hill possibly of somewhat the same extent as the present upland; this is briefly discussed on page 25 of this report under the heading Relief of the Paleozoic Floor.

The north end and the south end of Casey Mountain are rock covered by a thin veneer of unconsolidated material; they are thought to be mostly erosion residuals of the pre-Paleozoic hill.

On the central part of Casey Mountain, in the vicinity of the Casey-Harris township line, the bedrock is covered by a considerable thickness of Lake Barlow-Ojibway clay, and the surface is a gently sloping clay plain. The steep west-facing slope of the mountain (between Langis Nos. 4 and 6 shafts in Lot 5, Con. I, Casey twp.) and the east-facing slope (in Lot 6, Con. I, Casey twp.) are erosional features (essentially terraces) that were developed in the Lake Barlow-Ojibway clays. Presumably the gently sloping clay plain on Casey Mountain and the lowland clay plain at one time merged into a gently curving slope; erosion in late Pleistocene time developed these abrupt slopes (terraces).

Natural Resources

Agriculture is the most important industry in the map-area; about one third of the area is under cultivation. The bedded clays of the nearly level lowland plain form good soils, but in places adequate drainage is a problem.

Lumbering was at one time of importance but is not at present, owing to the depletion of timber resources.

General Geology

Rocks present in the map-area represent three major geological time units: a Precambrian era; the Paleozoic era; the Cenozoic era.

TABLE OF FORMATIONS

CENOZOIC	
RECENT	Swamp and stream deposits.
PLEISTOCENE	Bedded clay, sand, gravel, boulder clay.
	Unconformity
PALEOZOIC	
SILURIAN	Lockport (Thornloe) Formation: Dolomite, magnesian limestone, sandstone.
	Disconformity(?)
	Wabi Formation: Limestone, shale.
	Disconformity(?)
ORDOVICIAN	Unnamed Formation: Shale.
	Disconformity(?)
	Liskeard Formation: Limestone, shale, sandstone.
	Unconformity
PRECAMBRIAN	
PROTEROZOIC	
KEWEENAWAN	Quartz diabase (Nipissing Diabase sill).
	Intrusive Contact
HURONIAN	Cobalt Group (Gowganda Formation): Conglomerate.
	Unconformity
ARCHEAN	
POST-ALGOMAN	Basic Intrusive Rocks: Lamprophyre.
	Intrusive Contact
ALGOMAN	Syenitic Plutonic Intrusive Rocks: Hornblende syenite.
	Intrusive Contact
PRE-ALGOMAN	Basic Intrusive Rocks: Metadiorite; amphibolite, talc-chlorite rock; lamprophyre.
	Intrusive Contact
KEEWATIN	Metasediments and Metavolcanics: Andesitic lavas. Mica schist. Iron formation (does not outcrop).

A division of the Precambrian into two parts can be made readily on the basis of age: a younger part, the Proterozoic; and an older, the Archean.

The Archean rocks include deformed and metamorphosed volcanic and sedimentary rocks, usually referred to as Keewatin, and a syenitic plutonic intrusion, usually referred to as Algoman, that intrudes the Keewatin rocks. Other intrusive Archean rocks are present but in relatively small amount.

From Archean time to the present, the area was not subjected to any forces giving noteworthy folding in the layered rocks. A long period of erosion intervened between the Archean and the Proterozoic.

The Proterozoic rocks include gently dipping Huronian sedimentary rocks of the Cobalt Group, and the Keweenawan Nipissing Diabase sill that intrudes the Huronian rocks. Only the lowest part of the Cobalt Group, the Gowganda Formation, is present in the map-area; this formation appears to be of glacial origin.

Following a long period of erosion, Paleozoic rocks were deposited. The Silurian and Ordovician rocks that remain constitute part of what is commonly referred to as the Lake Timiskaming Paleozoic outlier. The structure of the outlier was influenced by post-Silurian faults. The gentle westerly dip of the Paleozoic rocks in the map-area is due essentially to the east-side-down movement along the Lake Timiskaming Fault that lies west of the map-area.

For the long period of time between the Silurian and the Pleistocene, there is no record of rock in the map-area.

The most striking characteristic of Pleistocene time is the continental glaciation that occurred then. Directly associated with the glaciation was erosion; directly and indirectly associated with it was deposition. In the final retreat of the ice a very large lake, Lake Barlow-Ojibway, formed in front of the ice and, in this lake, bedded varved clays were deposited. With final withdrawal of the ice, the lake was drained and this may be taken as the start of Recent time.

During Recent time there have been changes of level of the land surface due to crustal warping. Those processes of erosion and deposition, such as may be seen going on at present, have been active.

KEEWATIN

Metasediments and Metavolcanics

Outcrops of rocks grouped under the name Keewatin make up less than ½ percent of the map-area. Keewatin rocks are found in four widely separated parts in the two townships: (1) Harris township, Concession V, Lots 7 and 8; (2) Casey township, Concession I, Lot 5; (3) Casey township, Concessions V and VI, Lot 11; (4) Harris township, Concession A and the adjacent part of Lake Timiskaming. In the first three areas, the Keewatin appears as outcrop.

For most of the other parts of the map-area, information is lacking on the nature and extent of the Keewatin due to deep burial beneath younger rocks.

The Keewatin rocks of (1) and (2) are predominantly lava; those of (3) and (4) are metasediments. The Keewatin rocks of (1), (2), and (3) have nearly vertical dips and are clearly pre-Algoman; information on the attitude and relationships of the Keewatin metasediments of (4) is limited.

The structural and stratigraphic relationships between the Keewatin of the four separated parts of the area are not known. Each part is treated separately in the description given below.

HARRIS TOWNSHIP, CONCESSION V, LOTS 7 AND 8

In Concession V, Lot 7 an outcrop area of Keewatin rocks occurs at and near the shore of Lake Timiskaming; in the SW.¼ of N.½, Lot 8, Concession V, information on the Keewatin underlying the Cobalt Group sedimentary rocks was afforded by diamond-drilling.

The Keewatin rocks of the outcrop-area consist of intermediate to basic lavas, in part fine-grained and with pillow structure, in part coarser-grained. The rocks are in general massive. In outcrops of lava within a few feet of the lakeshore and at about 2,400 feet south and 1,750 feet west of the northeast corner of Lot 7 in Concession V, rare prehnite-filled vesicles of about ½-inch-diameter occur.

The intersections of Keewatin rock in the drillholes on the Benner-Harris Group are indicated in Figure 6. In addition to basic to intermediate lavas, tuffaceous rocks and typical bedded cherty magnetite-bearing iron formation were intersected. At least three bands of iron formation were intersected; the widest of these appears to have a true thickness of about 25 feet. In the iron formation cut by Drillhole No. 10, yellow-brown garnet occurs in crystals up to ¼ inch across and aggregated into irregular bands. Magnetite was not in general plentiful; it occurred in bands up to ½ inch in width. In places, pyrite and pyrrhotite were present.

The absence of any significant magnetic anomaly at this vicinity on Aeromagnetic Series Map No. 514G suggests that the zone of iron formation bands, or at least of those with important magnetite content, is not extensive.

The Keewatin lava flows strike approximately N.60°E. and have steep dips; as shown by pillow shapes on outcrops, the tops of the flows are toward the southeast.

CASEY TOWNSHIP, CONCESSION I, LOT 5 AND VICINITY

In Lot 5, Concession I, Casey township, only one Keewatin outcrop is known; it is but a few square feet in area and is 700 feet north of the Langis No. 3 shaft. In general, rather limited exposures of Keewatin rocks are present in the underground workings of the Langis Nos. 3 and 6 shafts.

The most extensive exposure is on the deeper levels, that is, the 355-foot level of Langis No. 3 shaft and the 401-foot level of Langis No. 6 shaft. North and northeast of the Langis mine, the Keewatin rocks are cut off by an Algoman plutonic intrusion. The position of the contact between Keewatin (to the south) and Algoman (to the north) is not known in those parts of Lots 6, 7, and 8, Concession I, Casey township, that are covered by younger rocks. The contact may be assumed to pass at depth through the middle of Lot 8; on Map No. 2066, this would place it midway between H. K. Explorations Limited Drillhole S-2 (NW.¼ of N.½) and the Langis drillhole shown in the NW.¼ of S.½.

Keewatin rocks exposed in the underground workings of the Langis mine and intersected by diamond-drillholes are predominantly intermediate to basic lavas; interflow beds of cherty sedimentary rocks and tuffs are present in quite subordinate amount. Some of the interflow beds contain carbonaceous material in such quantity that the fingers become soiled in the handling of specimens.

This carbonaceous material is exposed along the No. 26W. drift (about 170 feet south and 370 feet west of No. 3 shaft) on the 355-foot level of Langis No. 3 shaft workings. A tuff exposed in the No. 43 vein drift (about 200 feet south and 120 feet west of No. 6 shaft) on the 401-foot level of Langis No 6 shaft workings shows light-grey angular fragments up to 2 inches across in a dark grey matrix.

A soft grey nondescript rock exposed recently in the southeast part of the 401-foot level of Langis No. 6 shaft differs from the Keewatin rock types previously mentioned; it may be an unusual tuffaceous rock, but further work is required to determine its nature and distribution.

The Keewatin flows have a generally easterly strike but show a considerable variation in this; the dips are nearly vertical. No satisfactory stratigraphic marker horizon has been found.

CASEY TOWNSHIP, CONCESSIONS V AND VI, LOT 11

The scattered Keewatin outcrops in Lot 11, Concessions V and VI, Casey township, are of mica schist. The derivation of the schist from bedded sedimentary rocks can be recognized in most places and it is believed that all the Keewatin here was of sedimentary origin.

The schist is grey with a faint brown tinge; the mica flakes are commonly about 0.1 millimetre in size but are up to 1 millimetre. In most exposures schistosity is well developed. In general the grain size (about 0.1 mm.) is too small to permit easy identification of the contained minerals but, in places, quartz grains can be identified. In some places the original bedding is distinct, in others quite obscure or absent. Andalusite metacrysts up to ¼ inch, but commonly 1/16 to ⅛ inch in size, compose about 15 percent of bands in the mica schist outcrop situated 4,000 feet south of the northeast corner of Lot 11, Concession VI. The metacrysts stand out about ⅛ inch above the weathered rock surface.

Quartz veins and veinlets of irregular shape are common in the mica schist.

The well marked schistosity has a northerly strike and a dip of 50°–70°W. In an outcrop about 2,300 feet south and 300 feet west of the northeast corner of Lot 11, Concession VI, well marked bedding (widths of ⅛ to 6 inches) with strike N.26°E. and dip 65°–75°W. was transected by schistosity striking N.9°W. and dipping 67°W.

The mica schist described here was assigned by Wilson (1918) in his early work to the Pontiac Series of the Abitibi Group. Burrows and Hopkins (1922, p. 5) described it under the heading "Keewatin".

HARRIS TOWNSHIP, CONCESSION A

The Keewatin rocks in Concession A, Harris township, and the adjoining part of Lake Timiskaming are deeply covered by younger rocks.

Information on their nature and extent, and to some degree their attitude, is given on G.S.C. Aeromagnetic Series Map No. 511G. Direct information was afforded by the Lake Timiskaming No. 1 Drillhole (LT-1) drilled under Lake Timiskaming in January and February 1963. General information on this hole is given in this report on page 59 under Description of Properties, Claim T.52104 and Adjacent Claims. This hole, after traversing 840 feet of Paleozoic rocks, entered Keewatin sedimentary rocks. On Figure 8 is a plan showing the isomagnetic lines of the anomaly as copied from the Aeromagnetic Series Maps, the location of Drillhole LT-1, and a vertical geological section of that part of the hole below the Paleozoic rocks.

Table I — *Drillhole LT-1, angles of bedding surfaces measured from planes normal to core*

Footage	Angle	Footage	Angle	Footage	Angle	Footage	Angle
845	48°	907	40°	1,149	33°	1,267	35°
847	50°	940	30°	1,176	30°	1,287	35°
850	40°	954	22°	1,192	22°	1,310	20°
861	42°	1,012	42°	1,198	25°	1,328	25°
868	30°	1,033	37°	1,201	25°	1,359	35°
896	35°	1,050	30°	1,218	22°	1,376	35°

A log of the part of the hole that intersected Precambrian rocks is given in Table II (p. 10). In summary these consisted of bedded sedimentary rocks of two types, greywacke and iron formation; the greywacke was present in larger amount. The core length of the sedimentary rocks intersected was 548 feet corresponding to a thickness of about 450 feet. There does not appear to be a systematic change in the nature of the sediments over this thickness. Although the thickest iron formation member was between footages 846 and 963, thinner bands of iron formation were present to the bottom of the hole.

No evidence of strong deformation of the sedimentary rocks was seen. If the evidence of the core only, and not the geological context, is considered, the formation that was intersected would be considered a moderately dipping one that is tilted but not strongly folded.

At various footages the angles were measured between the bedding surfaces and planes normal to the core; these are listed in Table I.

If the entire length of the hole had been truly vertical (90°), these angles would be the dips; however, because the hole is vertical at the collar and only about 5° (tested) from vertical at the bottom, the difference between the angles shown in the core and the actual angles of the dips is presumably everywhere less than 5°. The angles range between 20° and 50°; taking into account the spacing of the readings, they average 31°. The average apparent dip of the beds is thus 31° $\pm$ 5°. Because the hole would have a tendency to become oriented normal to the bedding surfaces, the average true dip of the beds is probably about 36°.

Iron Formation

In Table II, the drill core logged as iron formation in Drillhole LT-1 consists of what may be termed iron formation-proper and greywacke, with the iron formation-proper composing more than 40 percent of the whole. The iron formation-proper is interbanded with greywacke and varies in abundance from place to place. Thus, of the iron formation between footages 846 and 963, that between 846 and 872 was roughly estimated to be 95 percent iron formation-proper, and that between 896 and 950 to be about 60 percent.

What is logged as greywacke in the hole includes, in places, minor amounts of iron formation-proper; in the greywacke between footages 1,291 and 1,388, a 0.3-foot length of iron formation-proper is found at footage 1,373.7, and a 0.1-foot length at footage 1,376. In general no difficulty was experienced in assigning the rock at any particular footage to either iron formation-proper or greywacke, but in places the interbanding is intimate.

Table II *Precambrian rock, Drillhole LT-1, footages 840–1,388*

Footage From	Footage To	Core Length in feet	Thickness of Stratum in feet	Descriptions and Remarks
0	27	——	——	casing.
27	840	——	——	Paleozoic rocks. (For log of these, *see* Table V, p. 27.)
				Precambrian. Keewatin rocks. 840 – 1,388
840.7	**846**	**5.3**	**3.5**	**greywacke.**
				845, a few beds of feldspar-rich greywacke.
846	**963**	**117**	**84**	**iron formation.**
				850, rare beds of feldspar-rich greywacke.
				850, a ¾-inch vein of pink calcite with quartz.
				850 – 872, about 3 percent of feldspar-rich greywacke bands.
				870, a 1¼-inch vein of pink calcite.
				885 – 894.5, about 60 percent of greywacke bands.
				896 – 944.5, about 40 percent of greywacke bands.
				944.5 – 963, about 55 percent of greywacke bands.
963	**1,027**	**66**	**49**	**greywacke.**
				966.5, more than 0.5 ft. of iron formation.
				1,013.5, a vein of quartz and pink calcite.
1,027	**1,054**	**27**	**22**	**greywacke and iron formation; the iron formation composes about 20 percent of the footage.**
1,054	**1,191**	**137**	**118**	**greywacke.**
				1,054 – 1,176, bedding absent or obscure.
				1,054 – 1,064, about 25 veinlets of quartz and calcite; widths up to ⅛ inch.
				1,077 – 1,083, breccia; fragments up to ¾ inch.
				1,088 – 1,111, about 25 veinlets, widths are ⅛ to ⅜ inch, mostly quartz, some calcite and some black tourmaline.
				1,111 – 1,135, about 12 quartz veinlets, widths up to ⅓ inch.
				1,143.5, a 1¼-inch vein of quartz and white calcite.
				1,159, a 1¾-inch vein of quartz and pink calcite.
				1,176 – 1,191, rare beds of iron formation.

Footage		Core Length in feet	Thickness of Stratum in feet	Descriptions and Remarks
From	To			
1,191	**1,291**	**100**	**87**	**greywacke with minor amounts of iron formation; for example, a 2-inch band at 1,191.5, and a 9-inch band at 1,191.7.**
				1,200 – 1,202.1, about 40 percent of iron formation bands.
				1,204.5 – 1,223, about 30 percent of iron formation bands.
				1,275 – 1,290.5, about 25 percent of iron formation bands.
1,291	**1,388**	**97**	**84**	**greywacke.**
				1,338, a 1½-inch vein of quartz and calcite.
				1,347.6 a 1½-inch vein of quartz, calcite, and minor amount of tourmaline.
				1,351 – 1,352.5, breccia.
				1,373.5, a 4-inch band of iron formation.
				1,376, a 1-inch band of iron formation.
1,388	End of hole.			

The iron formation-proper is finely and conspicuously bedded with laminae and beds ranging from 0.1 to 3 millimetres thick.

Many beds are red or red-brown and this gives a distinctive colour to the rocks as a whole; other beds and laminae are black, grey, or greenish.

The iron formation-proper contains, as essential constituents, chert,magnetite, and hematite; the amount of each of the essential constituents varies from bed to bed or lamina to lamina. Accessory constituents include quartz grains, rock grains, chloritic material, carbonate, and sulphides; in all places sulphides constitute less than a fraction of 1 percent.

Table III | *Drillhole LT-1, footages 846–872 (Analysis by Laboratory Branch, Ontario Department of Mines)*

	percent
Iron (Fe)	15.46
Silica (SiO_2)	41.74
Phosphorus pentoxide (P_2O_5)	0.90
Sulphur (S)	0.12
Manganese (Mn)	trace (less than 0.05)
Titanium (Ti)	trace (about 0.10)

The 26-foot section of Drillhole LT-1 between footages 846 and 872 contained iron formation more abundantly than any other similar length of the hole. The analysis is given in Table III.

Greywacke

The greywacke is grey to grey-green; it is soft in contrast to the iron formation. Bedding is generally not well marked; in some places it is prominent, but over considerable lengths of the core it is not readily observable. For the most part, the individual grains cannot be seen distinctly in hand specimens, but in places quartz, feldspar, and rock grains are prominent. Commonly the grain size is 0.1–0.2 millimetres, but in a few places are rock fragments up to 5 millimetres.

Structure and Correlation

The assignment of the Precambrian sedimentary rocks intersected by the hole to their proper stratigraphic unit depends to a large extent on the correct interpretation of the structure.

Correlation on the basis of lithological similarity does not afford an easy answer even though Miller (1913, p. 58) recorded the presence of Keewatin iron formation in outcrop at Sharp Landing in the northeastern part of Bucke township (*see* Figure 8) about 2½ miles west of Drillhole LT-1. Miller saw the outcrop of iron formation, reported as about 25 feet in length, before the surface of Lake Timiskaming was raised by a dam; the present author on his map (No. 1956a) of Bucke township (Thomson 1956) did not show the outcrop because it was not exposed when the map was made. Miller reported that the iron formation was of interbanded material striking a little north of west. Presumably exposure was very poor in 1910 as no information was given on the dip of the banding or on the structural relationship between the iron formation and the closely adjacent Timiskaming sedimentary rocks.

The position of the Keewatin outcrop on Map No. 19e (Miller 1913) is on an anticlinal axis defined by Timiskaming rocks as is shown on Map No. 1956a. Thus the rock in the outcrop is older than the Timiskaming conglomerate and greywacke abundantly exposed nearby. Miller (1913, p. 58) reported that the pebbles in the adjacent exposures of Timiskaming conglomerate contain numerous representatives of the iron formation.

At present the precise structural relationships have not been determined between the Timiskaming rocks (particularly those included under this designation in the north and central parts of Bucke township) and the Keewatin rocks (as exposed in the vicinity of Cobalt). The Keewatin, comprising both volcanic and sedimentary rocks, is presumably older than the Timiskaming containing, as far as is known, sedimentary rocks only. Both have been closely folded and intruded by an Algoman plutonic intrusion. Whether a period of folding and subsequent erosion intervened between Keewatin and Timiskaming times is unknown.

Owing to paucity of information, the following notes on the correlation of the Precambrian sedimentary rocks in Drillhole LT-1 must be regarded as conjectural.

The author tentatively correlates the iron formation, assigned by Miller to the Keewatin and occurring at Sharp Landing, with the assemblage of iron formation and greywacke intersected by Drillhole LT-1. The author assumes that folded Keewatin rocks lie beneath the folded Timiskaming rocks of much of the north part of Bucke township. It seems probable that any major fold in the Timiskaming would have a corresponding and somewhat similar fold in the Keewatin rocks below.

It is clear that the magnetic anomaly shown on Figure 8 is due to the iron formation that was intersected in Drillhole LT-1. The direction of elongation of the anomaly may be taken as the strike of the iron formation and associated greywacke. The anomaly may be thought of as having an axis oriented at N.66°E. in the vicinity of the drillhole; from this axis the intensity of the anomaly decreases sharply to the north and a little less sharply to the south. The fact that the decrease to the south is less sharp suggests that the beds in the drillhole dip south.

The geophysical results must be reconciled with the geological information afforded by the drillhole as well as that given by the exposures of Timiskaming sedimentary rocks on the west shore of Lake Timiskaming in the northern part of Bucke township. As shown on Map No. 1956a (Bucke township) Timiskaming sedimentary rocks are widely exposed on the west shore of Lake Timiskaming from the north boundary of Bucke township for about 1½ miles south; farther south of this are Paleozoic rocks.

Southwest of Drillhole LT-1 the anomaly progressively decreases in intensity, extends beyond Lake Timiskaming, and covers ground occupied at surface in part by Paleozoic rocks and in part by Timiskaming sedimentary rocks. The occurrence of part of the anomaly over ground that is occupied at surface by Timiskaming sedimentary rocks is thought to demonstrate that Keewatin iron formation lies below these rocks.

On the shore of Lake Timiskaming, immediately north of the Paleozoic rocks, the part of the Timiskaming sedimentary rocks that are covered by the anomaly strikes about N.60°E. and is overturned; the rocks dip steeply south but face north. The similarity in strike of the Timiskaming sedimentary rocks to the direction of the axis of the anomaly suggests that the Timiskaming and Keewatin rocks are involved in the same fold. Difficulty arises in reconciling the small angle of dip, about 36°, of the sedimentary rocks in Drillhole LT-1 with the steep dips of the Keewatin and Timiskaming rocks in the general vicinity, particularly with steep dip of the Timiskaming sedimentary rocks on the west shore of Lake Timiskaming. In the author's opinion, the small angle of dip of the sedimentary rocks in Drillhole LT-1 is explained by assuming that the hole is near the axis of a fold. Information that would permit the drawing of a geological section across the area covered by the anomaly is not available; in the author's view such a section would probably show an anticlinal fold with a steep north limb and a south limb of more moderate dip.

The anomaly decreases markedly in intensity west of Lake Timiskaming. The west side of the Lake Timiskaming Fault was displaced upward about 800 feet relative to the east side; if the anomaly-producing material continues westward directly under the Paleozoic rocks as in Drillhole LT-1, the intensity of the anomaly would be increased markedly on the west side of the fault. That the anomaly decreases west of the fault may be due possibly to one or all of three factors:

The nature of the iron formation was changed so that it became impoverished in magnetite.

The iron formation pitches westerly at a steep angle.

The iron formation was eroded prior to the deposition of the Timiskaming sedimentary rocks.

Of these possibilities, the last suggested to the author by E. E. Campbell, a drilling supervisor, seems the most probable.

Attempts to clarify the stratigraphic relationships of the iron formation by tracing it on the Aeromagnetic Series maps do not give conclusive results, partly because of the prevalence and thickness of younger rocks. Anomalies at several places on these maps can be safely interpreted as indicating the presence of iron formation, but not its structure or attitude. On G.S.C. Aeromagnetic Series Map No. 514G the anomaly that is shown to extend from the west part of Bucke township, through Firstbrook and on into Barr township, presumably indicates the presence of iron formation that is the westerly extension of that intersected by Drillhole LT-1. No direct information on the nature or structure of the iron formation in the three townships is available owing to the presence of younger rocks that overlie it there.

Relatively minor anomalies on G.S.C. Aeromagnetic Series Map No. 511G in the northeast corner of Harris township and the adjacent part of Casey may indicate the presence of iron formation, but no drilling test of this has been made. A water well put down in Lot 11, Concession VI, Harris township, 300 feet south and 40 feet west of the northeast corner of the lot, intersected greywacke between footages 290 and 300.

In the northwestern part of Casey and the adjacent part of Brethour township, pronounced anomalies are shown to occur on Aeromagnetic Series Map No. 511G. The anomalies in Casey have not been investigated by drilling, but one anomaly in the southwestern part of Brethour township was shown to be due to iron formation in a 210-foot vertical drillhole in Lot 3, Concession II, Brethour township, 2,380 feet north and 600 feet west of the southeast corner of the lot. The hole was put down by Dominion Gulf Company in 1953. The assessment work log by D. K. Burke records footages 0 to 123 as casing, and 123 to 210 as iron formation and greywacke with two small diabase dikes; the iron formation was stated to contain magnetite and hematite; the dips of the bedding in the iron formation were reported as ranging between vertical and 75°. This iron formation appears to be similar in nature to that in Drillhole LT-1.

PRE-ALGOMAN

Basic Intrusive Rocks (Haileyburian)

Wherever Keewatin rocks are exposed in the map-area, they contain pre-Huronian basic intrusions. Some of these intrusions were, no doubt, closely associated with Keewatin volcanism; other intrusions appear to be younger and in large measure independent of the volcanism.

In the map-area, nearly all basic intrusions that are held to be independent of Keewatin volcanism are not found in contact with the Algoman syenitic plutons; because of this, their age relationships are not directly determinable. In other parts of northeastern Ontario, similar basic intrusions have been shown to be pre-Algoman, and this is the age assumed by the author for those intrusions in Casey and Harris townships. C. W. Knight (1924, p. 30) gave "a legend, after W. G. Miller, showing the rock formations in northeastern Ontario, including the Cobalt silver area, the Sudbury nickel area, and the Porcupine and Kirkland Lake gold areas", in which basic intrusive rocks ("lamprophyre, diabase, serpentine, etc.") were designated Haileyburian; this usage is retained by the present author.

The pre-Algoman (Haileyburian) intrusions in the present map-area include three types: metadiorite; talc-chlorite rock and amphibolite; lamprophyre.

METADIORITE

An outcrop in Lot 11, Concession V, Casey township, and another in Lot 11, Concession VI, are thought to be parts of a large basic intrusion of approximately metadioritic composition. The exposures, though insufficient to permit the drawing of contacts with assurance, are regarded as indicating an intrusion with strike N.25°W. and a width greater than 600 feet. It seems certain that the dip is steep; possibly the dip approximates the bedding and schistosity of the Keewatin mica schist that lies east of the intrusion.

The metadiorite is not of uniform composition; however, one common variety contains amphibole crystals (to 4mm.) that compose two-thirds of the rock, and feldspar crystals (to 2mm.) that compose one-third. Part of the feldspar is pink, and part is grey. In places, the amphibole crystals are greater than a centimetre in size. A few inclusions of mica schist are present.

Although the metadiorite is generally massive, schistosity is present in some places and has approximately the same attitude as that in the adjoining mica schist.

TALC-CHLORITE ROCK, AND AMPHIBOLITE

The presence of a basic intrusion on the shore of Lake Timiskaming in Lot 8, Concession V, Harris township, is indicated by a small outcrop there as well as by the rock in the dump of a small pit collared in Cobalt Group sedimentary rocks about 100 feet north of the outcrop. The outcrop is in part an amphibolite; possibly part of it is altered Keewatin lava or tuff. The rock has been irregularly fractured and partly schisted. On the pit dump are pieces of talc-chlorite rock; this is soft, dark grey to black, and contains carbonate seams to one-twentieth of an inch in width. Exposure is insufficient to give information on the size, shape, or attitude of the intrusion.

The diamond-drilling on the Benner-Harris property in Lot 8, Concession V, Harris township (*see* Figure 6), revealed the presence of talc-chlorite rock below the Huronian rocks. The longest intersection of this was obtained in Drillhole No. 7 between footage 345 (the bottom of the Huronian rocks) and footage 406. That the talc-chlorite rock represents an intrusion is inferred from its nature. No information on the shape or attitude of the intrusion is available.

LAMPROPHYRE

Biotite lamprophyre dikes are exposed in the underground workings of the Langis mine in Casey township, and in surface outcrop cutting through the Keewatin outcrop in Lot 7, Concession V, Harris township. They were intersected in the diamond-drilling (*see* Figure 6) done on the Benner-Harris group in Lot 8, Concession V, Harris township, and in drilling done on the SW.¼ of N.½, Lot 6, Concession I, Casey township (*see* Figure 5). Presumably the dikes are widespread in the Keewatin but, from the evidence of those places accessible for observation, they are not abundant.

On the 355-foot level of Langis No. 3 shaft workings a biotite lamprophyre dike passes about 20 feet southeast of the shaft, strikes N.40°E., and dips steeply.

The dike, along its strike, varies in thickness from 6 to 30 feet; it has been traced over a length of at least 400 feet. The lamprophyre contains biotite crystals (to about 3 mm. across) that form about 15 percent of the rock in a grey-green nondescript matrix.

One or two other lamprophyre dikes are exposed in both No. 3 shaft workings and No. 6 shaft workings.

On the Benner-Harris property lamprophyre dikes were intersected in certain of the drillholes (*see* Figure 6). Biotite, in flakes commonly 1–2 millimetres in diameter, forms about 20 percent of the rock.

The lamprophyre dikes in the map-area are similar to those occurring in the vicinity of Cobalt. Presumably they are also similar in age and manner of origin. No genetic relationship with other igneous rocks exposed at surface seems to be distinguishable in either of the localities.

ALGOMAN

Syenitic Plutonic Intrusive Rocks

Hornblende syenite that outcrops on Casey Mountain in Lots 4 and 5, Concession II, Casey township, is part of a large syenitic plutonic intrusion whose extent is very imperfectly known; at no place was its contact with older rocks seen. The only other outcrop of it in the map-area is in Lot 2, Concession II, Casey township.

Hornblende syenite was shown to occur at bedrock in a drillhole in NW.¼ of N.½, Lot 6, Concession I, Casey township. Other occurrences under a cover of younger rock are as follows: in the underground workings of Casey Mountain No. 2 shaft (Lot 6, Con. III, Casey twp., as shown in Figure 3); in two drillholes in NW.¼ of N.½, Lot 6, Concession I, Casey township; in the two H. K. Explorations Limited Drillholes in NW.¼ of N.½, Lot 8, Concession I, Casey township; and in two drillholes near Casey Mountain No. 1 shaft (NE.¼ of N.½, Lot 6, Concession I, Casey township), shown as "syenite" in the lower footages of drillholes Nos. 3 and 4 in Figure 2.

No exposures of the hornblende syenite or of related dikes are known in the underground workings of the Langis mine; but in the most northerly Langis claim (SE.¼ of N.½, Lot 6, Con. I, Casey twp.) diamond-drill cores showed short lengths of feldspar prophyry and these are thought to represent dikes related to the hornblende syenite.

The hornblende syenite in hand specimens is a massive rock; about three-quarters is of reddish feldspar (about 2 mm. in grain size) and most of the remainder is green-black amphibole (in prisms about 5 mm. long). In places the amphibole prisms show, to a slight extent, parallel orientation. The rock of the pluton appears to be essentially uniform in the different exposures.

Inclusions, up to 6 inches in size, are of common occurrence in the syenite. The inclusions are of various kinds: light-grey to pink felsite; green-black amphibolite (grain size about 2 mm.); and, greenstone. The shape of the inclusions is varied; in some places they are subrounded, in others angular. The inclusions show no alteration effects from the enclosing syenite and have sharp contacts.

In places the syenite is intersected by quartz veins.

R. E. Hore, who was the first to map and describe the syenite, stated that microscopical examination showed it was composed largely of orthoclase and hornblende and contained quartz, sphene, iron ores, and secondary chlorite (Miller 1913, p. 147).

Although the contact of the Algoman pluton with Keewatin rock is not exposed in the map-area, those parts of the Keewatin in the southern part of Casey township that lie closest to the pluton (as in the SW.¼ of N.½, Lot 6, Con. I) do not show important metamorphic effects or the development of schistosity; they do not appear to have undergone plastic deformation.

POST-ALGOMAN

Basic Intrusive Rocks

LAMPROPHYRE AND APLITE DIKES

Contained within the Algoman pluton are small dikes, some light-coloured, others dark, that are thought to be closely related genetically to the pluton. In Lot 4, Concession II, Casey township, four dark-coloured lamprophyre dikes were seen; these had northerly strikes (between north and N.15°W.) and moderate west dips (less than 40°). One green-black dike at about 3,000 feet south and 400 feet west of the northeast corner of the lot shows an estimated 10–15 percent chlorite (after biotite) flakes up to 2 millimetres in a finer-grained nondescript matrix that contains abundant carbonate. The width of this dike appeared to be about 25 feet; it was the largest seen.

A nearby dike is dark green and contains abundant amphibole prisms up to 5 millimetres in length.

Aplite dikes intrude the hornblende syenite outcrop in Lot 2, Concession II, Casey township. A half dozen dikes were seen with widths of 1–7 inches; the longest was traceable over a length of several hundred feet. The largest and longest dike strikes N.32°E. and dips about 65°N.; other dikes have strikes between N.74°E. and N.80°E., and dips of 35°N.–40°N.

The alplite is pink to grey. Feldspar crystals to ½ millimetre may be distinguished, but in general the grain size is too small to permit identification. Dark-mineral content is about 2 percent; it appears to be amphibole that is in crystals up to 2 millimetres long but for the most part less than ½ millimetre.

HURONIAN

Cobalt Group

GOWGANDA FORMATION

Only the Gowganda Formation, the lowest of the Cobalt Group, is present in the map-area. The largest outcrop area of the formation is in the central part of the map-area; an isolated hill-outcrop is present in N.½, Lot 4, Concession VI, Casey township.

Distribution and Thickness

Information on the distribution and thickness of the Cobalt Group sedimentary rocks is largely restricted to Lots 5–8 in Concessions I and II, Casey township, and Lots 5–8 in Concessions V and VI, Harris township; whether they are present or absent under the very extensive areas of younger (Paleozoic and Pleistocene) rocks is for the most part unknown.

The Gowganda Formation consists of horizontal or gently dipping sedimentary rocks whose original thickness is unknown. The lower contact of the formation is an unconformity on Archean rocks; the upper contact is an intrusive contact where the overlying rock is Nipissing Diabase, and is an erosional contact where the overlying rock is Paleozoic rock or Pleistocene unconsolidated material.

The greatest reported thickness of Gowganda rocks in the map-area is more than 772 feet; this was intersected by the Trethewey Silver Cobalt Mine Drillhole TW-1 in the southeast corner of Lot 6, Concession VI, Harris township. The altitude (by aneroid) of the hole collar is 706 feet; the bottom of the hole (still in Gowganda Formation) is 84 feet below sea-level. Three other drillholes, in the NE.¼, SE.¼, and SW.¼, Lot 6, put down by the same company, intersected shorter lengths of the sedimentary rocks (for details, *see* p. 65, Description of Properties). The thickness of the Gowganda Formation along the Casey-Harris township line is shown in the vertical section on accompanying map No. 2066. It will be noted that beneath the Nipissing Diabase sill the Gowganda Formation is very thin. Whether it pinches out is not definitely known, but at the east end of the underground workings of Langis No. 6 shaft the thickness is less than 10 feet.

The greatest thickness definitely determined in the vicinity of the Langis mine is 447 feet; this is found 70 feet west of the Dolphin-Miller shaft. East and south of the shaft, the thickness is greater. The thickness of the Gowganda Formation at the Langis shafts is as follows: No. 1, 230 feet; No. 3, 280 feet; No. 4, greater than 146 feet and estimated to be a few feet less than 200; No. 6, 125 feet (below Nipissing Diabase). Drillholes put down by the Cocase Prospecting Syndicate in the SW.¼ of N.½, Lot 6, Concession I, Casey township (*see* Figure 5), showed the Gowganda rocks to be approximately 60 feet thick. The Seneca shaft (NW.¼ of N.½, Lot 6, Con. VI, Harris twp.) is about 345 feet deep but apparently did not reach the underlying Keewatin. Indications of the thickness of the Gowganda Formation in the vicinity of the Langis mine are given by the structural contours on Figure 4.

At Casey Mountain No. 1 shaft (NE.¼ of N.½, Lot 6, Con. II, Casey twp.) the Gowganda beneath the diabase is about 150 feet thick (*see* Figure 2). At Casey Mountain No. 2 shaft (SE.¼ of S.½, Lot 6, Con. III, Casey twp.) the Gowganda is about 180 feet thick (*see* Figure 3).

In the NW.¼ of N.½, Lot 8, Concession I, Casey township, drillholes put down by H. K. Explorations Limited (*see* p. 73) showed the thickness of the Gowganda there to be 68 feet in Drillhole S-1, and 42 feet in Drillhole S-2.

The Gowganda in the NW.¼ of S.½, Lot 8, Concession I, Casey township, was shown by the Langis Silver and Cobalt Mining Company Drillhole S-20 (collar at 175 feet north and 350 feet east of the southeast corner of the quarter; direction S.45°E.; inclination −45°) to have a vertical thickness of 230 feet.

The Gowganda in the northeast corner of the SW.¼ of S.½, Lot 5, Concession VI, Harris township (*see* p. 64), was shown to have a vertical thickness greater than 527 feet.

The Gowganda in the southeastern part of the NE.¼ of N.½, Lot 5, Concession V (*see* Dolphin-Miller Mines Ltd., p. 63) was shown to have a vertical thickness greater than 292 feet.

Shape of Bottom Contact of Gowganda Formation

The bottom contact of the Gowganda Formation over much of the central part of the map-area has a somewhat basin-like shape. A geological section on Map No. 2066 illustrates this shape along the Casey-Harris township line; about a mile farther north, along the Concession I–II line in Casey township, this contact has a similar basin-like shape. For an east-west vertical section through the northern part of Concession V in Harris township, the east side of the basin-like shape of this contact can be distinguished, but no information is available on the presence or position of the west side of the shape. These vertical sections and information on the altitudes of the contact at other places seem sufficient to indicate that the basin-like shape has a northerly elongation as one of its most important elements.

A short discussion of the origin of this basin-like shape is given on page 38 under the heading Structural Geology in this report; the possibility is mentioned that it is largely an original feature representing the topography immediately prior to the deposition of Huronian sediments.

Superimposed on the broad basin-like shape of the contact are irregularities that are more local than regional. The structural contours on Figure 4 show that the bottom contact of the Gowganda near the Casey-Harris township line is not an even easterly-dipping surface. A trough-like depression of the contact is situated between Langis No. 3 shaft and the ventilation raise; another lies north of Langis No. 4 shaft. A greater irregularity is situated north of the Dolphin-Miller shaft. The dips of the contact in the trough-like depressions show large variation over short distances; they range from nearly horizontal to nearly vertical.

At the Langis mine, abrupt steepenings of dip occur over vertical distances of up to 40 feet; these steepenings are difficult to follow laterally. The 50-foot contour interval used on Figure 4 is too large to show them satisfactorily. A few feet west of the Dolphin-Miller shaft, the contact shows a difference in altitude of 286 feet over a horizontal distance of 450 feet, that is, a dip of 31°. This dip is much greater than usual; at about 1,000 feet northeast of the Langis No. 1 shaft the dip is about 15°.

To the author, these irregularities in the contact appear to be due to erosion acting prior to the deposition of the Huronian sedimentary rocks. The pre-Huronian surface on which the Gowganda Formation rests was not a smooth peneplain but had a considerable relief. Folding and faulting do not appear to have been significant factors in the origin of the irregularities.

In consequence of the contact having a considerable relief, thicknesses of the overlying sedimentary rocks vary considerably from place to place. The precise thickness of the Gowganda rocks in the map-area is known only where it has been determined by drilling or underground work.

Lithology

Many of the rock types of the Gowganda Formation are unusual. The types may perhaps be considered to make a series whose end members are conglomerate and well-bedded greywacke. Important variables distinguishing the types in the series include: abundance of contained boulders, cobbles, pebbles; size of boulders, etc.; shapes of boulders, etc.; nature of matrix as to whether it is greywacke-like or arkosic; and, nature and perfection of bedding.

Photo 2 — Bedded, boulder-containing, greywacke of the Gowganda Formation near Langis No. 3 shaft; the bedding is in couplets. A mould of the dislodged boulder can be seen above the scale, which is 6 inches long.

The conglomerate exposed in Lot 4, Concession VI, Casey township, and in the adjoining part of Brethour township, has in places a boulder content of 40 percent with the boulders up to 3 by 5 feet in size. The shape of the boulders ranges from sharply angular to rounded. The matrix is generally of unbedded greywacke; this in places contains irregular arkose bands.

Boulders compose about 45 percent of the conglomerate that appears in an outcrop in contact with Keewatin rocks 600 feet northwest of Langis No. 1 shaft. The unsorted boulders are up to 2 by 3 feet. Bedding is absent or obscure in the greywacke matrix.

A boulder content of about 15 percent is contained in the conglomerate outcrop at Langis No. 1 shaft. Boulders are up to 2 by 2 feet. The matrix is well bedded greywacke with beds ranging from 1/80 inch to 1 inch in thickness.

A boulder content of about 3 percent is contained in the bedded greywacke outcrop on the hillside north of Langis No. 3 shaft; this outcrop is shown in photo 2. Couplet bedding is clearly revealed. Sedimentary rocks of this type may be more appropriately named "bedded greywacke with boulders" rather than conglomerate.

Bedded greywacke without boulders, from the same vicinity as the above, is shown in photo 3. The beds are not uniform; they range from about 1/8 inch to 1 inch. Most of the beds are dark grey and very fine-grained; a few are lighter grey and coarser-grained.

In another kind of greywacke, known locally as slaty greywacke, the beds are much more uniform and thinner, commonly 1/16 inch to 1/4 inch. This kind of bedded greywacke occurs on the Benner-Harris Group (Lot 8, Con. V, Harris twp.).

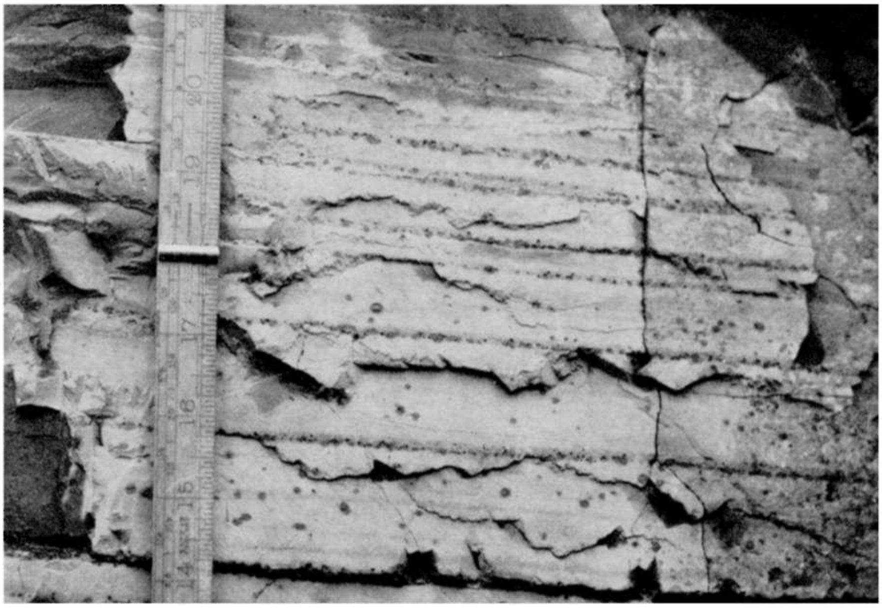


Photo 3 — Bedded greywacke of the Gowganda Formation near Langis No. 3 shaft; spotted chlorite alteration follows certain beds and is disseminated. Scale is ¾ inch wide.

In places the matrix of the conglomerate contains feldspar grains in such abundance as to be arkosic. Where the proportion of boulders becomes very small, the rock is an arkose.

C. E. Grozelle, mine geologist at the Langis mine, reported (personal communication 1962) that most of the conglomerate in the trough-like depressions of the pre-Huronian surface has a boulder content of about 75 percent; the usual proportion elsewhere is about 50 percent.

One phenomenally large boulder in the conglomerate was encountered at the Langis mine. On the 355-foot level of No. 3 shaft, at 300 feet south and 300 feet west of the shaft, a boulder about 25 by 25 feet in horizontal measurements and greater than 10 feet vertically was traversed by the workings. The base of the boulder is not exposed but is presumably close to the bottom contact of the Gowganda. In hand specimens, the boulder appears to be hornblende-biotite diorite; the grain size is 3–5 millimetres; the rock has a gneissose texture.

The shapes of boulders show a marked diversity. Presumably the sharp angularity of some of the boulders is a consequence of their having been broken near their present positions and then moved only a short distance afterward. Some of the boulders are facetted.

Among the varied kinds of boulders present, hornblende syenite is probably the most common.

The Gowganda Formation shows, in general, great variation both laterally and vertically from one rock type to another. At the Langis mine, for instance, no distinctive member in the vicinity of No. 3 shaft has been correlated with a corresponding member at No. 6 shaft.

At the Benner-Harris Group (Lot 8, Con. V, Harris twp.), however, two bedded greywacke members were easily correlated from one drillhole to another (*see* p. 60 under Description of Properties).

Bottom Contact of Gowganda Formation

The contact of the Gowganda Formation with the underlying basement rocks is clearly an unconformity. The gently dipping sedimentary rocks of the Gowganda Formation rest on the nearly vertical Keewatin rocks.

The nature of the contact of the Gowganda Formation with the underlying rocks is not uniform in the map-area. In describing a contact (presumably in Lot 5, Con. II, Casey twp.), R. E. Hore stated:

> The contact of syenite and conglomerate is very well exposed for several yards . . . At the immediate contact large angular blocks of syenite are cemented together by fine grey material, forming a breccia conglomerate. A few feet from the syenite the fragments are well rounded, and farther on pebbles of other composition form a greater and greater percentage of the conglomerate. (Miller 1908, p. 134)

One feature of the contact as described by Hore occurs commonly in the analogous contact in the vicinity of Cobalt: large angular blocks in the conglomerate are of the same kind of rock as those constituting the basement. At numerous places in the vicinity of Cobalt a transition from solid basement rock to decomposed rock, and finally to conglomerate, can be seen. In contrast to those conditions, the bottom contact of the Gowganda at the Langis mine was sharp wherever observed by the author. The boulders in the conglomerate near the contact did not appear to be predominantly of the same rock as those constituting the basement below. In places the top of the Keewatin had a smooth surface, but exposure was at no place sufficient to permit a careful examination.

Mode of Origin

The hypothesis that glaciation was involved in the origin of the Gowganda Formation, originally proposed by A. P. Coleman, is a satisfactory explanation of many of its features.

Correlation

The author (Thomson 1957b, pp. 40–42) has suggested a division of the Cobalt Group into three formations instead of the two given before 1957. The Gowganda, as defined by Collins (1917, p. 63) is divided into two formations. The succession in descending order is given for both usages in the accompanying table.

Table IV *Cobalt Group, division into formations*

Thomson 1957	Collins 1917
LORRAIN FORMATION Arkose, quartzite.	LORRAIN FORMATION
FIRSTBROOK FORMATION Argillite.	GOWGANDA FORMATION
COLEMAN FORMATION Conglomerate, bedded greywacke, quartzite.	

In the present report, the author uses the term Gowganda although the rocks described under that heading clearly belong to the Coleman Formation.

The Firstbrook Formation does not occur in the map-area; while it was being deposited (a thickness greater than 1,960 feet was attained in Henwood township, 12 miles west of the map-area), the Coleman Formation was presumably being eroded.

KEWEENAWAN

Nipissing Diabase

Nipissing Diabase is the youngest intrusive rock known in the map-area. At one time it extended in a gently dipping sill-like form over the whole area. An erosional remnant is present in Concessions I, II, and III, Casey township, and Concession VI, Harris township.

On the south part of Lot 8, Concession II, Casey township, the presence of diabase immediately below Paleozoic rocks was recorded by Hume (1925, p. 22). The diabase was intersected in a drillhole that passed through a vertical thickness of 65 feet of overburden and 92 feet of Paleozoic rocks. Hume did not give the exact position of the hole, and no attempt is made to show the hole on Map No. 2066. The category (post-Nipissing dike, Nipissing sill, or Archean) to which the diabase should be assigned was not stated by Hume. If the diabase in the hole is Nipissing Diabase, it is presumably a down-faulted part of the Nipissing sill exposed on Casey Mountain.

Apart from this unverified occurrence of Nipissing Diabase and its extensions, it seems unlikely to the author that other remnants are present beneath the widespread younger (Paleozoic and Pleistocene) rocks. On Ontario Department of Mines Map No. 31b, Nipissing Diabase is shown on Lot 11, Concessions V and VI, Casey township; on Map No. 2066, accompanying this report, this occurrence is shown as an Archean intrusive rock.

Presumably the sill had, prior to erosion, a thickness of about 1,000 feet, that is, about the same thickness as near Cobalt where the complete thickness is preserved in places. In the map-area, the greatest thickness is probably between 400 and 500 feet.

A section across the sill remnant is shown on the vertical geological section along the Casey-Harris township line on Map No. 2066. The dip of the bottom contact of the sill where it passes through Langis No. 6 shaft is about 14°. The bottom contact of the sill has an elongate basin-like shape with the elongation in a north-south direction. The bottom contact of the Nipissing Diabase sill is neither parallel to nor near the Cobalt Group–Archean contact. The direction of dip of these two contacts is the same on the east-west vertical geological section along the boundary between Casey and Harris townships shown on Map No. 2066. As shown on the section, the wedge of Cobalt Group sedimentary rocks between the Nipissing sill and the Keewatin pinches out about 600 feet east of Langis No. 6 shaft; if the eroded part of the contact of Nipissing sill over Cobalt Group sedimentary rocks be restored as far west as Langis No. 3 shaft, and if a dip of 14° be assumed for this contact, the thickness of the wedge of Cobalt Group rocks at Langis No. 3 shaft would be about 700 feet.

Lithology

The Nipissing Diabase is not of uniform composition throughout the Timiskaming silver-cobalt area. In places in the Cobalt area, where complete vertical sections of the sill have been investigated by Hriskevich (1952), the following varieties of diabase have been found in descending order:

Fine-grained diabase at top contact.

Quartz diabase (in many places with coarse texture).

Hypersthene diabase $\pm$ olivine.

Quartz diabase.

Fine-grained diabase at bottom contact.

Presumably all these varieties were present originally in the sill of the map-area but erosion has removed those above the hypersthene diabase.

The presence of olivine in hypersthene diabase was determined (NE.¼ of N.½, Lot 6, Con. II, Casey twp.) on the 135-foot level of Casey Mountain No. 1 shaft and in the Murray Mining Corporation Drillhole No. 3 at footage 200. In the S.½, Lot 5 in Concession II, Casey township, at about 450 feet west of the northeast corner of the NE.¼, olivine-bearing diabase is exposed at surface. Lowes (1963, p. 28) recorded the presence of olivine-bearing diabase in the outcrop at the southeast corner of Lot 7, Concession I, Casey township. Presumably olivine is widespread in the hypersthene diabase of the map-area.

PALEOZOIC

The Paleozoic rocks in the map-area are part of the large Paleozoic outlier covering about 250 square miles in the vicinity of Lake Timiskaming. Hume's memoir (1925) is the standard reference on the Paleozoic rocks of the outlier and incorporates the results of a great deal of earlier work by others. Additional information was obtained largely from the Lake Timiskaming No. 1 hole (for location *see* Fig. 8), drilled in January and February 1963. For the sake of brevity in the present report, this is referred to as Drillhole LT-1. General information on Drillhole LT-1 is given in this report on page 59 under the heading Claim T.52104 and Adjacent Claims. The log of the Paleozoic rocks in the drillhole is given in Table V (p. 27).

Distribution

In addition to the extensive areas of Paleozoic rocks shown on Map No. 2066, it is probable that others occur in those parts of the map-area deeply covered by unconsolidated material of Pleistocene age. Possibly deeply covered Paleozoic rocks extend from Lot 8, Concession V, Harris township, along the east and north sides of the Casey Mountain upland. Hume (1925, p. 22) stated that Paleozoic rocks to a thickness of 92 feet (beneath 65 feet of overburden) are present on the east side of the upland on the south part of Lot 8, Concession II, Casey township.

Lithology

The Paleozoic rocks in the map-area include limestone, shale, dolomite, and sandstone. Intermixture and gradation of these rock types giving, for instance, calcareous shale or shaly limestone, is common and such intermixture and gradation makes classification difficult in places.

Paleozoic limestone containing minor amounts of shale is exposed at the turn of Highway No. 65 in Lot 3, Concession V, Harris township, and is shown in photo 4.

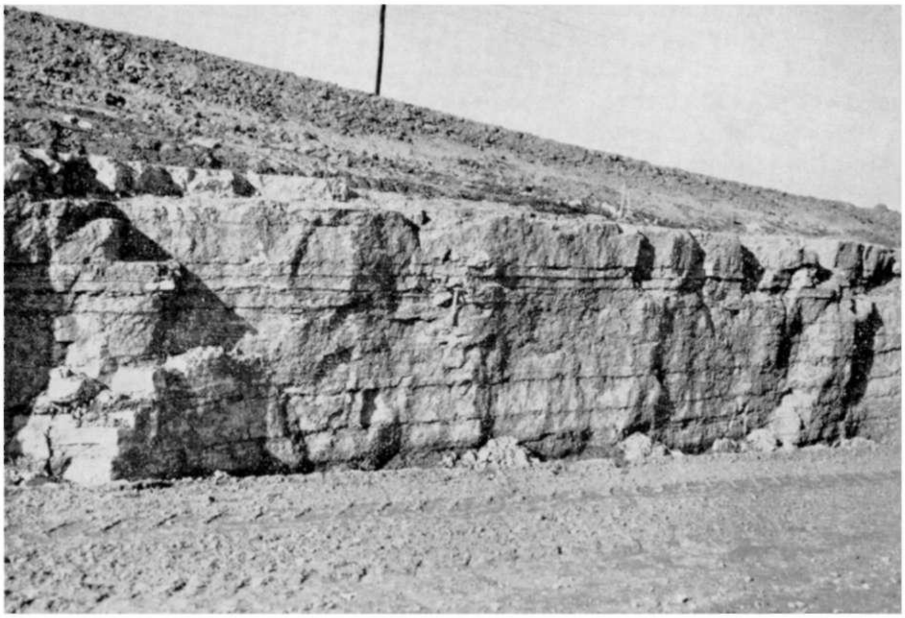


Photo 4 — Paleozoic limestone in rockcut on Highway No. 65, Lot 3, Concession V, Harris township.

Chert nodules (up to 6 in.) and lenses occur in the Lockport(Thornloe) Dolomite exposed in the southeastern part of Lot 4, Concession I, Harris township.

Gypsum occurs in Drillhole LT-1 as veinlets, blebs, and grains in limestone and shale between footages 274 and 356. It is more abundant between footages 294 and 305, but the total amount present is quite small.

Brown fluorite in irregular areas to 5 millimetres in length occurs in limestone at footage 95 of Drillhole LT-1.

Thickness

The Paleozoic rocks in Drillhole LT-1 are 813 feet thick (*see* Figure 7), consisting of 70 feet of the Lockport(Thornloe) Formation and 743 feet of other formations (including the Liskeard with a thickness of 366 feet) below the Lockport(Thornloe).

The thickness of the Lockport(Thornloe) Formation in the map-area is estimated to be greater than 360 feet.

The greatest thickness of the Paleozoic rocks in the map-area is in Lot 2, Concession III, Harris township, and is estimated to exceed 1,103 feet.

Relief of the Paleozoic Floor

Hume (1925, p. 14) pointed out the existence of a considerable relief in the Paleozoic floor in the vicinity of Lake Timiskaming. On certain islands in the northern part of the lake, he noted quaquaversal dips in the Paleozoic strata around cores of Precambrian rocks, and he further noted that the Paleozoic rocks resting directly on the Precambrian rocks are stratigraphically at a considerable height above the lowermost Paleozoic rocks in the vicinity. Thus a relief of the Paleozoic floor greater than 190 feet is implied for Bryson Island, about 8 miles south of Harris township, which Hume stated rises 190 feet above the lake and which has Ordovician strata (of the upper member of the Liskeard Formation) dipping steeply away from the island.

In parts of the Casey-Harris map-area, it seems certain that the Paleozoic floor has a considerable relief. Prior to deposition of the Paleozoic rocks, there appears to have been a hill that was possibly about the same extent as the present Casey Mountain upland. Presumably this hill was completely covered by Paleozoic rocks; but at present only four small outcrops of these (Liskeard Formation) rocks remain and they are near the foot of the upland as follows: in Casey township, Concession II, one outcrop in each of Lot 4 and Lot 5; and in Harris township, Concession V, 2 outcrops in Lot 7.

The altitude of the Paleozoic-Precambrian contact in the outcrop in Lot 4, Concession II, Casey township, is about 600 feet; the altitude of the Precambrian rocks at the top of Casey Mountain is about 850 feet. Thus a relief of greater than 250 feet for the Paleozoic floor is implied.

The altitude of the Paleozoic-Precambrian contact in the Paleozoic occurrence mentioned by Hume (1925, p. 22) in Lot 8, Concession II, Casey township, on the east side of Casey Mountain, is about 440 feet; but, use of this figure to obtain an indication of the relief of the Paleozoic floor is scarcely warranted in view of the possibility that this lower altitude is partly due to faulting.

STRATIGRAPHY

The Paleozoic rocks in the map-area are in part Ordovician and in part Silurian in age.

Hume (1925, p. 13) assigned the Silurian rocks of the Timiskaming outlier to two formations. He regarded the upper formation as being of the same age as the Lockport Formation in southern Ontario. Ollerenshaw and MacQueen (1960), on the basis of paleontological evidence, suggested that the Lockport Formation of Hume in the outlier is not of the same age as the Lockport Formation in southern Ontario. They used the name Thornloe, and included in it precisely the same strata as those that Hume included in the Lockport. Regardless of possible correlations of formations in the outlier with those in other places, the use of a local name such as Thornloe seems desirable. However, in view of the widespread use of Hume's designation, Lockport, the present author uses, in this report and on the accompanying map, the designation Lockport(Thornloe) Formation for what Hume called the Lockport Formation and what Ollerenshaw and MacQueen termed Thornloe.

Hume proposed the name, Wabi Formation, for the Silurian rocks that lie below the Lockport in the outlier.

Hume's investigations extended over the whole Paleozoic outlier; but so far as Silurian stratigraphy is concerned, his results were largely summed up in a carefully measured section across the escarpment on the east side of Dawson (Wabi) Point in Harris township (Hume 1925, pp. 30, 34). The present author shows, in the upper right part of Figure 7, the Lockport(Thornloe) and Wabi formations in a columnar section that was made from Hume's data obtained at the escarpment; the section shows Hume's "total thickness" for each of the formations.

Hume's "total thickness" for the Lockport(Thornloe) Formation was 186 feet with the upper contact still not reached. The bottom 2 feet of the Lockport Formation is made up of sandstone, and Hume's report stated that it rests disconformably on the underlying Wabi.

Table V | *Paleozoic rocks, Drillhole LT-1, footages 27–840*

Footage From	Footage To	Thickness of Stratum in feet	Descriptions and Remarks
0	27	27	casing (stick-up, ice, water, mud).
27	**97**	**70**	**Silurian. Lockport(Thornloe) Formation.**
		2.5	27 – 29.5, dolomite, very fine-grained, light grey to buff.
		55.2	29.5 – 85, limestone.
			30.7 – 31.4, dark grey, very fossiliferous.
			31.4 – 85, bedding is distinct and sharply defined; light grey or buff beds are mostly 1–2 inches, dark grey beds are ⅛ to ¼ inch; within the bottom 20 feet are 10 fossiliferous bands of 2 inches or less, mainly of crinoid stems.
		8	85 – 93, shaly limestone, transitional to rock below, variable.
			90, a 2-inch band containing crinoid stems.
		4	93 – 97, sandstone with associated limestone and shale, varied, grey to dark grey.
			95, fluorite, light brown, in irregular area up to ¼ inch by ⅛ inch.
97	**375.7**	**278.7**	**Silurian. Wabi Formation.**
		115	*97 – 212, this section is definitely of the Wabi Formation.*
		163.7	*212 – 375.7, this section is tentatively inlcuded in the Wabi Formation.*
		23	97 – 120, limestone.
			97 – 101.3, varied, limestone and minor amounts of shale; bedding is varied, in part fine and even (¼ to ⅛ inch) and in part obscure or absent; beds are grey-green and light grey.
			101.3 – 108.2, fine-grained, unbedded.
			108.2 – 118, varied bedding.
		14	120 – 134, limestone and shale; for the most part sharply defined dark shaly beds up to 1/10 inch and thicker light grey beds.
		19	134 – 153, limestone.
			134 – 136.2, grey, fine-grained, poorly bedded.
			136.2 – 137, well bedded (1/64 to ⅛ inch); minor shale bedding is grey and dark grey.
			137 – 148.3, contains shale partings up to ½ inch, some scalloped and irregular.
			148.3 – 153, gradational into calcareous shale below.
		5	153 – 158, calcareous shale, well bedded; grey shaly and buff calcareous beds are about 1/64 inch thick.

Footage From	Footage To	Thickness of Stratum in feet	Descriptions and Remarks
		Silurian.	**Wabi Formation. (cont'd)**
		1	158 – 159, limestone, fine-grained, buff.
		7	159 – 166, calcareous shale, very fine and even bedding to indistinct bedding; minor limestone is buff, shale is grey.
		11	166 – 177, limestone, varied in colour and bedding.
			166 – 168, buff, unbedded, fine-grained.
			168 – 169.2, grey, with brownish irregularly scalloped beds up to ¼ inch thick.
			169.2 – 177, grey, varied with a few well marked brown beds up to ¼ inch thick.
		19	177 – 196, shale with some limestone.
			177 – 191.7, grey-green and grey-brown shale bedding, buff limestone beds from ½ inch to 2 inches thick.
			191.7 – 195, light grey-buff, well bedded.
		13	196 – 209, limestone with shale bands, grades into the shale below.
			198, intraformational breccia over 4 inches.
		13	209 – 222, shale, grey-green and grey in colour; fine and even bedding.
		10	222 – 232, limestone with shale partings.
			222, breccia of more than 8 inches; green fragments up to 2 inches in a light grey matrix.
			228 – 232, very irregular discontinuous dark green shale bands in light grey material.
		31	232 – 263, shale; in general, bedding is distinct.
			232 – 245.3, green-grey.
			236.7 – 239.2, reddish in part.
			246.2 – 246.7, intraformational breccia; red pieces up to 1¼ inch in grey matrix.
			248.3 – 248.4, limestone, buff.
			248.5 – 248.6, limestone, buff.
			248.7 – 249.0, limestone, buff.
		20	263 – 283, limestone.
			263 – 264, unbedded, grey, fine- to medium-grained.
			264.4 – 283, grey interbedded with grey-green, in irregular scalloped bands.
			281.7 – 282.7, gypsum, in dark grey irregular markings up to ½ inch wide.

Footage From	Footage To	Thickness of Stratum in feet	Descriptions and Remarks
		Silurian.	**Wabi Formation. (cont'd)**
		38.8	283 – 321.8, shale.
			283 – 287.2, fine grey bedding, pronounced.
			287.2 – 292, green and unbedded.
			292 – 321.4, red with minor amounts of green; bands of gypsum as follows: ¼ inch at 293; ¼ inch flesh-coloured and fibrous at 294.2; ¼ inch at 297; ½ inch at 298.1; ¾ inch at 300.3; ¾ inch at 301; 1 inch at 302.1; ¼ inch at 302.5; ½ inch at 303.8; ¼ inch at 304.8; 6 inches at 317; 1 inch at 321.
			321.4 – 321.7, light grey-white.
			321.7 – 321.8, grey-green, bedded.
		4.4	321.8 – 326.2, shaly limestone, white-grey-faint-buff; occasional darker beds up to ⅛ inch thick.
			322.3, gypsum bands, ¼ inch.
		44	326.2 – 370.2, limestone.
			326 – 329.5, fine-grained, light grey to buff; sharp 1/40-inch greenish partings in minor amounts, stylolites.
			329.5 – 355, light grey to grey, with irregular scalloped darker grey markings in small amount; bedding not well defined.
			348.7, one inch of gypsum.
			355.4, gypsum.
			355 – 370.2, transition to shale; rather dark grey, fine-grained; no bedding; very soft.
		0.5	370.2 – 370.7, shale; fissile, grey-green.
		5.0	**370.7 – 375.7, limestone; clastic white fragments (1/16 to ⅛ inch) in grey matrix; numerous fossil fragments; crinoid stems; poor bedding.**
375.7	*473.7*	*98*	*Unnamed Formation. Presumably Ordovician, Cincinnatian Series.*
375.7	**473.7**	**98**	**shale; fissile; most is green-grey, small part is reddish.**
			400 – 437, in places dark grey, in places fossiliferous.
			468 – 469, bedded; graded 2-inch beds.
			473.5 – 473.7, contains subrounded dark grey-brown shale pebbles up to 1 inch, crinoid stem fragments, and a ½-inch band of pyrite or marcasite.
473.7	**840**	**367**	**Ordovician. Liskeard Formation.**
		150.3	**473.7 – 624, limestone.**
			473.7 – 480.4, dark buff, coarse-grained; bedding indistinct; **minor shale bands, numerous crinoid stem fragments.**

Footage From	Footage To	Thickness of Stratum in feet	Descriptions and Remarks
		Ordovician. Liskeard Formation. (cont'd)	
			480.4 – 487, evenly fine-grained, light buff; some fucoid markings.
			487 – 604, mottled; prominent fucoid markings.
			604 – 624, nature of mottlings changes, becomes darker green and more shaly, and amount progressively increases; transition, not sharp contact, to the next bed described below.
		20	624 – 644, shale with limestone; green, fissile, with irregular or uneven bedding.
		6	644 – 650, calcareous shale; fine-grained, dark grey, unbedded.
		14	650 – 664, limestone; fine-grained, grey, fossiliferous.
		17	664 – 681, calcareous shale.
			664.5 – 672.5, grey-brown.
			672.5 – 681, green, except for 677.8 – 681 is in part reddish coloured; about 4 percent of quartz grains.
		2	681 – 683, limestone with minor shaly bands.
		2.7	683 – 685.7, shale; dark grey with irregular white markings.
		48.3	685.7 – 734, siltstone and sandstone; in parts shaly, green, reddish brown, dark grey; bedding in general poor.
			719.5 – 723, siltstone; dark grey; bedding absent.
			723 – 730, lenticular markings up to 1 inch by 1/10 inch on side of core compose about 40 percent of the core.
			730 – 734, siltstone; light grey-green; bedding obscure.
		16	734 – 750, shale and silty shale; dark grey; fissile; bedding obscure; light grey markings on side of core.
			743, rare siliceous brown fragments up to ¼ inch.
		6	750 – 756, sandstone; grey, fine-grained.
		84.7	756 – 840.7, no core recovered; *assumed to be Liskeard Formation.*
840.7	1,388	——	Precambrian rocks. (For log of these, *see* Table II, p. 10.)
1,388		End of hole.	

Note: Fine-grained is in range of 0.1 mm. to 1.0 mm. Medium-grained is in range of 1 mm. to 2 mm.

Hume's report gave the "total thickness" for the Wabi as 115 feet with the bottom contact not reached.

Hume assigned the Ordovician rocks of the outlier to a formation he named the Liskeard. So far as the Ordovician stratigraphy is concerned, his results were largely summed up in a section through a drillhole in Lot 11, Concession III, Bucke township (Hume 1925, p. 16). The approximate position of this drillhole is shown on O.D.M. Map No. 1956a of Bucke township (Thomson 1956). In the present report, in the lower right part of Figure 7, the Liskeard Formation is shown in a columnar section made from Hume's data obtained from the Bucke township drillhole and showing Hume's "total thickness" for the formation, which was 240 feet with the upper contact of the formation not reached.

Hume recognized that his two sections (one from the escarpment in Harris township, the other from the drillhole in Bucke township) did not give a complete stratigraphic section. He stated (1925, p. 27) that a gap of 40 feet intervenes between the bottom of the Wabi Formation shown on the escarpment section and the top of the Liskeard Formation shown on the drillhole section. If the present author's correlations are correct, the gap is 377 feet.

Stratigraphy as Shown by Drillhole LT-1

A log of the Paleozoic rocks in Drillhole LT-1 is given in Table V (p. 27) and a columnar section in Figure 7. This columnar section includes a complete stratigraphic section from the top of the Wabi to the base of the Paleozoic rocks.

Designation of Rock Members in Drillhole LT-1

Simply by using the footages, convenient designations for the various rock members in the core of Drillhole LT-1 are obtained. For example, the shale between footages 375.7 and 473.7 is referred to as the Footage 375.7-473.7 Shale Member in this report.

Correlation of Hume's Sections with Strata in Drillhole LT-1

Figure 7 in this report shows correlations between the strata in Drillhole LT-1 and those in Hume's sections. The critical correlations are:

- The Footage 93-97 Sandstone in Drillhole LT-1 with the sandstone at the bottom of the Lockport Formation in Hume's section.
- The bottom of the Footage 473.7-624 Limestone in Drillhole LT-1 with the bottom of the upper limestone of the Liskeard Formation in Hume's section.

Some confirmation that the Footage 93-97 Sandstone in Drillhole LT-1 is indeed the bottom of the Lockport Formation is afforded by Hume's statement (1925, p. 35) that the strata at the south end of Dawson (formerly Wabi) Peninsula at Wabi Point Wharf (in Lot 3, Con. A, Harris twp.) are about 90–100 feet above the base of the Lockport(Thornloe) Formation. The wharf is about 2,000 feet southeast of Drillhole LT-1. The Footage 93-97 Sandstone in Drillhole LT-1 is at approximately the footage that might be inferred from its position at the wharf.

The lithology of the strata in Drillhole LT-1 compared with that shown on Hume's sections supports the correlations made on Figure 7.

After all formations shown in Hume's sections are correlated with their equivalents in Drillhole LT-1, a thickness of 377 feet remains in Drillhole LT-1, representing the gap between Hume's sections.

Presumably the Footage 473.7-624 Limestone of Drillhole LT-1 is the complete section of the "upper limestone member" of the Liskeard Formation partially shown in Hume's section. The present author places the top of the Liskeard Formation at footage 473.7 in Drillhole LT-1.

Footage 212 in Drillhole LT-1 is thought to be stratigraphically equivalent to the lowest part of the Wabi Formation given in Hume's section although the present author did not find any *Leperditia* fossils between footages 196 and 212. Between footages 212 and 473.7 occur Paleozoic strata whose stratigraphic equivalents are not known to be exposed in the Lake Timiskaming outlier and have not been intersected by any previous drillhole. The assignment of these strata to appropriate formations would have to be based on paleontological work lying outside the scope of this report.

Stratigraphy of the Footage 212-473.7 Strata of Drillhole LT-1

The Footage 375.7-473.7 Shale Member of Drillhole LT-1 is regarded by the author as being of Ordovician age and of the Cincinnatian Series. In the Table of Formations, and in the legend of the accompanying map No. 2066, this shale member is referred to as the "Unnamed Formation". Presumably this is part of Hume's (1925, pp. 27, 28) "Richmond Formation", which he did not find in the area but whose presence he suggests as follows: "From what is known about the Richmond invasion, it ought to be represented in this area."

The Footage 212-375.7 Strata are included tentatively by the present author in the Wabi Formation (of Silurian Age). On this basis, the bottom contact of the Silurian is placed at footage 375.7.

Only 70 feet of the lower part of the Lockport(Thornloe) Formation was intersected by Drillhole LT-1 between footages 27 and 97. Hume (1925, p. 34) gives the lower 186 feet of the Lockport in his section.

General Correlations of Paleozoic Rocks in the Lake Timiskaming Outlier

The correlations of the Paleozoic formations of the Lake Timiskaming outlier with the standard divisions of the geological time scale have undergone changes since Hume's work was done. Hume's paleontological correlations permitted lithological correlations particularly between the formations in the outlier and those in southern Ontario; the more recent paleontological work does not appear to admit of these lithological correlations.

Hume (1925, p. 13) stated that the Ordovician rocks of the outlier included rocks of the Champlainian Series (Middle Ordovician)-Trenton Stage and possibly included those of the Champlainian Series-Black River Stage (below the Trenton). As noted previously, he suggested that Ordovician rocks correlatable with the Richmond Formation of the Cincinnatian Series (Upper Ordovician) would probably be found in the outlier. More recent work would appear to suggest that all the Ordovician of the outlier belongs to the Cincinnatian Series; tables by Caley and Liberty (1957, pp. 215, 238) assigned all the Ordovician rocks of the outlier to the Richmond Stage of the Cincinnatian Series.

The Wabi Formation and Hume's Lockport Formation of the Lake Timiskaming outlier were regarded by Ollerenshaw and MacQueen (1960, p. 114) as probably equivalent in age to the Clinton Group, a group that in the Niagara Peninsula and the Toronto area in southern Ontario underlies the Lockport.

Description of Paleozoic Formations in Map-Area

LISKEARD FORMATION

Although the Liskeard Formation is widely distributed in the map-area, only four small outcrops are known, and they are as follows: one by the side of Highway No. 65, in Lot 4, Concession II, Casey township; one near the south end of Lot 5, Concession II, Casey township; two on the shore of Lake Timiskaming, Lot 7, Concession V, Harris township. Whether the formation is present or absent in many places under the extensive areas heavily covered by overburden is not definitely known. The author's preliminary maps (P. 162 and P. 163) were drawn without the information afforded by Drillhole LT-1 that was drilled later; on the basis of this drillhole information the Liskeard Formation has a wider distribution than previously shown.

The presence, as disclosed by a drillhole, of about a 92-foot thickness of Liskeard Formation under 65 feet of overburden on the south part of Lot 8, Concession II, Casey township, was mentioned by Hume (1925, p. 22), who gave a detailed section of the rock types. The altitude of the Liskeard-Precambrian contact is about 440 feet, assuming the altitude of ground surface to be about 600 feet. Probably the Liskeard Formation has a wide distribution under the area of deep overburden on the east side of the Casey Mountain upland. The Liskeard Formation has a thickness of 366 feet in Drillhole LT-1.

Table V and Figure 7 give a lithological description of the formation as shown by Drillhole LT-1 between footage 473.7 and 840.

From footage 756 to 840, no core was recovered. The material intersected is believed to be shale, silt, and sandstone; the sandstone is believed to be predominant. The material was very poorly consolidated; it is thought to be similar to the poorly consolidated sandstone exposed in Lots 19 and 20 of Guiges township in the Province of Quebec, immediately east of the north end of Lake Timiskaming.

The Footage 473.7-624 Limestone Member was shown, by simple acid tests, to be a pure limestone except between footages 604-624.

UNNAMED FORMATION
(Footage 375.7-473.7 Shale Member in Drillhole LT-1)

This is mentioned under the heading Stratigraphy; the author regards this member as being of Ordovician age and of the Cincinnatian Series. No exposure is known either in the map-area or in the outlier.

WABI FORMATION

Most exposures of the Wabi Formation are limited to the escarpment in Lot 5, Concessions I, II, and III, near the shore of Lake Timiskaming. Hume's (1925, p. 30) measured section of the Wabi was taken on these exposures. The same parts of the Wabi are found in footages 97-212 of Drillhole LT-1.

Northward along the escarpment from Concession III, Harris township, outcrops are very rare. Hume (1925, p. 28) reported one small outcrop of Wabi Formation on the north part of Lot 2, Concession VI, Harris township, and another on the south part of Lot 2, Concession I, Casey township.

LOCKPORT(THORNLOE) FORMATION

Only the lowest 70 feet of the Lockport(Thornloe) Formation is represented in Drillhole LT-1. Figure 7 shows Hume's (1925, p. 34) detailed section of the lowest 186 feet as exposed on the escarpment along the east side of Dawson (Wabi) Point in Harris township.

The basal sandstone is exposed on the escarpment about 1,700 feet south of the north end of Lot 5, Concession I, Harris township, at about 120 feet above Lake Timiskaming. An estimate of the greatest thickness of the Lockport(Thornloe) Formation in the map-area may be made by assuming that the bottom contact of this formation dips westerly at 2° from Lot 5, Concession III, Harris township, to directly below the outcrop of Lockport Dolomite at the bend of Highway No. 65 in Lot 2, Concession III, Harris township, and that this dip is not disturbed by faulting. Based on these assumptions, the thickness of the Lockport(Thornloe) Formation is 360 feet in Lot 2, Concession III, Harris township.

Between the top of Hume's section on the escarpment and the bend of Highway No. 65 occur numerous outcrops of dolomite showing that the Lockport(Thornloe) Formation between 180 and 360 feet above its bottom contact is largely if not exclusively dolomite.

The outcrop of Lockport(Thornloe) dolomite exposed at the bend in Highway No. 65 in Lot 2, Concession III, Harris township, is the stratigraphically highest Lockport(Thornloe) Formation in the map-area. West of this outcrop to the edge of the map-area, the Paleozoic rocks are covered by postglacial clays.

CENOZOIC

Pleistocene

During the earlier part of the Pleistocene Epoch, the map-area was subjected to continental glaciation. Evidence of only one glaciation, the last or Wisconsin, was found.

PRE-PLEISTOCENE TOPOGRAPHY

It is believed that glacial erosion removed only a small amount of material from the tops of the upland areas; whether much larger amounts were removed from the deep linear valleys defined by the bedrock surface is not definitely known. The approximate concordance in elevation of the rock surface of the top of the north part of Casey Mountain and of the rock surface of the top of the upland in the western part of Harris township suggests that these surfaces represent residual parts of a nearly level erosional surface older than the Pleistocene. The elevation of this erosional surface in the map-area is about 850 feet. It appears to be the same erosional surface seen on Highway No. 65 about 3½ miles northwest of the New Liskeard railway station, with elevation at that point of about 830 feet.

The outline of the north end of Lake Timiskaming and the positions of the deep linear valleys (defined by the bedrock surface) extending northward from the bays, as seen at Sutton Bay, suggests an ancient river system established long before the Pleistocene Epoch. The main channel of this system presumably lay somewhere under the position now occupied by Lake Timiskaming. The erosional surface that was developed on bedrock and the depressions that are thought to represent an ancient river system suggest the nature of the topography over which the continental glaciers advanced in Pleistocene time.

DIRECTION OF GLACIER MOVEMENT

The directions of glacial striae observed in the map-area are between S.5°W. and S.75°E. The author infers that the direction of ice-advance was between S.40°E. and S.60°E. and that deviations from this were due to the effects of local topography, particularly to linear depressions in the bedrock surface, under the ice.

The direction of the linear depression near the west shore of the north part of Lake Timiskaming is about S.30°E.; this is also the direction of the linear depression extending inland from Sutton Bay in Harris township. Hume (1925, pp. 10, 12) emphasized the importance of the depression in the bedrock surface, now partially occupied by Lake Timiskaming, as a factor influencing the direction of glacial movement and the amount of glacial erosion.

PLEISTOCENE DEPOSITS

The Pleistocene deposits in the map-area were laid down while the glacier was in process of northerly retreat. Three stages of deposition can be recognized in descending order:

Third stage: sand, gravel, etc., formed in the bars and beaches of Lake Barlow-Ojibway after the ice-front had receded north of the map-area.

Second stage: bedded (varved) clays deposited in Lake Barlow-Ojibway while the ice-front was receding across the map-area and after it had receded.

First stage: sand, gravel, and bouldery deposits more or less directly associated with the ice-front while in process of retreating across the map-area.

Deposits Associated with the Ice-Front

The sand, gravel, and bouldery deposits of the first stage occupy only a small fraction of the total exposure of Pleistocene deposits in the map-area. They rest directly on bedrock and in a few places can be seen under the Lake Barlow-Ojibway bedded clay. Records on file at the office of the Resident Geologist at Cobalt show that many water wells in the map-area have intersected sand, gravel, boulders, quicksand, or hardpan (all thought to belong to the first stage) after passing through the Lake Barlow-Ojibway clay. The sand, gravel, etc., are presumably close to bedrock that, however, was not commonly reached in the deeper wells.

The deposits of the first stage have characteristics suggesting a glaciofluvial origin but may contain a proportion of morainic material. Where these deposits are of sufficient size and are in a suitable position, they have been utilized as a source of sand, gravel, and road ballast; the best exposures are in such pits.

One such exposure is shown by the gravel pit in Lot 5, Concession II, Harris township, on the east side of the Paleozoic escarpment. The pit material ranges from fine sand to gravel with boulders up to 5 feet. The bedding shows great variation in definition from place to place. At the north end of the pit, varved clay overlies the gravel.

The gravel pit near Judge (Post Office) in Lot 9, Concession II, Casey township, exposes crossbedded sands overlying sandy boulder clay that shows faint bedding. The boulders are up to 6 feet in size. The greatest thickness of the deposit is about 65 feet. Varved clays can be seen overlying the sand.

In Lot 6, Concession II, Casey township, both near the top and at the base of Casey Mountain, occurs sand, gravel, and cobbly material thought to belong to the first stage.

As reported in well logs, the sand, gravel, boulders, quicksand, or hardpan lying beneath the Barlow-Ojibway clay have thicknesses ranging up to 70 feet. A well in Lot 3, Concession I, Casey township, is reported to have intersected 70 feet of quicksand and gravel after passing through 180 feet of clay. A well in Lot 10, Concession II, Casey township, in the vicinity of the Judge gravel pit, is reported to have traversed 55 feet of quicksand and gravel beneath 60 feet of clay.

Bedded Clays Deposited in Lake Barlow-Ojibway

Nearly all the exposures of Pleistocene deposits in the map-area are the bedded (varved) clays deposited in Lake Barlow-Ojibway. As shown by water-well records, the thickness of the clays is considerable; the greatest thickness shown is 268 feet for a well in Lot 5, Concession V, Casey township.

Bars and Beaches of Lake Barlow-Ojibway

A thin discontinuous bed of poorly sorted sand and gravel (with cobbles up to 6 inches) that extends from Lot 5, Concession I, Harris township, to the northwest corner of the township represents a bar in Lake Barlow-Ojibway. An exposure of this material is found in the gravel pit in the east part of Lot 4, Concession I, Harris township.

Sand or gravel beach deposits formed in Lake Barlow-Ojibway are rare in the area. A sand pit occurs in one such beach on Lot 7, Concession V, about 1,300 feet south and 1,300 feet west of the northeast corner of the concession. A pit with sand, gravel, and cobbles in Lot 8, Concession V, Harris township, about 2,600 feet south and 200 feet east of the northwest corner of the lot, is on a beach about 25 feet above Lake Timiskaming. In some places, around rock hills, the poorly sorted sand, gravel, boulders, and heterogeneous material containing considerable amounts of clay represent reworked Lake Barlow-Ojibway clays and material underlying the clay.

LAKE BARLOW-OJIBWAY

The name "Lake Barlow" was given by Wilson (1918, p. 143) to the proglacial lake in which was deposited the varved clay so widely exposed in the vicinity of Lake Timiskaming and extending at least as far north as the Hudson Bay-St. Lawrence drainage divide. Later it was established that this proglacial lake extended far beyond the divide and was not separated from a proglacial lake north of the divide that was named Lake Ojibway by Coleman (1909, p. 284). The name Barlow-Ojibway expresses the unity of what were formerly considered two separate lakes.

The extent of the lake when at its maximum spread is shown with reasonable accuracy by the extent of the bedded clay deposited in it; at that time all the Casey-Harris map-area was submerged. The position of the shoreline of the lake at its maximum spread is shown approximately by the limit of the bedded clay and more precisely by such shoreline features as beaches and washed surfaces.

The highest shoreline known (Thomson 1960c, p. 25) in the vicinity of the map-area is identified by a washed surface at elevation 970 feet, 15 miles south of the south end of Harris township in Lot 15, Concession IV, Lorrain township. Farther north, the highest shoreline of Lake Barlow-Ojibway is at higher elevations. Hughes (1960) recorded that, in the Kirkland Lake map-area, all surfaces below 1,200 feet elevation were formerly submerged.

It is clear that elevation and differential elevation of the land surface has taken place since Lake Barlow-Ojibway existed; the greatest rise was in the north.

Lake Barlow-Ojibway, except for that part north of the then-existing height-of-land, came to an end by drainage to the Ottawa River through the waterway now occupied by Lake Timiskaming.

The low water-level of Lake Timiskaming is about elevation 578 feet, much below the highest shoreline of Lake Barlow-Ojibway in the immediate vicinity.

The question of what constituted the barrier preventing the drainage of Lake Barlow-Ojibway, when at its higher levels, down the waterway at present occupied by Lake Timiskaming does not appear to be satisfactorily answered at present.

Wilson (1918, p. 143), in discussing this matter, wrote:

> It is obvious that a glacial lake covering a large part of the Timiskaming basin could not have existed unless the relative elevations of the northern and southern parts of the Timiskaming basin have changed several hundred feet since the lacustrine deposits were laid down; or unless a glacial ice-lobe projected from the front of the Labradorean ice-sheet across either the lower part of the Timiskaming trench, or the Ottawa valley below the Timiskaming trench.

Of these two hypotheses he considered the latter, that an ice-barrier blocked drainage through the Lake Timiskaming trench, as the more probable. Antevs (1925, pp. 74, 75), by contrast, considered that the Lake Timiskaming trench was blocked only by a drift barrier, as it is at present, and that the existence of Lake Barlow-Ojibway to the north was due to that part of the region being relatively depressed.

As mentioned previously, the map-area was at one time completely submerged in Lake Barlow-Ojibway; in consequence, no shorelines of the lake at its highest level are present in the map-area.

Before the lake had receded greatly, an extensive bar developed, and this is represented by the discontinuous belt of sand, gravel, etc., extending from Lot 5, Concession I, Harris township, to the northwest corner of the township. The belt attains a maximum width of about 500 feet; the greatest thickness of the sand, etc., is probably less than 10 feet. As shown on O.D.M. Map No. 31b (Burrows and Hopkins 1922) the belt of sand, etc., extends more than 12 miles northwest from the northwest corner of Harris township. The surface elevation of the sand in the northwest corner of Harris township is about 850 feet.

Structural Geology

The rocks of the map-area were affected by diverse disturbances at different stages in their geological history. The Archean rocks were subjected to intense horizontal stresses resulting in folding; they have, in general, nearly vertical dips. The Proterozoic, Paleozoic, and Cenozoic rocks have been affected by vertical movements of the earth's crust but not by intense horizontal stresses; they have, in general, gentle dips.

ARCHEAN STRUCTURE

Information on the Keewatin rocks in the map-area is restricted to four isolated parts: Harris township, Concession V, Lots 7 and 8; Harris township, Concession A, and the adjacent parts of Lake Timiskaming; Casey township, Concession I, Lot 5; Casey township, Concessions V and VI, Lot 11.

In the first three, the strikes of the beds and lava flows are north of east, and schistosity has not been developed. In the last, the attitude of the beds is generally uncertain owing to metamorphism, and a well marked schistosity strikes between north and N.15°W. and dips 50°–70°W.

The Algoman pluton exposed in Casey township, Concession II, Lots 2, 4, 5, and 6, is massive; schistosity appears not to have been developed in the intruded rocks near its south contact.

PROTEROZOIC STRUCTURE

The Proterozoic rocks have been affected by structural disturbances that are not evident in casual examination.

The description of the Gowganda Formation pointed out the basin-like shape of its bottom contact, considered as a whole over the central part of the map-area. The description of the Nipissing Diabase pointed out the basin-like shape of its bottom contact.

Hypotheses in explanation of these shapes are of two distinctly different kinds:

1. The shapes are due to deformation by folding.
2. The shapes are original but may have been modified by differential subsidence or elevation.

HYPOTHESIS 1

The hypothesis that the shapes were due to folding appears to have been advanced originally by Whitman with application to the Cobalt area particularly. Whitman (1922, p. 263) stated that gentle folding took place shortly after the injection of the Nipissing Diabase. Whitman believed that the folding determined the shape of the Huronian-Archean contact, the attitudes of the Huronian rocks, the attitudes of the Nipissing sill, and the presence and nature of many joints and faults.

Knight (1924, pp. 32, 33) in his discussion of the Cobalt area gave little attention to the problem. Under folding, he appeared to include warping of strata, and the bending intimately associated with faulting of strata. He stated that the Cobalt Group sedimentary rocks and the Nipissing sill were affected by folding in the vicinity of Cobalt Lake. In regard to trough-like depressions in the Cobalt Group–Keewatin contact Knight (1924, p. 6) wrote: "These troughs appear to the writer to have formed by erosion in the old Keewatin surface. Possibly a little folding, after the Cobalt series was laid down, may have accentuated the troughs." He pointed out (1924, p. 32, 34) that the existence of the arch or dome-like structure of the Nipissing sill near Kerr Lake is not due to folding or other deformation.

Griffis (1962, pp. 30, 31) reaffirmed the hypothesis that the attitudes of the Nipissing sill and the presence and nature of many joints and faults were determined by deformation after injection of the sill; the stresses causing the deformation were thought to be external to the sill.

HYPOTHESIS 2

The hypothesis that the basin-like shapes of the contact between the Archean and Proterozoic sedimentary rocks are original was the only one considered by Miller (1913, p. 76) for the Cobalt area. He believed that the shapes were derived directly from the relief of the pre-Huronian surface immediately prior to deposition of the Cobalt Group sediments.

The present author regards Miller's explanation as substantially correct. Presumably some later modification of the shapes took place, and it is certain that the Proterozoic rocks and the Nipissing Diabase sill were subjected to stresses causing the vein structures of the silver-cobalt veins and certain low-dipping joints and faults.

Basin of Cobalt Group Sedimentary Rocks

The present author regards the Cobalt Group sedimentary rocks in the central part of the Casey-Harris map-area as having occupied a shallow and local depositional basin. This inference is supported by Lowes' statement (1963, p. 33) that the dips of the strata gradually increase as the bottom contact is approached; near the contact the strata are conformable with the contact. Lowes (1963, p. 13) regarded the appreciable dip of the Cobalt Group strata as indicated that subsidence into basin structure followed their deposition.

Fractures, Faults, and Joints

The Proterozoic rocks in the map-area have been affected by fractures, faults, and joints. What follows deals largely with the fractures, faults, and joints at the Langis mine, but may be applicable to other places where information may be lacking.

The fractures, faults, and joints may be classified on the basis of dip. The one class has steep dips, ranging between 70° and vertical; the other has gentle dips, in general less than 30°. The steeply dipping class includes all the vein structures of the silver-cobalt veins. In general, the vertical displacements shown by the vein structures are less than 2 feet, but the displacement of the fault shown by No. 30 vein of Langis No. 3 shaft may be as great as 5 feet. This is the largest displacement known for any fault of the steeply dipping class.

GENTLY DIPPING STRUCTURES

In this classification (gently dipping structures) are included a large number of slips and small faults; the Casey Fault, which is the most important one at the Langis mine, is also included.

Structures of this class are abundant in the Cobalt Group sedimentary rocks; they occur to some extent in the Keewatin rock at the east end of the Langis No. 6 shaft workings and in Nipissing Diabase on the 275-foot level of No. 6 shaft. A fault surface of this class occurs along the contact of Nipissing Diabase over Cobalt Group sedimentary rocks at the east end of the No. 6 shaft workings.

The direction of dip of the slips and faults is, for the most part if not exclusively, the same as both that of the Cobalt Group-Keewatin contact considered as a whole and that of the Cobalt Group strata.

In the Langis No. 3 shaft workings the Casey Fault is prominent but other slips and faults of the gently dipping class are not abundant. In the Langis No. 6 shaft workings, slips and faults of this class are abundant and widespread; uncertainty is experienced in identifying the Casey Fault.

All the slips and faults of this class are thought by the author to be closely related, that is, formed during the same interval of time and in response to the same stresses. The author regards all the faults of this class as being younger than the solidification of the Nipissing Diabase. In a gently dipping fault traversing Cobalt Group sedimentary rocks at about 240 feet northwest of No. 6 shaft on the 275-foot level, epidote occurs with calcite; presumably epidote in Cobalt Group sedimentary rocks could have formed only after intrusion of the Nipissing Diabase.

Determination of the displacement along these structures is in places impossible owing to the absence of a suitable vertical surface of reference. The veins, which are approximately vertical, are displaced by the gently dipping faults; but to the author it seems unlikely or at least uncertain that the vein displacements equal the total displacements.

In view of the displacement of silver-cobalt-bearing veins, it is clear that part of the movement along the faults is younger than the main period of vein formation. The occurrence of argentite along a few of these faults, and the lack of evidence that it was dragged there, suggests that vein formation continued after movement along the faults had ended. The occurrences of argentite, though not seen by the author, were reported (personal communication 1962) by L. S. Lafoy, underground superintendent, who was present when they were mined. The argentite was restricted to those parts of the faults immediately adjacent to the vertical veins.

The Casey Fault is exposed in Langis No. 3 shaft workings; for part of its course the approximate position and attitude of the fault line at rock surface is shown in Figure 5. The Casey Fault was carefully mapped and studied by Lowes (1963, pp. 34–39); for the vicinity of Langis No. 3 shaft, Lowes made a contour plan showing the position of the fault and, in addition, an isochore plan showing the vertical thickness of Cobalt Group sedimentary rocks intervening between the fault and the Cobalt Group-Keewatin contact. On the isochore plan, the thickness of the sedimentary rocks was shown to range between 0 and 105 feet. The variation in thickness is very largely due to irregularities in the contact.

Away from the Langis No. 3 shaft workings, faults of a similar nature and attitude occur, but their correlation with the Casey Fault is not entirely definite. Thus, in the Dolphin-Miller shaft (for location, *see* Figure 5), a gently dipping fault at about 250 feet below the collar and about 198 feet above the Cobalt Group-Keewatin contact is presumably the Casey Fault. In the Langis No. 6 shaft workings on the 335-foot level, at about 400 feet southwest of the shaft, a nearly horizontal fault may be the Casey Fault. A vein, which below the fault is known as No. 43 vein, is displaced about 40 feet north along the fault; above the fault it is known as No. 42 vein. On the 420-foot sublevel (at about 600 feet in a direction a little south of east from Langis No. 6 shaft) a fault along the bottom contact dips about 10° east; this may be the Casey Fault.

The Casey Fault is up to several feet thick and contains fractured rock and gouge.

Displacement of the silver-cobalt veins by the Casey Fault ranges from 6 to 10 feet. The hanging-wall segments of the vein are displaced northward (up dip) from the footwall segments.

ORIGIN OF FRACTURES AND FAULTS

Lowes (1963, pp. 59, 63) concluded that the steeply dipping structures and the gently dipping structures were formed at different times and in very different ways. The steeply dipping structures were, he thought, formed shortly after the deposition of the Cobalt Group sediments; they arose, in his view, by the compaction of the sediments and the subsidence of their basin of deposition, and were controlled to an important extent by the shape of the basin that is defined by the Cobalt Group-Keewatin contact.

Lowes (1963, pp. 63, 83) considered that Casey Fault, and presumably also the other gently dipping faults, to have originated long after the vein structures. He regarded the stresses causing the gently dipping structures as being directly related to the Grenville orogeny estimated to be 1,200 million years younger than the Nipissing Diabase intrusion.

Lowes' conclusions were based in part on a statistical study of the attitudes of fractures in the Cobalt Group sedimentary rocks and in the Keewatin rocks; the pattern of fracturing in the Cobalt was compared with that in the Keewatin.

To the present author, the conclusion that all the steeply dipping structures, in particular the vein structures, are independent of and much older than the gently dipping structures is not satisfactorily proved; the association of the two seems to be too intimate to rule out the probability that a relationship exists between them.

It seems probable that the stresses leading to the steeply dipping fractures are of "local origin", as Lowes has suggested. That this "local origin" is of the nature of a differential subsidence of minor magnitude appears to be a helpful hypothesis. The positions and attitudes of the fractures were greatly influenced by the configuration of the basin-like shape defined by the Cobalt Group-Keewatin contact.

No evidence limiting the time of origin of the fractures is presented by Lowes; to the present author a time of origin (at least for the vein structures) subsequent to the intrusion of the Nipissing Diabase seems probable. The adjustments in the earth's crust brought about by the transfer of magma attendent upon and following the intrusion of the Nipissing Diabase sill seem a plausible mechanism for the differential subsidence that caused the fractures.

PALEOZOIC STRUCTURE

The preservation from erosion of the Paleozoic rocks in the Lake Timiskaming outlier appears to be primarily due to a broad downwarp of the earth's crust after their deposition, as was suggested by Hume (1925, p. 51). Faulting is another structural disturbance affecting the distribution and attitude of the Paleozoic rocks in the outlier; this faulting is certainly post-Silurian in age and possibly much more recent. The relationship, if any, between the downwarping and the faulting does not appear to be definitely known at present.

Lake Timiskaming Fault

The best known and most important post-Silurian fault in the outlier is the Lake Timiskaming Fault. Miller (1913, pp. 119, 120) was the first to detect it. Many authors have written about this fault, but nearly all the information obtained prior to Hume's 1925 G.S.C. Memoir is summarized in that memoir; this earlier information is not referred to further in the present report.

The Lake Timiskaming Fault (*see* Figure 8) lies west of the Casey-Harris map-area; but, owing to its importance in determining the attitude and preservation from erosion of the Paleozoic rocks in the map-area, information on its position and nature is repeated here. As shown on O.D.M. Map No. 1956a (Bucke township) the fault strikes N.32°W. In the northern part of Lake Timiskaming, it lies near the west shore; it passes through a position about 13,000 feet due west of Dawson (Wabi) Point. The position and nature of the fault are indicated in a figure by Hume (1925, p. 47) on an east-west section through New Liskeard. This section shows the east side of the fault to be downdropped so that Silurian rocks on the east wall abut Precambrian rocks on the west; the westerly dip of the Paleozoic rocks east of the fault (including those in Casey-Harris) is directly due to the displacement along the fault.

Hume (1925, p. 48) gave the amount of vertical displacement of the fault northwest of New Liskeard as 770 feet and, at about 5 miles farther north, as 1,000 feet.

The author (Thomson 1960a, pp. 146, 147), on the basis of a drillhole traversing the fault near the Agaunico mine in Lot 15, Concession I, Bucke township, and about 21,500 feet due south of Dawson (Wabi) Point, estimated the displacement there to be about 770 feet. O.D.M. Preliminary Map P.67A by the author (Thomson 1960b) shows a profile across the Lake Timiskaming Fault, in which the attitude of the base of the Paleozoic rocks on the east wall of the fault is shown as 210 feet below sea-level.

Information that would permit a precise determination of the amount of westerly dip of the Paleozoic rocks lying east of the fault is not available.Hume (1925, p. 47) indicated, on his section through New Liskeard, a west dip slightly less than 2°. If it be assumed that the bottom contact of the Paleozoic rocks dips uniformly west from its outcrop on the east shore of Lake Timiskaming to an altitude of 210 feet below sea-level on the east wall of the Lake Timiskaming Fault near Agaunico mine, then a dip of slightly greater than 2° is indicated. Possibly 2°W. may be taken as the dip of the Paleozoic rocks until more precise information is available.

Assumed Fault on East Side of Casey Mountain

Evidence suggesting the presence of a fault on the east side of Casey Mountain is afforded by a drillhole, reported by Hume (1925, p. 22), in the south part of Lot 8, Concession II, Casey township.

The presence of Paleozoic rocks and of what may be a sill of Nipissing Diabase in the hole suggests the existence of a fault between the drillhole and Casey Mountain. If the diabase is indeed Nipissing Diabase, a downward displacement of the east side of the fault amounting to several hundred feet is indicated.

On the basis of the position of Casey Mountain, the direction and position of the Blanche River, and the strike of known post-Silurian faults near Lake Timiskaming, the strike of the assumed fault on the east side of Casey Mountain is estimated to be about N.25°W.

Northeast Lineament at North End of Lake Timiskaming

Miller (1913, pp. 116–19) noted that linear topographic features, particularly the watercourses in the general vicinity of Cobalt, tend to lie along either of two directions, northeast and northwest. He also noted that many of these lineaments were along fault lines. Miller (1913, p. 117) described and illustrated a northeast lineament along the axis of the northeast bay of Lake Timiskaming, that is, passing through a point about a mile south of Dawson Point at the south end of Harris township; the Cobalt Lake Fault is shown as lying on the southwest extension of the lineament. Miller's account implied that the part of the lineament along the axis of the northeast bay of Lake Timiskaming indicates either the presence of the Cobalt Lake Fault or of a related "line of weakness."

To the present author, the lineament along the axis of the northeast bay of Lake Timiskaming is so poorly defined that any inference as to either the position or the presence of a fault along it is scarcely warranted. No evidence of a fault, other than the lineament, seems to have been found.

Metamorphic Geology

Only one type of metamorphism (referred to locally as spotted chlorite alteration) is considered here. This metamorphism affects certain rocks of the Gowganda Formation in the Casey-Harris map-area.

The metamorphism consists (*see* photo, p. 21) of the development of dark spheroidal bodies of chlorite that range in size from a pinhead to ½ inch, and in abundance up to 40 percent of the rock. Typically the spheroidal bodies are isolated but they may be aggregated into clots. As shown in the photo, the spots are developed preferentially along certain beds. The susceptibility of any bed to this type of alteration depends on the abundance of mafic minerals; where mafic minerals are absent, as in arkose, the spots have not developed. The author believes the chlorite bodies to have been formed by concretionary replacement under special conditions not normally present. In places, grains of pyrite are present at the centre of the bodies, and appear to be nuclei around which the chlorite grew.

In the Casey-Harris map-area, spotted chlorite alteration is exposed at surface in the vicinity of the Langis No. 3 shaft in Casey township, and in Lots 7 and 8, Concession V, Harris township. It is exposed in the drill core and in the underground workings of the Langis mine, and in the drill core of the Benner-Harris Group (Lot 8, Con. V, Harris twp.). No attempt was made to determine its distribution in the map-area.

The origin of this metamorphism is not clear; possibly it is related to the Nipissing Diabase but the relationship is not a simple one. Spotted chlorite alteration does not appear in the wallrocks along the contact of the diabase sill nor does it appear within the diabase.

The question of a possible association of spotted chlorite alteration with silver-cobalt deposits is discussed in the section Economic Geology, under the heading Spotted Chlorite Alteration on page 53.

Economic Geology

Mineral deposits, of value because of their metal content, and deposits of industrial minerals occur in the map-area. Metallic minerals have been of greatest interest so far.

Silver is the only metal that has been produced in appreciable amounts. In the recovery of the silver, small quantities of associated metals such as cobalt, nickel, and copper, have been obtained.

Iron-bearing deposits of economic potential occur.

Industrial minerals utilized in the map-area include sand, gravel, ballast aggregates, and water; other minerals of interest include limestone, shale, and building stone.

SILVER-COBALT

The Casey-Harris map-area lies within the Timiskaming silver-cobalt area as defined by Reid (1943, p. 1) and contains the two geological units, Nipissing Diabase and Cobalt Group sedimentary rocks, that are characteristic of the area.

In the map-area, silver-bearing or cobalt-bearing veins have been found on the properties of Langis Silver and Cobalt Mining Co. Ltd., Dolphin-Miller Mines Limited, and the Benner-Harris Group. Such veins have also been reported on the property of Quincy Creek Mines Limited and on the claim of Casey-Seneca Silver Mines Limited, but the underground workings on these two have not been accessible for many years and authentic information on mineral occurrences in them is not available to the author. Individual descriptions of these properties are given elsewhere in this report.

The Langis mine has been the only productive mine in the map-area; it is the only one on which extensive development work was done. In view of this, most of the discussion under the heading Silver-Cobalt refers particularly to the Langis mine.

General Type of Vein

Silver-cobalt-bearing veins in the Timiskaming silver-cobalt area may in general be assigned to either of two types: the "normal vein" type of the Cobalt area, and the "aplitic vein" type. One distinctive characteristic of the "aplitic

Photo 5 — Vein 30, Langis No. 3 shaft workings; rich silver-cobalt vein about 6 inches wide in Gowganda conglomerate. (Photo courtesy of J. E. Jerome.)

vein" type is the association of red feldspathic material (aplite) as dikes and alterations with the veins. The host rock of the "aplitic vein" type is almost exclusively Nipissing Diabase. Some "normal vein" types have Nipissing Diabase as host rock, but a greater number of them are in Cobalt Group sedimentary rocks or Keewatin rocks.

The silver-cobalt-bearing veins of the Casey-Harris map-area are of the "normal vein" type.

Nature of Veins

The veins in the Casey-Harris map-area are very similar to those occurring in the Cobalt area.

The "normal vein" type is usually pictured as having striking and conspicuous features; photo 5 shows massive metallic mineral in widths up to 6 inches accompanied by calcite occurring in a nearly vertical and approximately rectilinear structure. This is typical of many of the ore shoots, but there are considerable variations along one vein and from vein to vein.

VEIN STRUCTURE

The largest vertical displacement known along any vein structure at the Langis mine is about 5 feet and is found in No. 30 vein of No. 3 shaft and is situated about 600 feet southwest of No. 3 shaft. The vein structure itself may be either a fault or a mere joint. The term "vein" is commonly used here to describe both the single-vein type of structure and the multiple-vein type of structure.

The multiple-vein structure may include up to perhaps three closely adjacent and subparallel structures, or may consist of an assemblage of many minor structures that are mined as a unit.

In the No. 3 shaft area of the Langis mine, most of the stopes are on veins with one to three structures; in the No. 6 shaft area, veins consist of assemblages of many minor fractures without any single outstanding structure. The minor fractures usually do not have abundant calcite along them. The assemblages are very different in appearance from the veins with up to three conspicuous structures; the assemblage type usually gives rise to wide stopes of mill-rock.

The dip of the veins is invariably between 70° and 90°. Angular inclusions are of common occurrence in the veins. The walls of the veins and veinlets are sharply defined.

NONMETALLIC GANGUE

The nonmetallic gangue in the veins is almost exclusively carbonate and is, for the most part, calcite. Dolomite occurs in smaller amounts. The colour of the carbonate is varied; it may be white, grey, or pink. "Black" calcite occurs in at least three veins (Nos. 23, 42, and 43), but the colour is due not to colouring material in the calcite but to innumerable very fine-grained inclusions of metallic mineral that, at one place, was determined to be safflorite.

A noteworthy characteristic of the veins is the absence of banding either symmetrical to the walls or otherwise; this applies not only to the nonmetallic gangue but also to the metallic minerals.

METALLIC MINERALS

Native silver and cobalt-nickel-iron arsenides and sulpharsenides are the common and typical metallic minerals of the veins. The author has identified the following metallic minerals associated with the veins: native silver, argentite, ruby silver, cobaltite, skutterudite (smaltite), safflorite, arsenopyrite, niccolite, native bismuth, bismuthinite, chalcopyrite, bornite, tetrahedrite, sphalerite, marcasite. Lowes (1963, p. 66) records the presence of loellingite and rammelsbergite.

Presumably all, or nearly all, the metallic minerals found in the silver-cobalt veins of the Cobalt area also occur in the veins of the Casey-Harris map-area.

Many of the cobalt-nickel-iron arsenides and sulpharsenides have physical characteristics that are so similar that, where the minerals are found occurring together in massive form, identification of the individual minerals is uncertain or impossible. The common local practice is to refer to such unidentified minerals as "cobalt"; the term "cobalt" thus may mean either the metal cobalt or one or several of the hard steel-grey cobalt-nickel-iron arsenides and sulpharsenides. The use of a short group name is a practical necessity; the term "smaltite" is sometimes used in the same sense as "cobalt" and is preferred by the author.

A comprehensive description of the vein minerals, of their textural relationships, and of their paragenesis is outside the scope of the present report. For these the reader is referred to the recent work by Lowes (1963, pp. 64–81), and the early work by Ellsworth (1916); other extensive literature on the minerals of the Cobalt area is also applicable to the silver-cobalt veins of the Casey-Harris map-area.

Native Silver and Silver Ores

Native silver is by far the most important silver-bearing mineral. It occurs in the vein-proper, and in the wallrock.

In general, where native silver occurs, "smaltite" is also present close-by. On the other hand, some parts of one vein may be silver-bearing, and others nearly exclusively "smaltite"-bearing. Thus, the upper part of Langis No. 1 vein is almost exclusively "smaltite"-bearing; the lower part is silver-bearing. It appears that certain veins, for instance No. 37 vein (1,200 feet southwest of Langis No. 3 shaft), are exclusively "smaltite"-bearing, but further work may demonstrate the presence of important amounts of silver in them.

Native silver occurs in the vein-proper in pieces ranging in size from slabs as large as perhaps two square feet in area and ½ inch in thickness and as small as tiny flakes that are referred to as "leaf silver". It also occurs in the vein-proper in very irregular shapes in the central part of "smaltite" masses or atoll-like shapes. In places, an exquisite pattern of dendritic silver enveloped in "smaltite" and contained in a white calcite matrix is found. The above types of silver occurrence constitute the "high grade" ore (with a silver content greater than about 500 ounces per ton) that yields remarkably quick and large profits to the fortunate discoverer.

Native silver occurs in the wallrock of the veins for the most part as leaf silver. The leaves occupy tiny fractures and subsidiary veinlets. The leaf silver in the tiny fractures is for the most part not accompanied by calcite. The leaf silver in the wallrock may extend to about 2 feet on either side of the vein-proper.

The wallrock of the veins-proper and those assemblages of minor veinlets mentioned under the heading Vein Structure make up the low-grade ore or mill-rock. The tenor of this is usually in the range 10–30 ounces of silver per ton.

Cobalt Ore

The metal cobalt apparently is not one that contributed, except to a minor extent, to the value of mineral production at the Langis mine. Its lack of importance in the value of production was partly due to the depressed price of cobalt when exploration and mining were carried on vigorously; this includes the period 1956 to the present. Lowes (1963, p. 3) reports that for the period 1956 to 1961 a production of 166,869 pounds of cobalt was obtained; during the same period approximately 3.3 million ounces of silver was produced. During the period 1952 to 1956, when a higher price was obtainable for cobalt, the mine was being worked in a desultory manner.

It would appear that the potential resources of cobalt ore in the map-area are not great; prospecting and exploration in the future might change this view.

Weathering of Metallic Minerals

The characteristic and distinctive hydrous arsenates, cobalt bloom (erythrite), nickel bloom (annabergite), and scorodite, form rapidly on exposure of the cobalt-nickel-iron arsenides and sulpharsenides to weathering. Such products of weathering are often helpful in revealing the presence, in small quantity, of the cobalt-bearing and nickel-bearing minerals.

Black earthy material, presumably for the most part asbolite or related cobalt-nickel-iron hydrous oxides, occurs for several feet below rock surface in the few veins that have been mined either to rock surface or almost to rock surface. The native silver appears to be unaltered although the cobalt-nickel-iron arsenides and sulpharsenides are thoroughly oxidized.

CONDITIONS RELATING TO ORIGIN OF SILVER-COBALT VEINS

A productive silver-cobalt vein is presumably the result of a number of conditions all requiring fulfilment. There must be a source for the ore fluids, channelways to conduct them, and agencies to precipitate the gangue and ore minerals. A comprehensive treatment of these conditions is far beyond present knowledge. In the following discussion, a few of the conditions that appear to have had some effect on the origin of the veins are considered.

Spatial Relationship to Nipissing Sill

Veins of the "normal vein" type may be classified on the basis of their spatial relationship to the Nipissing Diabase sill. One class is below and the other above the central part of the sill (or such was the case prior to erosion). The veins of the Casey-Harris area belong to the "below-the-central-part-of-the-sill" class. In view of the fact that the upper part of the sill and the Precambrian rocks above it have been eroded in the map-area, the question of the former presence of the other class of veins is of no practical interest.

It is believed that the relationships that exist for the "below-the-central-part-of-the-sill" class in the Cobalt area will also hold, although possibly with some modification, in the Casey-Harris map-area.

Economically Significant Contacts

For the "below-the-central-part-of-the-sill" class in the Cobalt area, particularly as made known by Miller (1913) and Knight (1924), two contacts are of great economic significance. These are the bottom contact of the Nipissing Diabase sill, and the contact of the Cobalt Group sedimentary rocks over Keewatin rocks. The productive parts of the veins have been found to be restricted to the vicinities of these contacts, but this generalization requires qualification. It was found that where the bottom of the Nipissing Diabase sill was in contact with Keewatin rocks, the vicinity of this contact was favourable to the occurrence of ore shoots in the veins; where a thickness greater than perhaps 25 feet of Cobalt Group sedimentary rocks intervened between the bottom of the sill and the Keewatin, the favourable position in a vertical sense was in general not the sill-bottom contact but rather the contact of the Cobalt Group sedimentary rocks over Keewatin rocks.

However, in No. 30 vein of Langis No. 6 shaft (*see* Figure 5), work done in 1962 and 1963 has shown the presence of significant amounts of ore in Nipissing Diabase. In this vein, a thickness of about 80 feet of Cobalt Group sedimentary rocks intervenes between the diabase sill and the Keewatin. The ore in the Nipissing Diabase extends upward from the bottom contact of the sill for at least 70 feet. But No. 30 vein of Langis No. 6 shaft was also productive in the Cobalt Group sedimentary rocks.

In the Casey-Harris map-area, the vicinity of the contact of Cobalt Group sedimentary rocks over Keewatin rocks has been, up to the present, the favourable horizon for the occurrence of ore shoots. Nearly all ore obtained has come from shoots in Cobalt Group sedimentary rocks within a distance of 150 feet from the contact; but, a small amount has come from shoots in Keewatin rocks within a distance of perhaps 50 feet below the contact.

It must be recognized that, although the ore shoots occur in the vicinity of Cobalt Group–Keewatin contact, great areas of this contact are barren of ore-bearing veins. Clearly the presence of the contact is only one of the factors favourable to the presence of ore-bearing veins.

Significance of Irregularities in the Cobalt Group–Keewatin Contact

The hypothesis that irregularities or depressions in the Cobalt Group–Keewatin contact are significant in the occurrence of silver-cobalt veins is one of long standing. Knight (1924, pp. 11, 12) mentions it briefly in describing the Cobalt area.

According to the hypothesis, silver-cobalt veins are more abundant in areas of Cobalt Group sedimentary rocks above or near trough-like depressions in the Cobalt Group–Keewatin contact than in areas above uniformly dipping parts of this contact. Refinements of the hypothesis are to the effect that the positions and attitudes of the veins are determined to a considerable extent by abrupt changes of dip in the contact, particularly steepenings of dip, around the edges of the trough-like depressions.

The applicability of the hypothesis to the Langis mine appears to have been considered in the early days, about 1912 to 1920, when the mine, under the name Casey mine, was worked by the Mining Corporation of Canada. This company used the hypothesis as a guide in exploration during their extensive work in the immediate vicinity of Cobalt. Roger Gareau (former mine manger), C. E. Grozelle (mine geologist), and L. S. Lafoy (former underground superintendent), regarded the hypothesis as helpful in carrying out prospecting and exploration at the Langis mine; the author is grateful to them for pointing out many features in this connection.

Lowes (1963, p. 53) carefully investigated the applicability of the hypothesis; he drew a contour plan of the Cobalt Group–Keewatin contact and, on this, marked the veins. From this he concluded: "The general influence of the basement conformation on the orientation and location of veins is apparent. With regards to general distribution, veins have formed over a greater width in the embayment (trough-like depression in the contact) than along the flank (somewhat uniformly dipping part of the contact); furthermore, veins and groups of veinlets lie over local steepenings and irregularities in the surface" (Lowes 1963, p. 54).

The present author has used part of Lowes' work in drawing Figures 4 and 5 to show the features referred to by Lowes. On Figure 4, in the area from 200 feet to 700 feet southwest of Langis No. 3 shaft, the structural contours delineating the Cobalt Group–Keewatin contact curve to the northwest; this is the embayment referred to by Lowes. By reference to Figure 5, it may be seen that veins are notably abundant in the embayment; it should be further noted that the embayment was the most productive part of the Langis mine.

If the hypothesis is generally valid, similar trough-like depressions or embayments might reasonably be expected to contain similar concentrations of veins. In Figure 4, part of an embayment is shown north of Langis No. 4 shaft, and part of a well marked irregularity is shown in the contact west of the Dolphin-Miller shaft. These features, pointed out to the author by the members of the Langis mine staff, have not so far been investigated.

That the positions and attitudes, as well as the abundance of veins, are determined to some extent by irregularities in the Cobalt Group–Keewatin contact, is thought to be exemplified by the embayment southwest of Langis No. 3 shaft. In Figures 4 and 5, the tendency of some of the veins to follow the structure contours may be discerned. The contour interval used on Figure 4 is too great to show the local steepenings of the dip over a vertical range of 10 to 30 feet; it is these steepenings that are thought to be significant in determining the positions and attitudes of the veins.

It should be kept in mind that the presence of the depressions in the contact is only one of the many factors affecting the presence, positions, and attitudes of the veins. From Figures 4 and 5, it is clear that veins are not restricted to embayments. The Langis mine staff is of the opinion that consideration should be given to a combination of two factors: irregularities in the Cobalt Group–Keewatin contact; and, the presence and position of gently dipping faults, such as the Casey Fault. Localities where the Casey Fault was found to lie close to the contact immediately above a steepening in dip of the contact in an embayment were regarded as particularly favourable by the mine staff.

The foregoing is an empirical treatment of the hypothesis.

Lowes (1963, pp. 59–63) treated it more fundamentally. The presence, positions, and attitudes of the vein structures are, he stated, due to structural adjustments arising from subsidence in Cobalt Group sedimentary rocks and in the basins containing them. The subsidence is thought to have occurred shortly after deposition of the sediments. The configuration of the Cobalt Group–Keewatin contact, particularly the embayments, is thought to have had a great influence on the nature of the structural adjustments.

Significance of Thickness of Cobalt Group Sedimentary Rocks between Nipissing Sill and Archean Basement

The question of the economic significance of the thickness of the Cobalt Group sedimentary rocks between the bottom contact of the Nipissing Diabase sill and the Cobalt Group–Keewatin contact is sometimes considered by prospectors and developers in choosing an area for prospecting and in choosing the depth at which exploration is to be carried on.

The Cobalt Group sedimentary rocks in the vicinity of their bottom contact (up to about 200 feet above it) have been host to productive veins where the thickness of the sedimentary rocks between the Nipissing sill and the Keewatin has been up to perhaps 700 feet. The question arises whether there is a limit to the thickness of the Cobalt Group rocks such that, if exceeded, productive veins will not be found in the vicinity of their bottom contact but may be found at some distance above it.

In many places a difficulty is introduced in that the contact of the Nipissing Diabase sill over Cobalt Group sedimentary rocks has been eroded and its former position can only be estimated by extrapolation from parts now remaining. In the vicinity of Langis No. 3 shaft, where the bottom contact of the Nipissing Diabase sill has been removed by erosion, projection of the contact from where it is preserved permits an estimate of 700 feet for the thickness of the Cobalt Group sedimentary rocks prior to erosion. In the vicinity of Langis No. 3 shaft, with this estimated thickness of 700 feet of sedimentary rocks, the productive zone in a vertical sense is clearly near the bottom contact of the Cobalt Group; west of Langis No. 3 shaft, the productive zone maintains this relationship, but estimation of the thickness (prior to erosion) of the sedimentary rocks becomes uncertain.

In parts of Lots 5 and 6, Concessions V and VI, Harris township, prior to erosion of the Nipissing sill the thickness of the Cobalt Group sedimentary rocks below the bottom contact of the Nipissing Diabase sill was almost certainly greater than 1,000 feet. In general in these parts, the contact of the Cobalt Group over the Keewatin is so far below surface that prospecting in the vicinity of the contact has been considered prohibitively expensive. In these parts no silver-cobalt occurrences have been found at surface. At present it appears that the vicinity of the Cobalt Group–Keewatin contact is still the favourable horizon for prospecting despite these great thicknesses (1,000 feet and greater prior to erosion) of Cobalt Group sedimentary rocks.

Significance of Nature of Basement Rocks

Many prospectors and developers in the Timiskaming silver-cobalt area consider that the nature of the Archean basement rocks below the Proterozoic is a significant factor in determining the presence of productive silver-cobalt veins either in the Archean rocks or in the directly overlying Proterozoic rocks.

The Archean basement rocks are of three general types: (1) Keewatin lavas with interflow sedimentary beds; (2) nearly vertically dipping sedimentary rocks of either Keewatin or Timiskaming age; (3) Algoman plutonic intrusions.

That areas in which Cobalt Group sedimentary rocks are underlain by basement rocks of type 1 are "favourable" to the occurrence of silver-cobalt veins is demonstrated in the Cobalt area and the vicinity of the Langis mine; areas in which the basement rocks are of types 2 and 3 are regarded by some as "unfavourable". Apparently the disfavour with which areas with basement rocks of types 2 and 3 are regarded is based not on any theoretical principle but on the fact that, to date, no silver-cobalt mine is situated in such areas.

On the other hand, occurrences of silver-cobalt veins in Algoman plutonic intrusions are known in the Cobalt area. At the Beaver mine, silver ore was mined from veins in a large (about 150 feet long and 65 feet wide) inclusion of granite in Nipissing Diabase (Knight 1924, p. 150). About 3 miles south of the Beaver mine, silver-bearing veins were found to occur in the main body of the granite pluton (Thomson 1961, pp. 59, 60).

In Lots 5, 6, and 7, Concession II in Casey township, the basement rock is an Algoman plutonic intrusion, and this is overlain for the most part by Cobalt Group sedimentary rocks. To date, no productive silver-cobalt veins have been found, but the presence of the intrusion seems to have discouraged the intensive prospecting efforts necessary to determine the presence or absence of such veins.

Spatial Relationship between Veins and Features of the Archean Rocks

In parts of the Cobalt area a spatial relationship between silver-cobalt veins and certain features of the Archean rocks has been described (Thomson 1957b, pp. 384, 385). Such features include interflow sedimentary bands in the Keewatin rocks, dikes, and quartz veins. Veins in the Archean rocks follow the features; veins in the Cobalt Group sedimentary rocks occur directly above the features.

The relationship is thought to be structural. The position of the vein structures in and along which silver-cobalt deposition took place was determined by the position of older pre-Huronian faults, fractures, and zones of weakness along the Archean features.

In the Cobalt area the relationship applies only to some of the veins; in the Casey-Harris map-area it is much less evident.

Instances of veins in the Cobalt Group sedimentary rocks following interflow bands in the Keewatin include No. 26W vein situated southwest of Langis No. 3 shaft, and No. 43 vein situated southwest of Langis No. 6 shaft.

On the Benner-Harris Group (*see* Figure 6), no significant veins were found in the Cobalt Group sedimentary rocks overlying a band of Keewatin iron formation, although cobalt-bearing veins occur in the vicinity.

An instance of close association between a productive vein and a lamprophyre dike is found in No. 6 vein situated near Langis No. 3 shaft. This vein was productive in the Cobalt Group sedimentary rocks above the dike and also below the contact of these rocks.

An example of a pre-Huronian quartz vein followed by a younger silver-cobalt vein is exposed on the 285-foot level of Langis No. 3 shaft, about 450 feet west of the shaft. The quartz vein, 6–8 inches wide, is in Keewatin lava; it ends abruptly against the Gowganda conglomerate. A quite minor calcite vein continues into conglomerate above the quartz vein. Leaf silver, smaltite, chalcopyrite, and sphalerite are contained in the quartz vein.

Variation in Veins in Relation to Vertical Distance from the Cobalt Group–Keewatin Contact

The short vertical distance, less than 150 feet, over which veins have been mined at the Langis mine is notable. Variation in a vertical sense in the veins may be considered under two categories: vein structure; abundance and nature of metallic minerals contained in the vein. The Cobalt Group–Keewatin contact is an appropriate surface of reference from which to measure variation in a vertical sense.

Almost all production to date has been obtained from veins in Cobalt Group sedimentary rocks and from that part of them adjacent to, and up to 150 feet from, the Cobalt Group–Keewatin contact.

In regard to the downward continuation of veins from Cobalt Group sedimentary rocks into Keewatin rocks, for most veins the vein structure diminishes in strength below the contact and the metallic minerals, particularly native silver, diminish in abundance. An exception to this is found in a few veins, notably No. 6 vein of Langis No. 3 shaft, where the vein structure and the content of metallic mineral have continued downward into Keewatin rocks so that mining could be continued to a depth of perhaps 50 feet below the contact.

For the productive part of the Langis property, the Nipissing Diabase sill is present only in the vicinity of No. 6 shaft. One or two veins in the vicinity of No. 6 shaft have been found to extend upward from Cobalt Group sedimentary rocks into the overlying Nipissing Diabase. Exploration of these veins in the diabase, particularly No. 30 vein of No. 6 shaft, has been undertaken only recently and neither the full vertical extent of the vein structure nor the metallic content has been determined. No. 30 vein has been shown to be ore-bearing in the Nipissing Diabase for a vertical distance of 70 feet upward from the bottom contact of the sill; it was productive in Cobalt Group sedimentary rocks for a vertical distance of about 80 feet below the Nipissing–Cobalt Group contact.

At Langis No. 3 shaft, the Cobalt Group sedimentary rocks have a thickness of 280 feet; as indicated in Figures 4 and 5, the thickness of these rocks in the vicinity is variable but is in general greater than the 150 feet mentioned previously as the greatest vertical distance over which the veins have been mined. The veins in the vicinity of Langis No. 3 shaft, with the exception of Nos. 23 and 33 veins, have not been mined from the Cobalt Group–Keewatin contact to rock surface. Two factors contribute to the limitation of the upward continuity of the veins as mineable units: the dying-out of the vein structure; and, changes in the nature and abundance of metallic minerals in the vein. The limiting factor for almost all veins is the dying-out of the vein structure.

The dying-out of the vein structures with increasing distance above the Cobalt Group–Keewatin contact is important in prospecting; if a drillhole or underground working above the contact is not sufficiently close to the contact, it may disclose no evidence of a profitable vein that may exist below the hole or working and closer to the contact; evidence may be so scant as to be considered insignificant despite the possibility of a profitable vein in the zone of the contact.

For many veins in the vicinity of Langis No. 3 shaft, no systematic variation is apparent in the abundance of silver-bearing and cobalt-bearing minerals relative to the distance above the Cobalt Group–Keewatin contact. For a few veins, such as No. 1 vein, the ratio of cobalt-bearing minerals to silver-bearing minerals increases with increasing distance above the contact, and in the upper levels silver is present in less than ore grade. This variation is the reverse of that occurring under analogous conditions at Cobalt.

Spotted Chlorite Alteration

Under the heading Metamorphic Geology (p. 43), information on spotted chlorite alteration is given. The question of a spatial relationship between this alteration and silver-cobalt deposits in the Timiskaming silver-cobalt area is of interest. It was investigated by J. G. MacGregor (mining geologist) some years ago.

Mr. MacGregor stated (personal communication 1949) that the occurrence of spotted chlorite alteration in Keewatin rocks and Cobalt Group sedimentary rocks was brought to his attention in 1947 by W. C. Martin (mining geologist). Mr. MacGregor decided to investigate the possibility of using this clue as a guide in prospecting for silver-cobalt deposits in the Cobalt area. An initial study showed the distribution of this type of alteration to have a close spatial relationship with the area as a whole but not with the individual vein. Spotted chlorite alteration does not occur as wallrock alteration to the veins.

A considerable amount of prospecting in areas selected on the basis of the presence of this type of alteration has not yet resulted in the discovery of a mine; nevertheless, the present author believes that the presence of such alteration has favourable economic significance.

In the Casey-Harris map-area, spotted chlorite alteration occurs in the vicinity of Langis No. 3 shaft (*see* photo, p. 21), and in Lots 7 and 8, Concession V, Harris township.

The finding of well-developed alteration in Gowganda conglomerate outcrops in the southeast corner of the SW.¼ of N.½, Lot 8, Concession V, Harris township, was the most important factor that led R. I. Benner (geological consultant) to undertake prospecting work in the vicinity. In this work, cobalt-bearing veins were discovered.

Prospecting

In prospecting for silver-cobalt veins in the Casey-Harris map-area, one must keep in mind the geological conditions, reported here, that have governed the occurrence of veins that have already been discovered. It is hoped that parts of the map-area with these conditions, but which have not been prospected to date, will yield similar veins. As shown on accompanying Map No. 2066, on the east-west vertical geological section along the boundary between Casey and Harris townships, bodies of Cobalt Group sedimentary rocks underlie the Nipissing Diabase sill (or did prior to its erosion). Profitable veins occur in these rocks at the Langis mine; it seems reasonable to expect that veins will be discovered in other places that have similar geological conditions.

The surface appears to have been investigated so carefully that further repeated use of prospecting methods of 50 years ago does not offer much promise.

The short vertical distance over which the valuable metallic minerals occur in the veins, the almost vertical dip, and the scattered and restricted areal extent of the ore shoots all combine to make prospecting unusually difficult. But it is rarely feasible to explore an area so carefully as to rule out the possibility of future discoveries.

Where the favourable geological conditions occur under a considerable thickness of nonfavourable material, prospecting is generally too costly to be undertaken. The great thickness of Pleistocene (surficial) material over many parts of the map-area, as indicated by the water wells shown on Map No. 2066, virtually eliminates those areas from exploration by old-time surface prospecting methods. Similarly, those parts of the map-area with Paleozoic rocks in considerable thickness do not offer much promise. In parts of Lots 6 and 7, Concession VI, Harris township, the depth of the Cobalt Group–Keewatin contact is so far below surface that prospecting could be carried out only with great difficulty.

The diamond-drill is the customary prospecting tool. The ease with which an occurrence of cobalt-nickel-iron arsenides or sulpharsenides can be missed in drilling should be kept in mind; a minor occurrence can be a very significant guide in development work.

The use of geophysical prospecting would appear to be restricted to those parts of the map-area where the ore-bearing parts of the veins are less than about 150 feet below surface. In diamond-drilling sited on the basis of a ratio-resistivity survey made on the Benner-Harris group (Lot 8, Con. V, Harris twp.), cobalt-bearing veins were discovered. All these are on file at the office of the Ontario Department of Mines Resident Geologist at Cobalt.

A list of assessment work reports (received by the author to December 1962), dealing with parts of Casey and Harris townships, is given in Table VI.

Table VI | *Assessment work reports to end of 1962, on O.D.M. Resident Geologist's file at Cobalt*

Location	Claim No.	Year Filed	Nature of Work	Signature; Property; Remarks.
Casey Township				
NE.¼ of S.½, Lot 7, Con. I	T.31149	1952	Geophysical (seismograph)	Dominion Gulf Co. Ltd. Claim cancelled 5 July 1954.
NE.¼ of S.½, Lot 7, Con. I	T.43848	1958	1 diamond-drillhole	L. S. Lafoy; Milrot claim.
NW.¼ of N.½, Lot 8, Con. I	T.46364	1959	2 diamond-drillholes	H. A. Kenty.
SE.¼ of N.½, Lot 8, Con. I	T.46368	1959	1 diamond-drillhole	H. A. Kenty.
NW.¼ of S.½, Lot 8, Con. I	T.43847	1959	2 diamond-drillholes	Langis Silver and Cobalt Mine Ltd.
Harris Township				
Claims under Lake Timiskaming, southwest of Con. A.	T.32183 to T.32191	1952	Geophysical (ground magnetic)	N. B. Keevil; Wabico Mines Ltd. Claims cancelled 25 Aug. 1953.
NE.¼ of N.½, Lot 5, Con. V	T.43767	1957	1 diamond-drillhole	H. R. Bischoff.
NE.¼ of N.½, Lot 5, Con. V	T.43767	1960	1 diamond-drillhole	Dolphin-Miller property.
SE.¼ of N.½, Lot 8, Con. V	T.43771	1957	1 diamond-drillhole	H. R. Bischoff.
NW.¼ of S.½, Lot 8, Con. V	T.43796	1958	2 diamond-drillholes	H. R. Bischoff.
N.½, Lot 8, Con. V	T.47692 to T.74694, and T.49415	1960	Geophysical (ground magnetic and ratio-resistivity)	D. Burton; Benner-Harris property.
SE.¼ of N.½, Lot 8, Con. V	T.49415	1960–61	8 diamond-drillholes	R. I. Benner; Benner-Harris property.
SW.¼ of S.½, Lot 5, Con. VI	T.43765	1959–60	3 diamond-drillholes	J. E. Jerome; Dolphin-Miller property.
SW.¼ of S.½, Lot 7, Con. VI	———	1952	Geophysical (seismograph)	Dominion Gulf Co. Ltd.
SE.¼ of S.½, Lot 7, Con. VI	———	1952	Geophysical (seismograph)	Dominion Gulf Co. Ltd.
NW.¼ of S.½, Lot 7, Con. VI	T.30924	1952	Geophysical (seismograph)	Dominion Gulf Co. Ltd. Claim cancelled 15 Sept. 1954.
SE.¼ of S.½, Lot 7, Con. VI	T.30925	1952	Geophysical (seismograph)	Dominion Gulf Co. Ltd. Claim cancelled 15 Sept. 1954.

IRON

Aeromagnetic Series Maps 511G and 514G show magnetic anomalies indicative of the presence of iron formation in the Casey-Harris map-area. The most conspicuous anomaly, and the only one investigated by diamond-drilling, is situated in Concession A of Harris township, and the adjoining part of Lake Timiskaming. This anomaly, and a vertical section of Drillhole LT-1 put down to investigate it, are shown in Figure 8; the drill core showed that the anomaly is due to iron formation, which is interbanded with greywacke. A log of the Precambrian rocks intersected by Drillhole LT-1 is given in Table II (p. 10); a description of the iron formation and associated greywacke is given in this report on pages 8–12 under the heading Harris Township, Concession A. The analysis given of what appeared to be the highest-grade section of the hole showed it to have a low iron content.

INDUSTRIAL MINERALS

Sand and Gravel

Deposits of sand and gravel are not plentiful in the Casey-Harris map-area, nor are they conveniently situated to serve the needs of the area. The two largest deposits are those from which most material has been excavated. They are: Casey township, Concession II, Lots 9 and 10, (south of Judge); Harris township, Concession II, Lot 5. Brief descriptions and notes on the origin of these are given on pages 35, 36 in this report under the heading Pleistocene Deposits.

Several of the many other smaller pits are described below.

Casey Township, Concession I, Lot 2

This pit is about 2,200 feet south of the northwest corner of the lot. The material in the pit is heterogeneous and ranges from coarse gravel through sand and reddish brown silt to clay. Boulders to 8 inches in size were present.

Casey Township, Concession I, Lot 5

This pit is about 1,500 feet southwest of the northeast corner of the lot. The material exposed in the pit is almost uniform fine sand with 5 to 10 percent of pebbles, cobbles, and boulders. At the north end of the pit, varved glacial clay overlies the sand.

Casey Township, Concession II, Lot 6

In the northeast corner of the lot a thin (average thickness 2–4 feet) deposit of sand (with clay and silt), containing rounded cobbles up to 1 foot in size, lies at the foot of Casey Mountain. The deposit is underlain by clay. A portable crushing plant was in operation at this pit in 1949 and the resulting product was used for highway construction.

A sand and gravel deposit about 2,000 feet southwest of the northeast corner of Lot 6, Concession II, Casey township, near the top of Casey Mountain, was investigated by systematic test-pitting in 1949. Test-pits to a depth of about 7 feet were put down at 50-foot intervals over an area about 1,000 by 500 feet. The test-pitting disclosed a layer of "pea gravel" up to about ⅛ inch in particle size and 2 feet in thickness underlain by cobbly material (cobbles to about 7 inches in size) in a sandy gravelly matrix. The cobbly material has a thickness of about 5 feet. Below the cobbly material is sand with boulders; test-pitting was stopped when the sand with boulders was encountered. This deposit has not been exploited.

LAKE BARLOW-OJIBWAY DEPOSITS

Deposits at the four localities described below are bars of beaches in glacial Lake Barlow-Ojibway; information on their origin is given on page 36, under the heading Bars and Beaches of Lake Barlow-Ojibway.

Harris Township, Concession I, Lots 4 and 5

In the northern part of these two lots a thin (up to 5 feet thick) but widespread deposit of gravel has been exploited over a considerable area. The gravel mainly rests directly on Lockport(Thornloe) dolomite and is composed to a large extent of dolomite fragments.

Harris Township, Concession II, Lot 4

In the eastern part of this lot a thin (up to 4 feet thick) deposit of gravel and sand has been exploited. Much of the deposit is underlain by clay.

Harris Township, Concession V, Lot 7

A small sand pit was opened about 1,300 feet south and 1,300 feet west of the northeast corner of the lot.

Harris Township, Concession V, Lot 8

A small pit about 2,600 feet south and 200 feet east of the northwest corner of the lot has yielded sand, gravel, and cobbles.

Water

Forty years ago, Hume (1925, pp. 53–57) dealt with the subject of water supply in that part of the map-area underlain by Paleozoic rocks. He mentioned three vital points:

That westerly-dipping Paleozoic limestones and dolomites are water-bearing.
That the post-glacial clays are impervious.
That drilling for water in the Precambrian rocks would probably be a failure unless, by mere chance, the drill penetrated a fissure suitable for the retention of water.

The present author has compiled, for the map-area, a list of the locations, depths, and drill logs for all the wells for which information was available up to December 1962. These data are on file at the office of the Ontario Department of Mines Resident Geologist at Cobalt. Although the information was collected primarily to assist in prospecting for metallic minerals (only the locations and depths of overburden are shown on Map No. 2066), the information may be of assistance in future drilling for water.

In those parts of the map-area not underlain by Paleozoic rocks but covered by considerable thicknesses of postglacial clays, the water-bearing media appear to lie, almost exclusively, immediately above bedrock surface; thus a drillhole for a well must in many places pass through a considerable thickness (up to 300 feet) of postglacial clay.

Limestone

By far the best limestone for industrial use in the Paleozoic outlier of Lake Timiskaming is the limestone member at the top of the Liskeard Formation of Ordovician age. This is the limestone member that has been quarried at the Farr quarry and other quarries in Bucke township on the west side of Lake Timiskaming. In Bucke township the limestone member is exposed at surface and only a part of the total thickness (about 40 feet at the Farr quarry) has escaped erosion. As shown in Figure 7 and described under the heading Paleozoic in this report, the total thickness of the member shown by Drillhole LT-1 is 150 feet. The log of the Paleozoic rocks in the drill core is given in Table V (p. 27). Visual examination of the core for the limestone member indicated that most of the core was pure limestone, but no analyses are available.

Within the Casey-Harris map-area, the limestone member is inaccessible for mining. It may be important to keep in mind that this considerable thickness of limestone may be accessible for mining in other parts of the outlier.

Shale

Hume (1925, pp. 57, 58) discussed certain shales in the Paleozoic outlier of Lake Timiskaming, and their suitability for making bricks; he considered these shales to be stratigraphically below the limestone at the top of the Liskeard Formation (of Ordovician age). Drillhole LT-1 (for vertical section, *see* Figure 7; for log, *see* Table V, p. 27) demonstrated that directly above the limestone is a 98-foot thickness of shale. This shale above the limestone may have the qualities required for brick-making; it has not been tested.

Within the Casey-Harris map-area neither the shale above nor that below the limestone is accessible for mining. It may be important to keep in mind that they may be accessible for mining in other parts of the outlier.

Building Stone

Possibly the Lockport(Thornloe) dolomite that is exposed abundantly in the west part of Harris township is a potential source of building stone. Very small quarries have been opened at three locations: 1,300 feet northeast, 1,300 feet north, and 800 feet northeast, of the southwest corner of Lot 5, Concession I, Harris township.

DESCRIPTION OF PROPERTIES

In this report the properties are described in order of their positions from south to north.

WABICO MINES LIMITED

This property lies under Lake Timiskaming, southwest of Lot 2, Concession A, Harris township.

In 1953 geophysical (magnetometer and also ratio-resistivity) surveys were made from the ice of a group of 13 claims under Lake Timiskaming. The centre of the group is roughly 4,000 feet south and 7,000 feet west of the northeast corner of Lot 2, Concession A, Harris township. The geophysical work was done by Mining Geophysics Corporation Limited. An assessment work report by N. B. Keevil stated that the results suggested that a fault (strike N.30°W.) passes through a point 4,000 feet south and 9,600 feet west of the northeast corner of Lot 2, Concession A.

CLAIM T.52104 AND ADJACENT CLAIMS

These claims lie under Lake Timiskaming, west of Concession A, Harris township.

The presence of a magnetic anomaly at the south end of Harris township was discovered by aeromagnetic work carried out by the Dominion Gulf Company in the period 1947 to 1949. The information was made public in Aeromagnetic Series Maps 511G and 514G (G.S.C. 1957a, 1957b). The conspicuous anomaly, copied from these maps, is shown on Figure 8. As far as the author knows, no drilling was done to test the anomaly until 1963, although magnetic surveys were made in winter on the ice, particularly between Concession A, Harris township, and the west shore of Lake Timiskaming.

At about the end of 1962 a large number of claims under Lake Timiskaming adjacent to Concession A, Harris township, were staked to cover most of the anomaly. A few magnetic profiles were run to test the aeromagnetic work and to determine the most appropriate site for a drillhole to investigate the anomaly.

The drilling was done under the supervision of E. E. Campbell. The author is indebted to Mr. Campbell for permission to examine the core and to publish the results.

In January and February 1963, the Lake Timiskaming No. 1 Drillhole (Drillhole LT-1) was put down from the ice of Lake Timiskaming on claim T.52104. The collar was situated approximately 4,420 feet south and 1,700 feet west of the northeast corner of Lot 2, Concession A, Harris township. The inclination of the hole at the collar was vertical, and at the bottom 85° (tested). Elevation of the collar was 583.8 feet. The depth of the hole is 1,388 feet; drill core was AXT size. The drilling was done by N. Morrissette Diamond Drilling Limited.

For footages 27 to 840, which intersected Paleozoic rocks, a log is given in Table V, (p. 27). For footages 840 to 1,388, which were in Precambrian rocks, a log is given in Table II (p. 10) and a vertical section is given in Figure 8.

The nature and, to some extent, the attitude of the Keewatin iron formation causing the anomaly were disclosed by the core. No significant base metal occurrence was intersected. A substantial addition to previous knowledge of the Paleozoic stratigraphy was gained.

BENNER-HARRIS GROUP

In 1960 the Benner-Harris Group consisted of six claims in Lot 8, Concession V, and one claim in lot 9.

Some of these claims had been staked and prospected in the period 1910 to 1920; pits and trenches, presumably made during that time, suggest that the surface was carefully prospected.

In 1957 three drillholes were put down on what became later the Benner-Harris Group.

The group was acquired by K. J. Benner (prospector and developer) about 1960. Magnetometer and ratio-resistivity surveys were done by Lundberg Explorations Limited under the direction of Douglas Burton. Under the direction of R. I. Benner (geological consultant), diamond-drilling to the extent of 9,500 feet (in 29 holes) was done in an exploration campaign financed by Rayrock Mines Limited. This geological and geophysical work was done in 1960 and 1961; no work was done in 1962.

The author, to whom records of the geological and geophysical work were made available, gratefully acknowledges the helpful discussions about the property with Mr. Burton and Mr. R. I. Benner.

Outcrops are abundant in the southwestern part of the group. A prominent rock hill occupies much of claim T.49414 but most of the other outcrops rise only a few feet above the muskeg-covered clay plain. Linear scarps up to 15 feet in height occur in claim T.49415 and other places. Two such scarps trending southeastward are shown in Figure 6; one is about 60 feet east of Drillhole No. 22, the other is southeast of Drillhole No. 7. These scarps, although they are not large topographic features, may have important structural significance.

The depths of overburden in the drillholes put down in claims T.49415 and T.47694 are shown in Figure 6. The greatest depth of overburden found was 40 feet in Drillhole No. 29 in claim T.49415. This hole is approximately on a northeast-trending line northwest of which, in claims T.49415 and T.49414, are rock hills. The depth of overburden east of this line is presumably considerable, as is indicated by the absence of outcrop.

General Geology

All the outcrops except one on the lakeshore in claim T.49414 consist of Cobalt Group sedimentary rocks.

The thicknesses of the sedimentary rocks intersected by the drillholes are indicated in Figure 6; the greatest thickness, more than 338 feet, is in Drillhole No. 25 in claim T.47694. The thickness increases from south to north.

The bottom contact of the Cobalt Group shows some irregularity; there appears to have been a pre-Huronian hill at the time the Huronian sediments were being deposited in what is now the southwestern part of claim T.49415. The northerly dips of the contact from this southwestern part of claim T.49415 appear to lie in the range of 12°–20°. The northerly dips of the sedimentary beds are much less, in the range of 0°–6°.

The rocks of the Cobalt Group on the property may be assigned to either of two types, conglomerate and bedded greywacke; but these, particularly the conglomerate, show large variations from place to place. Boulders, up to 2 feet in diameter and unsorted, form up to 35 percent of the rock in places in the southwestern part of claim T.47694, but in other places boulders are so uncommon that the rock might more appropriately be named greywacke or arkose. Bedding is obscure in most places.

Bedded greywacke is mostly restricted to two members in the conglomerate. Thus R. I. Benner, in his section of Drillhole No. 10, shows the following succession, in vertical thicknesses, from rock surface down: 57 feet of bedded greywacke; 130 feet of conglomerate; 59 feet of bedded greywacke; and 24 feet of conglomerate that is in contact with Keewatin.

The intersections of Keewatin rocks in the drillholes were not sufficiently extensive to give a clear picture of Keewatin structure. Greenstone (presumably altered lava), iron formation, and tuffaceous rocks occur. The position of the iron formation intersections in Drillholes Nos. 8, 9, and 10 indicates a northeasterly strike for the Keewatin rocks; a steep, nearly vertical, dip is also suggested.

Biotite lamprophyre dikes intrude the Keewatin rocks.

The talc-chlorite schist intersected in some of the holes, notably Drillhole No. 7, is interpreted by the author to be an altered basic intrusive rock.

Diamond-Drilling

Information on the 29 holes (approximately 9,500 feet) drilled in 1960 and 1961 is given in Figure 6. A plan showing drillholes, geophysical anomalies, and outcrops was supplied by R. I. Benner. To this the present author added the elevations of the hole collars as determined by aneroid barometer, as well as the elevations of the bottom contact of the Cobalt Group. From these elevations the thickness of the Cobalt Group sedimentary rocks can be readily computed.

Summaries of three assessment work drill logs (signed by H. R. Bischoff) put down during 1957 in Lot 8, Concession V, Harris township, are given below. No mention of vein occurrence is contained in the core logs. These three holes are not shown on the map or figures in this report.

Drillhole No. 1; 142 feet south and 370 feet east of the northwest corner of NW.¼ of S.½, Lot 8, Concession V, Harris township; direction N.65° W.; inclination −46°; 0–212 conglomerate, 212–232 Keewatin greenstone.

Drillhole No. 2; 100 feet south and 170 feet west of the northeast corner of NW.¼ of S.½, Lot 8, Concession V, Harris township; direction S.60°E.; inclination −45°; 0–280 conglomerate, 280–303 Keewatin greenstone.

Drillhole No. 3; 210 feet north of the southwest corner of SE.¼ of N.½, Lot 8, Concession V, Harris township; direction N.15°E.; inclination −45°; 0–186 conglomerate.

Economic Geology

Silver and cobalt appear to be the only metals of economic interest on the property. The iron formation intersected in a few drillholes is too small and has too low an iron content to be of economic interest. Sand and gravel occurs in what appears to be minor quantity.

The property is in the prospect stage. The 1960-1961 work discovered silver-cobalt-nickel mineralization but not in sufficient grade or size to constitute ore. The discovery is important, notwithstanding the lack of success in developing orebodies, because it demonstrates that the distribution of silver-cobalt is not restricted to the immediate vicinity of the Langis mine.

At surface, little of economic interest is visible. The ordinary surface prospecting that was done in the early days did not result in the discovery of silver-cobalt mineralization. Five small pits in claim T.49415 are shown in Figure 6. On the dump of the pit about 40 feet west of Drillhole No. 7, pink calcite vein-material containing chalcopyrite and pyrite mineralization was seen. The widest vein had a width of ½ inch and the material was scanty. On the dumps of other pits, small pieces of quartz with minor calcite were seen.

On claim T.49414, two pits were noted. One, situated about 650 feet south and 700 feet west of the northeast corner of the claim, has a depth estimated to be between 25 and 50 feet. It is collared in Cobalt Group conglomerate but passes into talc-chlorite schist. The other pit, situated at about 600 feet south and 1,150 feet west of the northeast corner, has a depth greater than 12 feet; it was put down on a northeast-striking fractured zone in conglomerate. Irregular lenses of quartz (in comb structure at the walls) and coarse carbonate (in the centre) may be seen on the side of the excavation.

General considerations that made the property attractive for silver-cobalt prospecting were: its proximity to the Langis mine (about 2 miles away); and, the presence of Cobalt Group sedimentary rocks of small thickness overlying Keewatin rock, a condition similar to that at the Langis mine. R. I. Benner reports that the specific feature that seemed to make the Benner-Harris claims worthy of a detailed and expensive prospecting program, despite the lack of any silver-cobalt occurrence on it, was the presence of spotted chlorite alteration in certain outcrops of Cobalt Group sedimentary rocks. His prospecting program included a geological survey, a magnetometer survey, a ratio-resistivity survey, and diamond-drilling, with the holes sited on the basis of the surveys.

In general the holes were stopped a short distance beyond the bottom contact of the Cobalt Group. But Drillholes Nos. 4 and 8 were extended deeper than that to investigate a magnetic anomaly; drill cores showed the anomaly to be due to the presence of iron formation. Drilling was in general restricted to areas where the Cobalt Group sedimentary rocks were less than 300 feet thick. It was considered that, at depths greater than this, the veins (presumably with strongest development near the bottom contact) would not give rise to noticeable anomalies in the ratio-resistivity work. Furthermore, the drilling expense of prospecting nearly vertical veins whose ore shoots have a restricted vertical range near the bottom contact of the Cobalt Group rises rapidly with increase in thickness of the Group over 300 feet.

Numerous veins and veinlets, mainly of calcite but also some of calcite and quartz, were intersected during drilling. No large vein was found. The widest vein was about 4 inches but, for the most part, veins were narrower than ½ inch. Figure 6 shows all intersections of veins containing cobalt-bearing mineralization found in the drill cores; in addition all veins, either containing or devoid of cobalt-bearing mineralization, that are wider than 1 inch are shown.

All the numerous intersections of cobalt mineralization, except for one intersection in Drillhole No. 4, were in an area about 400 feet square in the west-central part of claim T.49415. The widest intersection of massive cobalt mineralization was 4 inches; most were less than 1 inch. Disseminated cobalt mineralization was present in small amount in the vein walls. The highest silver assay return obtained was 6 ounces per ton. Other metallic minerals present in the veins included chalcopyrite, sphalerite, and galena; none of these was present in significant amount.

All the intersections of cobalt mineralization were in veins contained in Cobalt Group sedimentary rocks near the bottom contact of this formation.

In general, great difficulty was experienced in correlating the veins from hole to hole, and correlation is not attempted on Figure 6. The drilling and the geophysical work indicate two sets of veins, one with strike about N.15°W., the other with a northeasterly strike.

Relationships between the veins (their positions and attitudes) and geological features are not clear. Some veins strike northeasterly, that is, in the same direction as the strike of the Keewatin iron formation but, in general, veins were not found in the Cobalt Group sedimentary rocks immediately above the iron formation.

Spotted chlorite alteration is well developed in the outcrop of Cobalt Group rocks situated at the southwest corner of claim T.49415 and is reported to be widespread and well marked in these rocks where intersected by the drillholes. It was not seen in the Keewatin.

DOLPHIN-MILLER MINES LIMITED

History

Dolphin-Miller Mines Limited in 1958 owned or held option-to-purchase agreements on 10 claims in Harris township, Concessions V and VI, Lots 5 and 6. Of these claims, two have been of greatest interest to date: SW.¼ of N.½, Lot 5, Concession VI; and, SE.¼ of N.½, Lot 5, Concession VI.

One claim, SW.¼ of N.½, Lot 5, Concession VI, was owned prior to 1914 by Harmak Mining Company. In 1914 the company put down a shaft to a depth of 40 feet; this shaft, originally known as the Harmak shaft, was subsequently deepened and became known as Casey No. 5 shaft. It is now known as the Dolphin-Miller shaft.

In 1918, the Casey Cobalt Silver Mining Company, which in turn was under the direction of Mining Corporation of Canada Limited, deepened the shaft to 375 feet and established levels at the 220- and 360-foot horizons. This was the last underground excavation done. Diamond-drilling was done from the underground workings.

Dolphin-Miller Mines Limited carried out prospecting work in 1958. Diamond-drilling was done from surface between the Dolphin-Miller shaft and the north boundary of the property. Later the shaft was dewatered, and underground drilling was carried out from the 220-foot and 360-foot levels. A narrow (½-inch) but rich (1,635 oz. silver per ton) intersection was obtained in Drillhole U-3 from the 220-foot level.

In 1960, drilling from surface was carried out by Dolphin-Miller Mines, which had by that time come under the control of Candore Explorations Limited. In this drilling, intersections yielding low silver assay returns were obtained from what appears to be the same vein as the one that gave the rich intersection in the underground drilling. Since 1960 the property has been dormant. A plan showing the surface geology of the vicinity of the Dolphin-Miller shaft and some of the surface drillholes is given in Figure 5; the underground workings and the structural contours of the Cobalt Group-Keewatin contact are given in Figure 4.

Neither the drill core nor the underground workings were examined by the author. The author is indebted for information to H. G. Miller who organized the company, and to L. S. Lafoy who supervised much of the work done.

Geology

All rock exposed at surface and in the underground workings belongs to the Gowganda Formation. Underground, the contact of the Gowganda over Keewatin rock at about 70 feet west of the shaft, as shown by a drillhole intersection, has an altitude of 185 feet; this elevation is 447 feet lower than the shaft collar and 72 feet lower than the shaft bottom.

Exposure at the shaft collar is poor. L. S. Lafoy reported that the shaft was put down at the intersection of a northwest-striking fault (with vertical dip) and a northeast-striking quartz vein. A nearly horizontal fault, presumably the

Casey Fault, is reported to pass through the shaft at about 250 feet below the collar. The vertical fault and the nearly horizontal fault are reported to intersect but without showing appreciable displacement. No veins of economic significance were exposed in the underground workings; all the lateral workings are crosscuts. The projection to surface of the vein giving the silver intersections is shown in Figure 5. The strike of the vein is northeast.

At about 240 feet in direction S.72°E. from the shaft collar (*see* Figure 5), a pit was put down on a calcite vein (about ¼ inch wide) striking N.40°E. and dipping 80°N.

Assessment Work

In the NE.¼ of N.½, Lot 5, Concession V, Harris township, two assessment work drillholes have been put down; these were Drillhole No. 4 put down in 1957 under the supervision of H. R. Bischoff, and Drillhole DM-15 put down in 1960. The drill logs record the following:

Drillhole No. 4 collar is 870 feet south of the northeast corner of Lot 5; direction S.25°W.; inclination −46°; length 403 feet; all in Gowganda conglomerate. This length corresponds to a vertical thickness of 292 feet of sedimentary rocks. The altitude of the collar, determined by aneroid, is 612 feet.

Drillhole DM-15 hole collar is 400 feet north and 275 feet west of the southeast corner of the NE.¼ of N.½, Lot 5; direction N.33°E.; inclination −45°; length 247 feet; all in Gowganda sedimentary rocks.

In the SW.¼ of S.½, Lot 5, Concession VI, two drillholes, DM-2 and DM-3, were put down in 1959 and 1960. The following notes are from assessment work logs of the holes. The holes were collared at the same place: 1,240 feet north and 150 feet west of the southeast corner of the quarter. The altitude of the collar, determined by aneroid, is 619 feet.

Hole DM-2, direction S.77°W.; inclination −45°, was drilled through Gowganda sedimentary rocks to footage 745. The bottom of the hole, still in sedimentary rocks, has an approximate altitude of 92 feet; a vertical thickness greater than 527 feet of sedimentary rocks is shown.

Hole DM-3, direction N.13°E.; inclination −45°, was drilled through Gowganda sedimentary rocks to footage 233.

CASEY-SENECA SILVER MINES LIMITED
(Murray Claim)

Casey-Seneca Silver Mines Limited at one time owned the NW.¼ of N.½, Lot 6, Concession VI, Harris township. The claim is sometimes referred to as the Murray claim.

Underground work was carried on in 1915 and 1916; in 1916 all surface equipment was destroyed by fire. As far as is known, no further work has been done to the present.

The Lake Barlow clays exposed at surface appear to have a considerable thickness. Below the clays are Gowganda sedimentary rocks. Whether the underground workings passed into Keewatin rocks is not definitely known. Shafts put down on other properties at about that time and in similar geological terrane were ordinarily sunk to the Cobalt Group-Keewatin contact and lateral work was ordinarily put out in the Cobalt Group sedimentary rocks just above the contact; presumably the inference is warranted that the 345-foot level of the Seneca shaft is near the contact.

It is rumored that a vein was intersected in the underground workings but the plan of these workings gives no indication of drifting along a vein.

A shaft, commonly referred to as the Seneca shaft, is reported to be 374 feet deep and with lateral work at the 345-foot horizon (O.D.M. 1916, p. 106). Apparently one level only was established. A plan of the underground workings is shown in Figure 4; this plan was copied from an old plan furnished by Langis Silver and Cobalt Mining Company Limited.

In 1962 the collar of the shaft was found to be in bad condition due to the caving in of the Lake Barlow clays.

TRETHEWEY SILVER COBALT MINE LIMITED

The NE.¼, the SE.¼, the SW.¼, of the S.½ of Lot 6, Concession VI, Harris township, were held at one time by Trethewey Silver Cobalt Mine Limited. In 1914 four drillholes were put down. Except for elevations, the information summarized here was obtained from logs and vertical sections signed by D. L. H. Forbes, consulting engineer; the elevations are aneroid determinations made by the present author. Presumably no encouraging intersections were obtained in the holes.

Drillhole TW-1; 48 feet north and 52 feet west of the southeast corner of SE.¼ of S.½, Lot 6, Concession VI, Harris township; approximate elevation of collar 706 feet above sea-level; direction west; inclination −47° at collar and −70° at bottom; length 919 feet; 0–26 casing; 26–919 conglomerate with slate, quartzite, and greywacke.

Drillhole TW-2; 1,120 feet north and 90 feet west of the southeast corner of NE.¼ of S.½, Lot 6, Concession VI, Harris township; approximate elevation of collar 647 feet above sea-level; direction west; inclination −45° at collar and −54° at footage 180; length 307 feet; 0–40 casing; 40–116 Nipissing Diabase; 116–307 conglomerate with slate, quartzite, and greywacke.

Drillhole TW-3; 340 feet north and 725 feet west of the southeast corner of SW.¼ of S.½, Lot 6, Concession VI, Harris township; approximate elevation of collar 756 feet above sea-level; direction west; inclination −40° at collar and −50° at footage 200; length 439 feet; 0–439 conglomerate with slate and greywacke.

Drillhole TW-4; 1,120 feet north and 900 feet west of the southeast corner of NE.¼ of S.½, Lot 6, Concession VI, Harris township; approximate elevation of collar not known; direction west; inclination −40° at collar and −43° at footage 250; length 416 feet; 0–148 casing; 148–416 conglomerate.

LANGIS SILVER AND COBALT MINING COMPANY LIMITED

The property of Langis Silver and Cobalt Mining Company Limited, as of 1962, is shown on Map No. 2066. What has been the most important part of the property until 1962 is shown on Figure 5.

The author is grateful to Langis Silver and Cobalt Mining Company Limited for granting access to their mine and for making freely available the information

Table VII | *Production statistics, Langis mine*

Year	Silver	Cobalt	Nickel	Copper
	ounces	pounds	pounds	pounds
1908	500			
1909	26,185			
1910	92,544			
1911	114,789			
1912	253,824			
1913	825,107			
1914	499,642			
1915	223,939			
1916	445,900			
1918	143,901			
1919	171,278			
1921	1,101			
1922	1,028			
1940	504			
1946	34,090			
1947	30,790			
1956	88,673	14,027	6,446	1,506
1957	483,769	26,556	5,000	5,577
1958	591,518	48,757	12,160	8,235
1959	1,102,528	77,937	17,912	13,015
1960	895,712	42,809	11,825	14,731
1961	595,449	36,350	10,078	10,498
Grand Totals	6,622,771	246,436	63,421	53,562

Note: The grand totals given include the following:
Production total 1908–1922 by Casey Cobalt Silver Mining Co. Ltd., 2,799,738 oz. silver.
Production totals 1956–1961 by Langis Silver and Cobalt Mining Co. Ltd., 3,757,649 oz. silver, 246,436 lb. cobalt, 63,421 lb. nickel, and 53,562 lb. copper.

on its operations. The author is indebted to: J. E. Jerome, manager; C. E. Grozelle, geologist; L. S. Lafoy, former underground superintendent; and M. Sharp, engineering assistant. Brian E. Lowes made a special geological survey of the Langis property in 1960 and 1961; the author is obligated to him for helpful discussions of certain results that were made available by the company. The basemap for Figures 4 and 5 was furnished by the company. Table VII gives production statistics from 1908 to the end of 1961.

History

The original discovery on the property was reported (Miller 1908, p. 131) to have been made in 1906 by David Bucknell. This discovery of the occurrence of cobalt bloom along the outcrop of No. 1 vein was by chance and not the result of prospecting. In the same year Casey Cobalt Silver Mining Company Limited was incorporated and underground work started.

Neither in the outcrop nor in the early underground workings (those made from 1907 to about 1911) was silver found in profitable amounts. In 1911 operations became profitable; No. 3 shaft was started, and shipments of low-grade ore

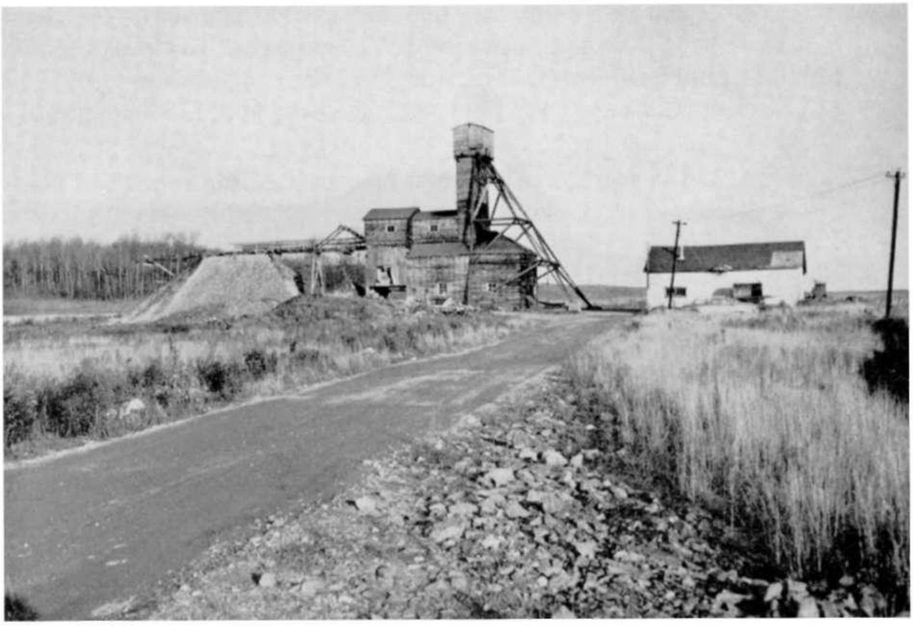


Photo 6 — Langis mine, No. 3 shaft.

were made to the Northern Customs concentrator at Cobalt (O.D.M. 1912, p. 119). It appears that discovery of the silver-bearing veins in the vicinity of what became the site of the Langis No. 6 shaft was made in the year 1912 by surface diamond-drilling because No. 6 shaft was started shortly afterward.

Operations were seriously affected by a fire that destroyed the surface plant in August 1916 (O.D.M. 1918, p. 116). A new mill was constructed in 1917 and 1918 to replace the one destroyed by the fire, and operations were resumed.

At about that time the Casey Cobalt Silver Mining Company was mining, presumably under a leasing arrangement, from claims (now parts of the Langis property) that were then held by other companies. Thus, Knight (1924, p. 18) records that in 1919 production was obtained from the NE.¼ of N.½, Lot 5 Concession VI, Harris township, owned by the Casey-Kismet Mining Company, and from the SW¼ of S.½, Lot 6, Concession I, Casey township, owned by the Harris Consolidated Mines Limited.

Operations ceased in 1919, and from 1920 to 1946 the mine remained dormant.

In 1946 that part of the property containing the workings was owned by Jack Koza, Roger Gareau, Robert McAllister, and Harry Korsan (O.D.M. 1949a, p. 105). No. 1 shaft was partly dewatered and small scale mining operations were carried on. Similar operations were carried on in 1947 (O.D.M. 1949b, p. 107).

In 1947 the Cocase Prospecting Syndicate, at that time owners of the SW.¼ of N.½, Lot 6, Concession I, Casey township, put down 8 drillholes from surface; these are shown in Figure 5. A summary of the logs is as follows:

Drillhole No. 1; 330 feet north and 660 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 643 feet above sea-level; direction S.30°W.; inclination −47°; length 221 feet; 0–90 casing; 90–170 conglomerate; 170–221 lamprophyre.

Drillhole No. 2; 250 feet north and 650 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 641 feet above sea-level; direction N.74°W.; inclination −62°; length 173 feet; 0–82 casing; 82–150 conglomerate; 150–173 feldspathic porphyry.

Drillhole No. 3; 155 feet north and 870 feet west of the southeast corner of SW¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 639 feet above sea-level; direction S.60°W.; inclination −52°; length 105 feet; 0–105 overburden.

Drillhole No. 4; 305 feet north and 650 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 643 feet above sea-level; direction S.55°W.; inclination −60°; length 181 feet; 0–80 casing; 80–151 conglomerate; 151–176 lamprophyre; 176–181 diorite.

Drillhole No. 5; 40 feet north and 610 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 639 feet above sea-level; direction N.60°W.; inclination −45°; length 234 feet; 0–63 casing; 63–191 conglomerate; 191–234 greenstone and feldspathic porphyry.

Drillhole No. 6; 160 feet north and 770 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 640 feet above sea-level; direction S.78°E.; inclination −45°; length 218 feet; 0–119 casing; 119–202 conglomerate; 202–218 Keewatin.

Drillhole No. 7; 20 feet north and 740 feet west of the southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 635 feet above sea-level; direction N.35°E.; inclination −40°; length 187 feet; 0–76 casing; 76–187 conglomerate.

Drillhole No. 8; 10 feet north and 630 feet west of southeast corner of SW.¼ of N.½, Lot 6, Concession I, Casey township; elevation of collar 638 feet above sea-level; direction N.60°W.; inclination −45°; length 149 feet; 0–50 casing; 50–136 conglomerate; 136–149 Keewatin.

New Casey Cobalt Silver Mines Limited was incorporated in 1948 and carried on small-scale underground work in 1948 and 1949 (Williams 1950, p.97; 1951, p. 95).

Langis Silver and Cobalt Mining Company Limited was incorporated in 1953. In that year and in 1954 only minor exploration was done. A small smelter was erected to produce cobalt speiss, but the unsuccessful venture was abandoned in 1955. In 1955 an underground exploration program was undertaken; in 1956 a 75-ton-per-day mill was constructed.

In 1958, Stadacona Mines (1944) Limited took an option on certain of the claims that now belong to Langis. Three drillholes (designated as SS-1, SS-2, and SS-3 on Figure 5) were put down on claim T.11110. The option was allowed to lapse.

Following a change in the Langis directorate in 1959, more emphasis was put on exploration. Since then the capacity of the mill has been increased to slightly more than 100 tons per day and Nos. 3 and 6 shafts have been deepened. Mining and milling at this rate were continuing in 1962.

Depths of Overburden

As shown Figure 5, numerous outcrops lie in a belt extending east of north through the Langis Nos. 1, 3, and 4 shafts. Southeast and northwest of this belt, the overburden is deep; no measurements of its depth have been made on the northwest side in the area covered by Figure 5 but to the south, along Highway No. 65 in Lot 5, Concession VI, Harris township, depths greater than 200 feet have been shown on Figure 5. On the southeast side of the outcrop belt, overburden is 141 feet deep at Drillhole SS-1 (about 400 feet south of Langis No. 6 shaft). The depths of overburden in the vicinity of certain points near the Langis and Dolphin-Miller shafts are shown in Figure 5.

Geology

The general geological relationships at the Langis property are shown by the east-west vertical geological section (*see* Map No. 2066) along the boundary between Casey and Harris townships. Resting on a basement of Keewatin volcanic rocks are Cobalt Group sedimentary rocks that either pinch out or are very thin beneath the thicker parts of the Nipissing Diabase sill. The outcrops and contacts of these at surface in the vicinity of the mine are shown in Figure 5. Structural contours at 50-foot intervals of the Cobalt Group-Keewatin contact and also of the Nipissing-Cobalt Group contact are given in Figure 4 for the vicinity of the mine.

Information on the structural geology at the mine is given under the heading Proterozoic Structure, pages 39–41 in this report.

Economic Geology

Because the Langis mine is the only important mine in the map-area, much of the material in the section on metals under the heading Silver-Cobalt (p. 44–55) in this report relates to the Langis mine.

Production statistics are given in Table VII (p. 66).

Large numbers of veins have been discovered; most of the productive veins discovered up to the end of 1962 are shown on Figure 5. The better veins in the vicinity of No. 3 shaft include Nos. 6, 23, 30, and 31 veins; those in the vicinity of No. 6 shaft include Nos. 22 and 42 veins.

As shown in Figure 5, the productive area of the mine is in two parts; the most productive parts are in the vicinity of No. 3 shaft and No. 6 shaft. An unproductive area lies between these. The vein pattern in the two productive parts is different. Most of the veins near No. 3 shaft may be assigned to either of two sets, one with northeasterly strikes, the other with northwesterly strikes. Many of the veins near No. 6 shaft may be assigned to either of two other sets, one with strikes north of west, the other with northerly strikes. Ore from No. 6 shaft is trucked to the mill.

Underground Workings

The two working shafts are Nos. 3 and 6. A diagrammatic section of the underground workings at the mine is shown inset on Figure 4. A composite plan of some of the lateral workings is also given in the figure; the particular workings selected were chosen especially to show the areal extent of the lateral workings.

QUINCY CREEK MINES LIMITED

The property of Quincy Creek Mines Limited, incorporated in 1950, as reported by Williamson (1950), included at the time the mining rights on all of Lot 6, Concession II, and the S.½ of S.½, Lot 6, Concession III. An option on the N.½ of N.½, Lot 6, Concession I, was also held. In the description that follows only those parts listed above are considered; at different times other adjacent claims were also held, as shown by the property boundary on Map No. 2066.

The author is indebted to the late W. R. M. Williamson, who made available his reports and maps of the property, and personally guided the author to places of interest. Through Mr. Williamson were made available to the author the results of diamond-drilling under the direction of J. G. Willars, done in 1959 by Murray Mining Corporation.

History

It appears that claims were staked in the N.½, Lot 6, Concession II, in 1907 soon after the silver discovery at what became the Casey Cobalt mine.

Parts of the property were worked by early companies. The Chief Inspector of Mines (O.D.M. 1916, p. 106) reported that on claims owned by The Casey Mountain Cobalt Mining and Development Company Limited in 1915, Casey Mountain No. 1 shaft (NE.¼ of N.½, Lot 6, Concession II) was 135 feet deep, and Casey Mountain No. 2 shaft (SW.¼ of S.½, Lot 6, Concession III) was 160 feet deep. The mine was in operation from 1915 to 1919 (O.D.M. 1917, p. 112; 1918, p. 117; 1919, p. 134; 1920, p. 92). Operations included shaft-sinking, winzing, crosscutting, drifting, and underground diamond-drilling. It appears that a reorganization of the original company had taken place because the above references give the name of the company as The Casey Mountain Mining Company Limited.

Information particularly relating to the depths below collar of the lateral work, and other parts of information, contained in the above Ontario Department of Mines reports, is at variance with information furnished by Williamson (1950). It seems in order to state that the late Mr. Williamson did not personally measure any underground working, except Casey Mountain No. 1 shaft down to the 135-foot level; his information on the other workings was derived from old company reports whose precision does not appear to be assured. However, Mr. Williamson's information (*see* Figures 2 and 3) is used in this report as being the most reliable that is available.

Following a period of dormancy, underground work at Casey Mountain No. 2 shaft in 1926 was reported by the Chief Inspector of Mines (O.D.M. 1928, p. 153). This work was done by the Casey Mountain Operating Syndicate Limited, which had been incorporated in 1920.

A geological survey of the claims was made in 1947 by W. R. M. Williamson.

No further underground work has been done since 1926 except that, in 1949, Casey Mountain No. 1 shaft was dewatered to the 135-foot level for sampling.

In 1959 Murray Mining Corporation Limited took an option on the property, which at that time included the NW.¼ of N.½, Lot 6, Concession I. On this quarter a minor amount of geophysical (ratio resistivity) work was done, and two diamond-drillholes were put down from surface in the vicinity of Casey Mountain No. 2 shaft.

From 1960 to 1962 the property has been dormant.

Geology

Nearly all the rock outcrop on the property is Nipissing Diabase. At Casey Mountain No. 1 shaft the thickness of the diabase is about 320 feet (*see* Figure 2), at No. 2 shaft about 100 feet (*see* Figure 3), and at the Murray Mining Corporation Drillhole No. 2 it is 177 feet.

Beneath the Nipissing Diabase, Cobalt Group sedimentary rocks are present over most of the property; in the southern part, as shown by Murray Mining Corporation Drillhole No. 2, they are absent. The thickness of the sedimentary rocks at Casey Mountain No. 1 shaft is about 150 feet (*see* Figure 2), at Casey Mountain No. 2 shaft about 180 feet (*see* Figure 3). The basement rocks below the Cobalt Group sedimentary rocks appear to be Algoman hornblende syenite almost exclusively. On Figure 2, Keewatin rocks are shown as reported in one underground drillhole and in the winze of the Casey Mountain No. 1 shaft workings. To the present author the intersection of Algoman hornblende syenite in Murray Mining Corporation Drillholes Nos. 3 and 4 appears to raise some doubt that the Keewatin rocks occur as reported.

Diamond-Drilling

For the underground diamond-drilling done by the Casey Mountain Mining Company Limited at No. 1 shaft in 1919, the only available record known to the author is a geological section by Williamson (1950); this information is incorporated in Figure 2.

Surface Drillholes Nos. 3 and 4, in the vicinity of Casey Mountain No. 1 Shaft, are shown in Figure 2; information on these two holes was supplied by J. G. Willars of the Murray Mining Corporation.

A summary of the logs by J. G. Willars of Drillholes 1 and 2 put down for the Murray Mining Corporation in the NW.¼ of N.½, Lot 6, Concession I, is as follows:

Drillhole No. 1; 890 feet south and 660 feet west of the northeast corner of the quarter; direction S.70°W.; inclination −64°; 0–40 clay, 40–90 gravel, 90–201 hornblende biotite syenite, 201 end of hole.

Drillhole No. 2; 830 feet south of the northeast corner of the quarter; direction west; inclination −46°; 0–110 clay, 110–192 gravel, 192–438 Nipissing Diabase, 438–465 hornblende syenite, 465 end of hole.

Economic Geology

Vein exposures on the property are minor and little information is available on what was disclosed by the underground workings. No production of silver or cobalt was obtained, and information on occurrences of silver and cobalt mineralization is vague and uncertain.

The bedrock surface in the vicinity of Casey Mountain No. 1 shaft is obscured by dump and overburden. It appears that the shaft was started on an east-striking fractured zone, dipping about 85°N.

Williamson (1950, p. 5) examined the zone on the 50-, 90-, and 135-foot levels and reported that some fractures are filled with calcite, subordinate quartz, and minor amounts of iron oxide; no mention was made of the presence of silver or of cobalt-nickel-iron arsenides or sulpharsenides.

The present author conjectures that, after obtaining discouraging results in exploration on the three upper levels, the company decided to continue the shaft as a purely prospecting venture. The Cobalt Group sedimentary rocks that were reached at a depth of about 320 feet below the collar were obviously regarded as a favourable formation for prospecting; they were the host rock for the productive veins at the Casey mine about two miles south. Williamson (1950, p. 5) reported: "So far as it is known, this work was not productive of ore, nor of indicated ore, in any of the workings." Williamson (1950, p. 6) also reported that the diamond-drilling from the 400-foot level showed calcite vein intersections containing low silver assay returns as shown in Figure 2; an intersection obtained in Murray Mining Corporation's Drillhole No. 3 is also shown.

Casey Mountain No. 2 shaft was started on a fracture in diabase striking irregularly at about N.37°E. and dipping 80°–85°N. One small pit is situated at about 35 feet southwest of the shaft and another at about 50 feet northeast.

Williamson (1950, p. 7) reported that 7 veins were encountered on the 270-foot level; of these, No. 7 vein would appear to have been the most attractive in that a winze (*see* Figure 3) was put down on it. Presumably this is the winze referred to by the Chief Inspector of Mines (O.D.M. 1928, p. 153): "... and a winze was begun at a point where some high-grade was found in the vein." Williamson (1950, p. 7) also reported: "So far as it is known, however, there was no ore developed, nor was any sampling done in the workings prior to suspension of operations."

Underground Workings

Information on the underground workings, as supplied by Williamson, is given in Figures 2 and 3. That the workings of Casey Mountain No. 2 Shaft are more extensive than indicated in Figure 3 is suggested by the following quotation from the report of the Chief Inspector of Mines (O.D.M. 1928, p. 153): "The workings of this level include crosscuts 100 feet east and 285 feet west, and drifts 125 feet south and 90 feet southwest, in addition to the drift mentioned." In the same report, the 'drift mentioned' was said to extend to 180 feet from the west crosscut, and all these lateral workings were said to be on the 235-foot level, which is presumably the same as that shown on Figure 3 as the 270-foot level in the present report.

H. K. EXPLORATIONS LIMITED

The property is in Casey township and consist of 7 claims; these claims cover the S.½, Lot 8, Concession II, and all of the N.½, Lot 8, Concession I, except the SW.¼. Prospecting carried out in 1959 consisted of dewatering an old pit, and the drilling of three diamond-drillholes in Lot 8, Concession I.

The old pit is situated at about the centre of the NW.¼ of N.½, Lot 8, Concession I, Casey township. From the size of the dump it was estimated to be about 25 feet deep. Material on the dump contained small calcite veinlets, and disseminated pyrite and chalcopyrite in minor amount.

The drill results, summarized from assessment work drill logs signed by H. A. Kenty, are given below. The drill logs do not mention veins, but report the Cobalt Group conglomerate to be "Fairly well fractured and mineralized with disseminated fine chalcopyrite and iron pyrite."

Drillhole S-1; 260 feet south and 530 feet west of the northeast corner of NW.¼ of N.½, Lot 8, Concession I, Casey township; direction S.45°E.; inclination −45°; length 161 feet; 0–96 Cobalt Group sedimentary rocks; 96–161 "red granite".

Drillhole S-2; 800 feet south and 425 feet west of the northeast corner of NW.¼ of N.½, Lot 8, Concession I, Casey township; direction S.45°E.; inclination −45°; length 159 feet; 0–59 Cobalt Group sedimentary rocks; 59–159 "red granite".

Drillhole S-3; 1,120 feet south and 300 feet west of the northeast corner of SE.¼ of N.½, Lot 8, Concession I, Casey township; direction N.45°W.; inclination −45°; length 275 feet; 0–275 overburden.

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INDEX

2,000–3600mh–1964

Chart A
Figures 2 to 5
Casey and Harris Report

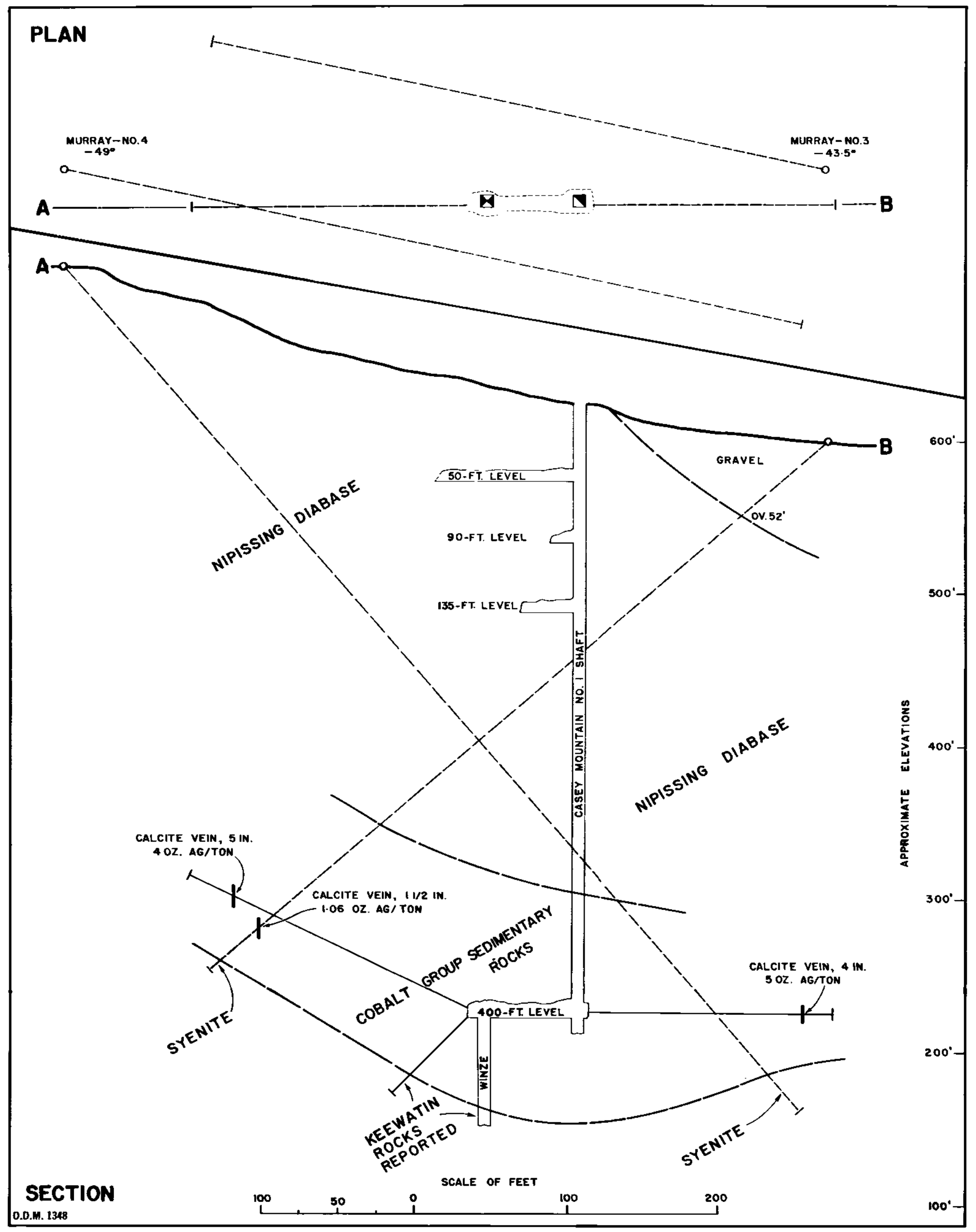


Figure 2 - Casey Mountain No. 1 shaft, lot 6, con. II, Casey Tp. - from Casey Mountain Mining Co. records prior to 1920, and drilling (holes 3 and 4) by Murray Mining Corp., 1959.

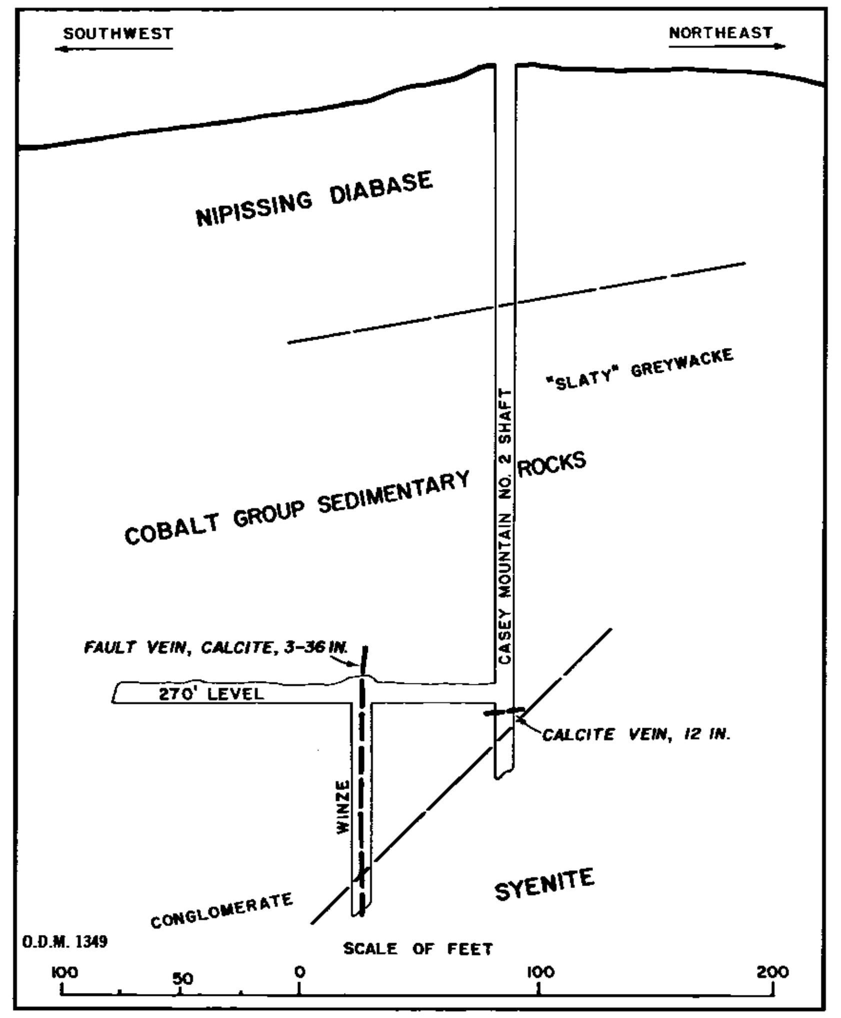


Figure 3 - Vertical section through Casey Mountain No. 2 shaft, lot 6, con III, Casey Tp. - from Casey Mountain Co. records, supplied by W.R.M. Williamson.

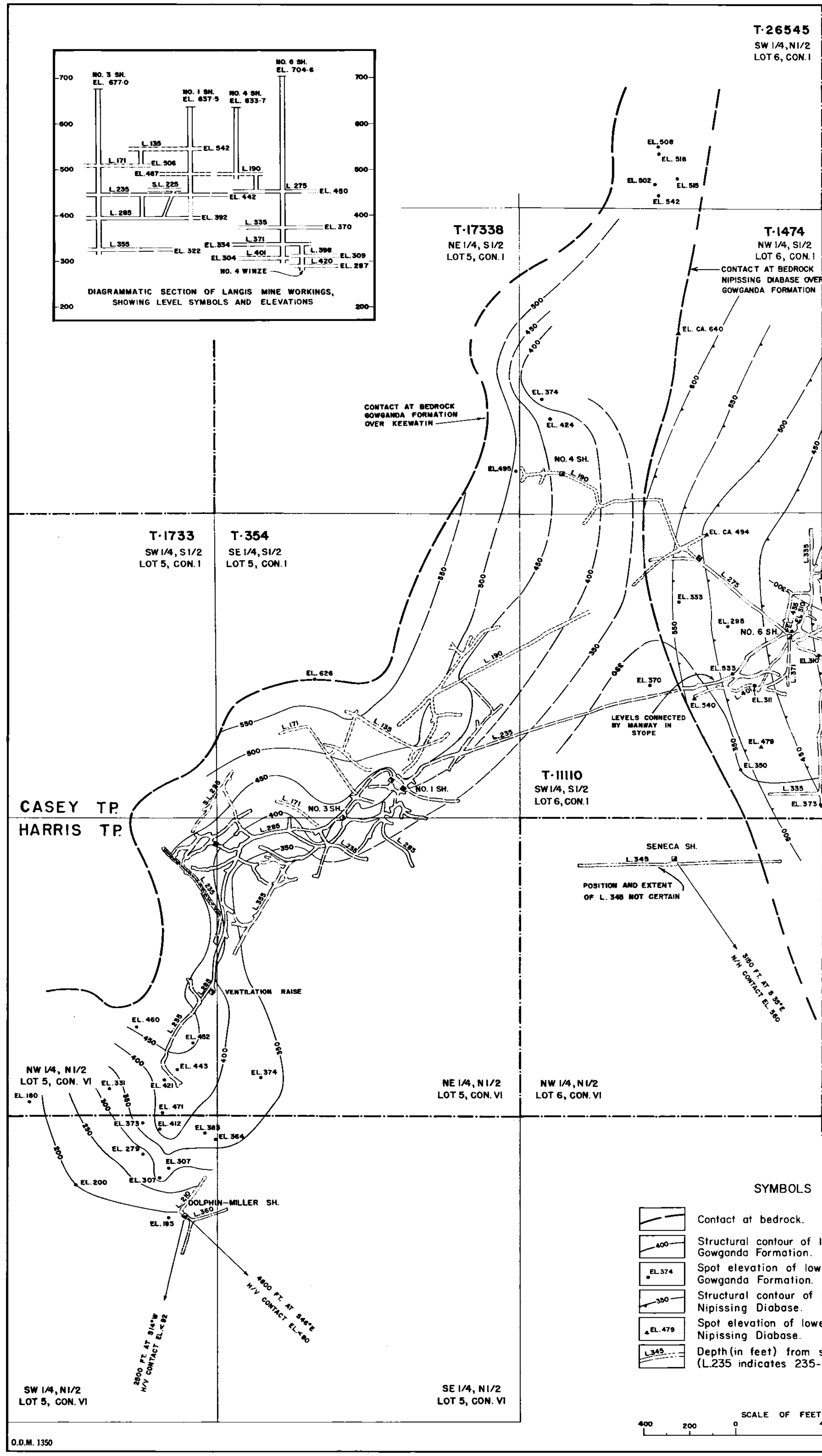


Figure 4 - Plan of Langis mine (part), Dolphin-Miller (part) and Casey-Seneca mine, showing structural contours and selected underground workings.

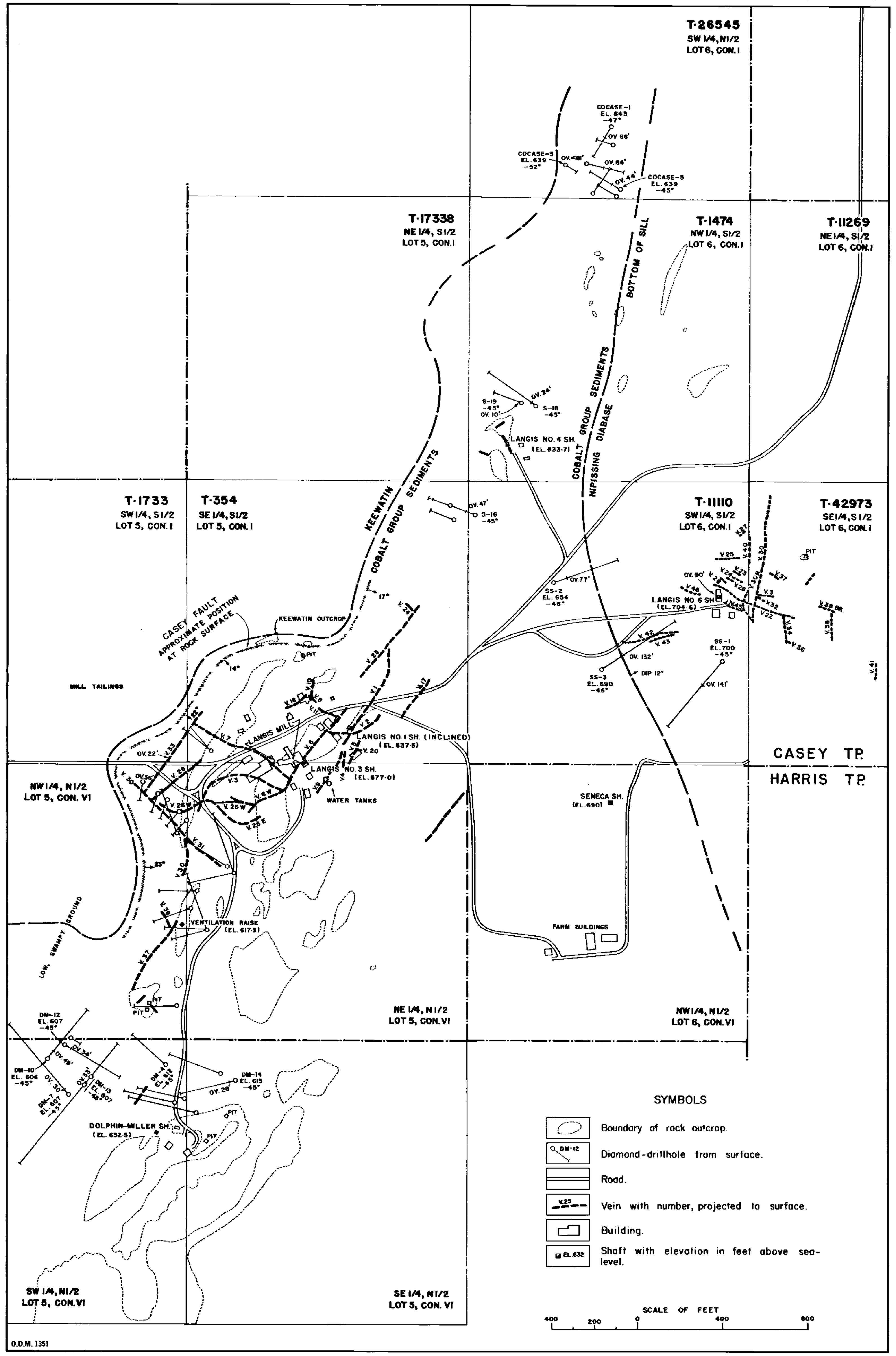


Figure 5 - Plan of Langis mine (part), Dolphin-Miller mine (part), Casey-Seneca mine, showing surface geology, major veins, and selected surface drillholes.

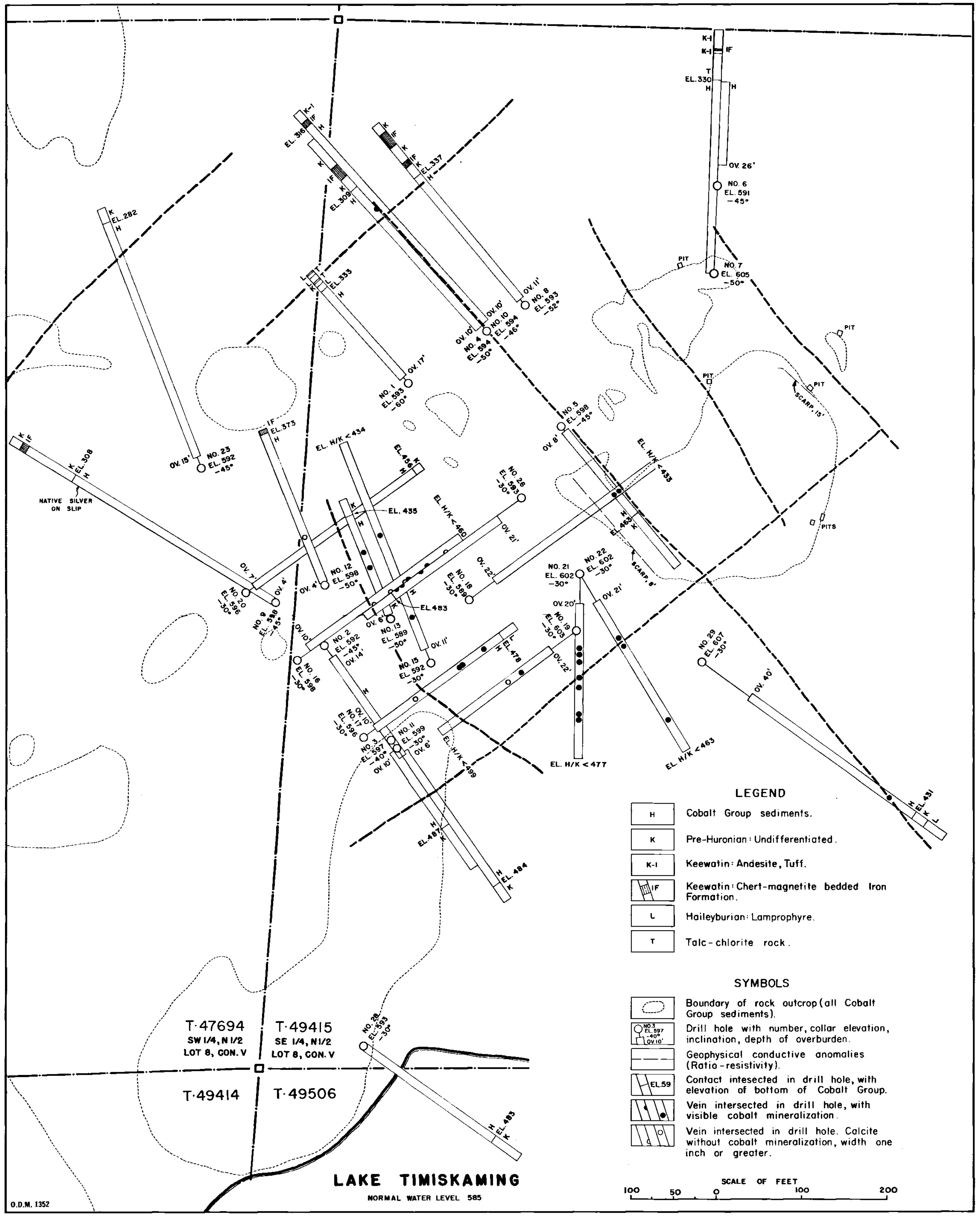


Figure 6 - Plan of Benner-Harris claim group, showing outcrops, diamond drilling and principal geophysical anomalies (ratio-resistivity) - from R.I.Benner.

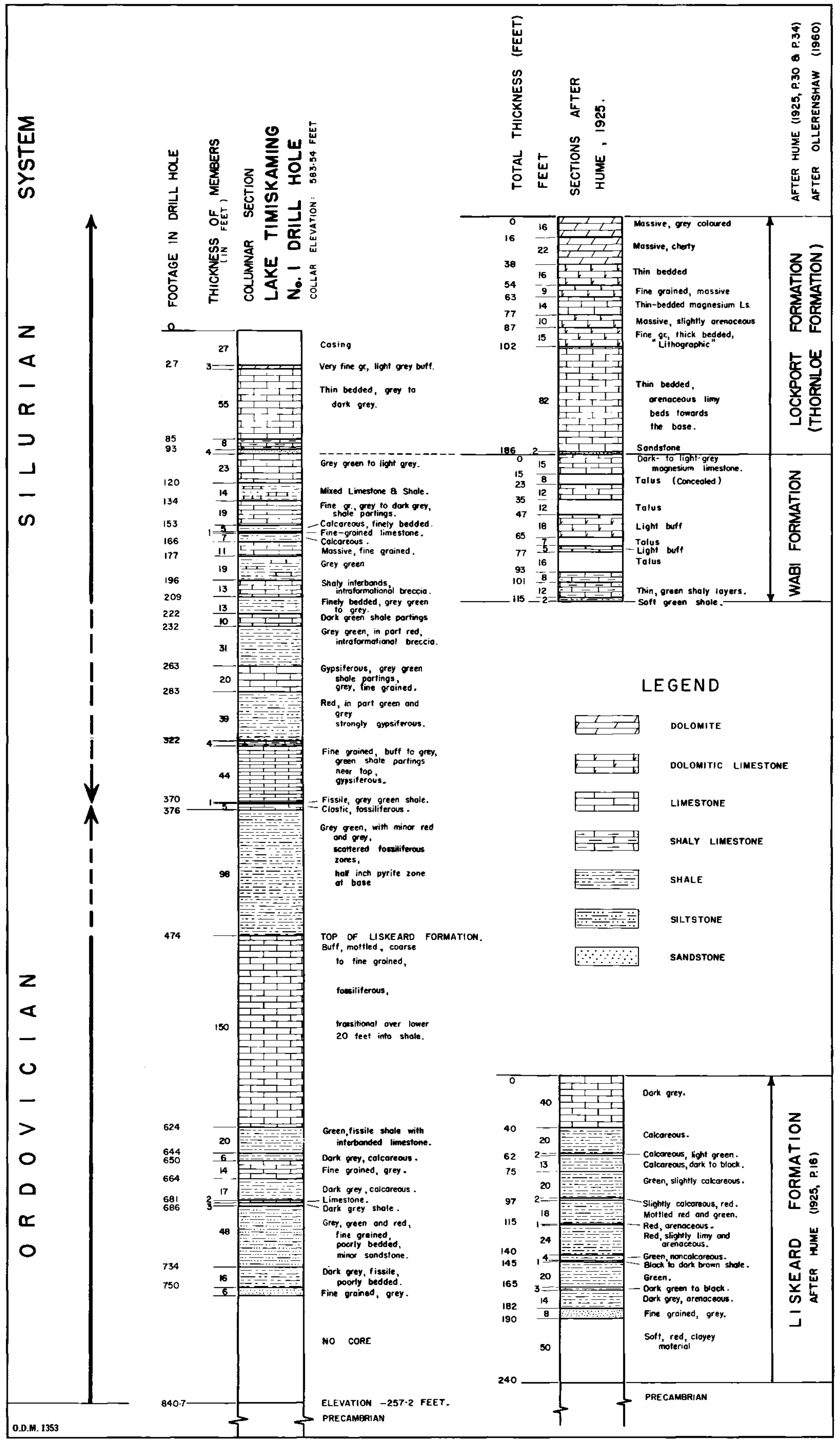


Figure 7 - Columnar section through Lake Timiskaming No. 1 drillhole (L.T. No. 1), showing Paleozoic rocks, correlated with sections given by G.S. Hume, 1925.

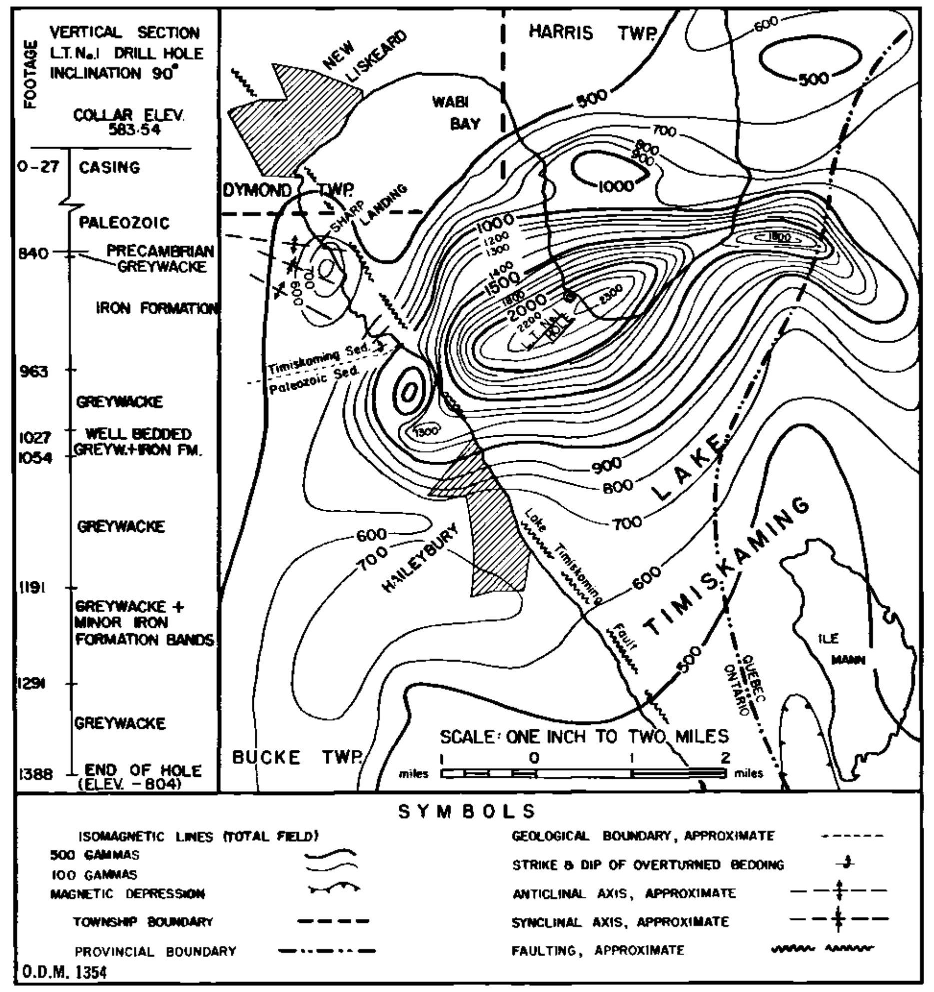
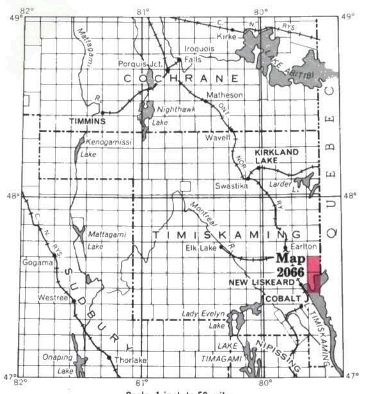
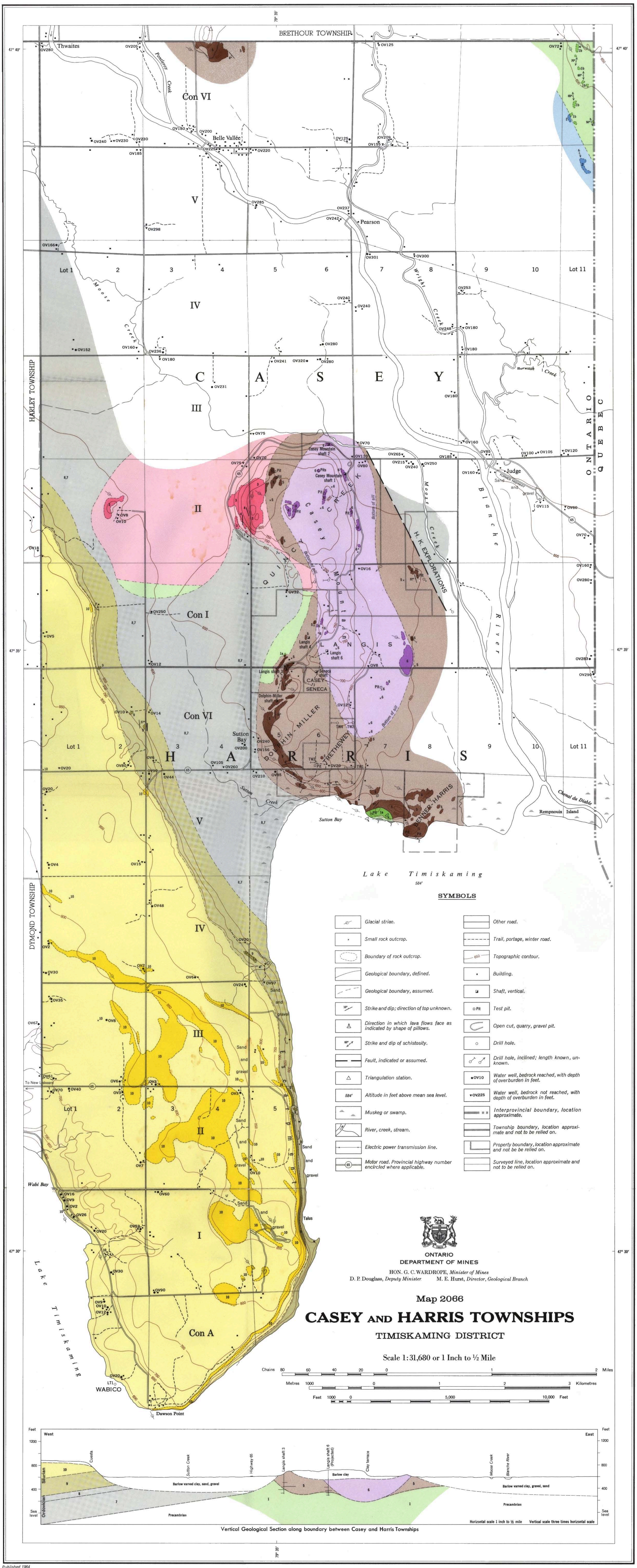


Figure 8 - Plan of south end of Harris Tp, showing magnetic anomaly, and vertical section through Lake Timiskaming No. 1 drill hole over anomaly.

Map 2066
Casey and Harris Townships



Scale, 1 inch to 50 miles
N.T.S. reference 31 M/5, 31 M/12



ONTARIO
DEPARTMENT OF MINES
HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2066

CASEY AND HARRIS TOWNSHIPS

TIMISKAMING DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

LEGEND

CENOZOIC*

RECENT
Swamp and stream deposits.

PLEISTOCENE**
Bedded clay, sand, gravel, boulder clay.

UNCONFORMITY

PALEOZOIC***

SILURIAN
LOCKPORT (THORNLOE) FORMATION
10 Dolomite, magnesian limestone, sandstone.

DISCONFORMITY?
WABI FORMATION
9 Limestone, shale.

DISCONFORMITY?
ORDOVICIAN
UNNAMED FORMATION
8 Shale.

DISCONFORMITY?
LISKEARD FORMATION
7 Limestone, shale, sandstone.

UNCONFORMITY

PRECAMBRIAN***

PROTEROZOIC

KEWEENAWAN
6 Quartz diabase (Nipissing Diabase sill).

INTRUSIVE CONTACT

HURONIAN
COBALT GROUP
GOWGANDA FORMATION
5 Conglomerate, bedded greywacke, arkose.

UNCONFORMITY

ARCHEAN

POST-ALGOMAN
BASIC INTRUSIVE ROCKS
4 Lamprophyre.

INTRUSIVE CONTACT

ALGOMAN
SYENITIC PLUTONIC INTRUSIVE ROCKS
3 Hornblende syenite.

INTRUSIVE CONTACT

PRE-ALGOMAN
BASIC INTRUSIVE ROCKS
2 Metadiorite; amphibolite, talc-chlorite rock; lamprophyre.

INTRUSIVE CONTACT

KEEWATIN
METASEDIMENTS AND METAVOLCANICS
1a Andesitic lavas.
1b Mica schist.
Iron formation (does not outcrop).

Ag	*Silver.*
Co	*Cobalt.*

**Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.*

***Lake Barlow-Ojibway (glacial) bedded clays almost entirely.*

****Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate block.*

SOURCES OF INFORMATION

Geology by Robert Thomson and assistants, 1962. Geology is tied to surveyed lines.

Preliminary maps, P.162, Casey Township and P.163, Harris Township, scale 1 inch to ¼ mile, issued 1962.

Cartography by R. G. Curtis and D. W. Robeson, Ontario Department of Mines, 1964.

Base map derived from Ontario Forests Resources Inventory maps and air photographs, contours from N.T.S., with additional information by Robert Thomson.

Magnetic declination approximately 10°W., 1962.

LIST OF PROPERTIES

Benner-Harris Group.
Casey-Seneca Silver Mines Ltd.
Dolphin-Miller Mines Ltd.
H. K. Explorations Ltd.
Langis Silver and Cobalt Mining Co. Ltd......Ag, Co
Quincy Creek Mines Ltd.
Trethewey Silver Mines Ltd.
Wabico Mines Ltd.

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