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Geology of Hyman and Drury Townships

District of Sudbury

By
K. D. Card

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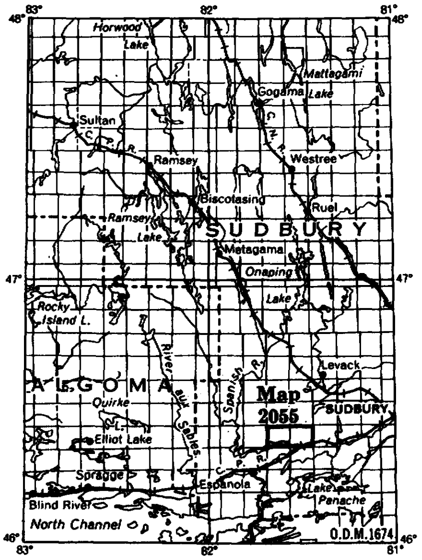
ABSTRACT

This report describes the geology of Hyman and Drury townships, District of Sudbury, an area of about 73 square miles located about 30 miles west of Sudbury. The map-area lies at the southwest end of the Nickel Irruptive, in an east-trending structural belt.

The rock groups consist of an older metavolcanic group, which was intruded by granitic rocks of the Birch Lake batholith some 2,000 million years ago. These groups are overlain unconformably by, or are in fault contact with, metamorphosed quartzitic, conglomeratic, and pelitic rocks of probable Huronian age. These rock groups are intruded successively by gabbroic rocks, by rocks of the Nickel Irruptive, and by late olivine diabase dikes.



Key map showing location of Hyman and Drury townships. Scale, 1 inch to 50 miles.

The gabbroic and older rocks were folded and metamorphosed during an orogeny that occurred some 1,600 million years ago. The structure consists of east-trending folds of various magnitudes. Faults are very abundant and are apparently steep reverse faults.

Deposits of copper, nickel, and uranium have been found in the townships; there has been production of copper and nickel from deposits associated with the Nickel Irruptive and the Worthington Offset.

Geology of Hyman and Drury Townships

By

K. D. Card[1]

INTRODUCTION

General

Hyman and Drury townships, together about 73 square miles, lie about 30 miles west of the city of Sudbury, north of highway No. 17. Old highway No. 17, now a township road, and the Sudbury–Sault Ste. Marie branch of the Canadian Pacific Railway cross the southern part of Drury township. A gravel road provides access to the northern part of this township. A gravel road leads from old highway No. 17 to High Falls, a power development of International Nickel Company of Canada Limited on the Spanish River. Agnew Lake, created by the power dam at High Falls, and a jeep road running north from this lake, provide the only means of access to most of Hyman township.

The map-area lies at the southwest end of the Nickel Irruptive and is underlain by a complex sequence of rocks of several geological ages. Some of these rocks are part of the eastward extension of Collins' Huronian sequence (Collins 1925), but there are problems of correlation. These problems were first brought to light by Thomson in mapping Baldwin township to the southwest (Thomson 1953a). The present mapping, carried out mainly in the field seasons of 1960 and 1961, is a continuation of the detailed mapping project begun by Thomson and carried on by Ginn (1961).

Structural complexity and difficulty of stratigraphic correlation make the use of Precambrian formational names (time-stratigraphic units) impractical, and a simpler rock-classification (rock-stratigraphic units) was employed in mapping. Tentative correlations are made with the stratigraphic sequences established in other areas, but these will be proven or disproven only by further detailed work in the area.

Mapping Methods

The boundaries of the townships were not found, except the Hyman–Porter boundary, which was resurveyed in preparation for the mapping of Porter township. Consequently, the Hyman–Drury township boundary was resurveyed from concession I to concession V by D. M. Armstrong of the Mining Lands Branch, Ontario Department of Mines. Three chained picket lines were cut across Hyman township from the third, fourth, and fifth concession posts.

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Pace-and-compass traverses were made at 9- to 10-chain intervals between these picket lines, or between topographic points such as bodies of water, roads, and power lines. Geological information was plotted on perfatrace overlays on air photographs (scale, 1 inch to ¼ mile). This information was later transferred to basemaps of the same scale.

Acknowledgments

The author is indebted to the following people and companies: J. McBriar, superintendent of the power plants of International Nickel Company of Canada Limited at High Falls; W. Insley, of International Nickel Company of Canada Limited, High Falls; W. Leson of Espanola; and C. Grimsell and T. Tamminen, local prospectors. International Nickel Company permitted the use of their roads in the area and provided a campsite. Falconbridge Nickel Mines Limited provided detailed geological maps of the Nickel Irruptive in northeastern Drury township.

The author was assisted in the field by the following: in 1960: T. P. Armstrong, J. Greenwood, and D. Ward; in 1961: H. Meyn, L. Davies, C. Patterson, and P. Watt. Discussions with J. E. Thomson of the Ontario Department of Mines and J. O. Kalliokoski of Princeton University were helpful.

Topography

The accompanying geological map (No. 2055, back pocket) shows the relative amounts and distribution of rock outcrop and drift, as well as topographic features such as roads and bodies of water.

The area is rugged, and cliffs are abundant. The average relief is about 200 feet; the maximum relief is about 500 feet.

Lithology influences the topography. Resistant rocks such as quartzite, granite, and gabbro stand out on high bare ridges. Areas underlain by pelitic metasedimentary rocks generally stand at lower elevations. Northwest-trending olivine diabase dikes weather rapidly and are expressed topographically by narrow, linear valleys.

Folds and faults are expressed topographically. The bends in John Creek and Spanish River are probably controlled by folds and faults. Agnew Lake lies in a valley that was apparently created by weathering along fault zones and gabbro-metasediments contacts. Faults and folds are commonly discernible on air photographs.

The valleys are filled with Cenozoic deposits of sand, gravel, and clay.

Vegetation is sparse, and there is little soil cover on the Precambrian rocks. Scrub oak, poplar, and maple grow in the high areas; second-growth jackpine, maple, poplar, and birch grow in drift areas; spruce and alder grow profusely in the swamps. The area has been extensively lumbered and burned-over in the past.

Previous Geological Work

The general geology of the region is shown on Geological Survey of Canada maps Nos. 291A (Espanola Sheet) and 292A (Copper Cliff Sheet).

The bibliography at the back of this report includes references to some of the literature dealing with problems of the geology of the region as a whole.

Problems of Stratigraphy

The following discussion of the findings of previous workers will possibly be more easily understood if Table I, Table III, and Table of Formations are consulted. The metasedimentary rocks that underlie this map-area are probably of Huronian age. The Huronian sequence was first described at Bruce Mines—the original "type area." Coleman (1914), working in the Sudbury area, distinguished the "Sudbury Series," a sequence of metavolcanic and metasedimentary rocks. Collins (1925) attempted to trace the Huronian sequence eastward and correlate the rocks of the whole region. Near Sudbury, he had difficulty in making correlation owing to the high degree of deformation and metamorphism. He was unable to locate the "great unconformity," which invariably separated Huronian from pre-Huronian rocks elsewhere along the north shore of Lake Huron. He finally placed the base of the Huronian sequence at the base of what is known, in the Sudbury area, as the Ramsay Lake Conglomerate.

Later workers suggested other interpretations. Collins (1936) and Burrows and Rickaby (1935) assigned a pre-Huronian age to the Sudbury Series. Cooke (1946) postulated that a fault at the base of the Copper Cliff rhyolite separates Huronian from pre-Huronian rocks. He divided the "Sudbury Series" into a pre-Huronian "Stobie Group" and a Huronian "McKim Formation." Later studies (Thomson 1957a) do not confirm the presence of this fault.

In Baldwin township Thomson (1953a) did not find evidence of an unconformity between the metavolcanic and metasedimentary rocks of supposed pre-Huronian and Huronian ages respectively. However, Ginn (1960) demonstrated the probable existence of this unconformity in the general area.

Thomson (1960) has found an unconformity between Huronian quartzite and conglomerate and pre-Huronian quartzite (Wanapitei) at the east end of the Nickel Irruptive near Wanapitei Lake. This would mean that the formations between the Nickel Irruptive and the Grenville Front are of pre-Huronian age, and it should be possible to locate the contact between these and the Huronian formations at the west end of the Irruptive.

GENERAL GEOLOGY

General

The rocks of the map-area are of Precambrian age. They are overlain unconformably by unconsolidated sediments of Pleistocene to Recent age.

The Precambrian rocks are divisible into several lithological groups. The oldest, the metavolcanic group, consists mainly of basic to intermediate metavolcanic rocks with minor amounts of metasedimentary material. This group is intruded by granitic rocks, which form a large batholith to the north. The main group of metasedimentary rocks, consisting of pelitic, quartzitic, and conglomeratic metasediments, lies unconformably on, or in fault contact with, the two older groups. Gabbroic rocks, including the Nickel Irruptive, intrude all the foregoing groups; they are in turn intruded by diabase dikes, the youngest rocks in the area. The generalized sequence is given in Table of Formations.

TABLE OF FORMATIONS

CENOZOIC

PLEISTOCENE AND RECENT

Sand, gravel, clay, silt.

Unconformable Contact
(Faulting)

PRECAMBRIAN

LATE BASIC INTRUSIVE ROCKS

Diabase, olivine diabase, porphyritic olivine diabase.

Intrusive Contact
(Faulting)

NICKEL IRRUPTIVE

Granophyre.
Light transition rocks, dark transition rocks.
Grey norite, dark norite.
Norite breccia.
Gabbro-diorite breccia (Worthington Offset).

Intrusive Contact

GABBROIC ROCKS

Hornblende metagabbro, amphibolite.
Pyroxene gabbro, pyroxenite.

Intrusive Contact
(Faulting; brecciation)

METASEDIMENTARY GROUP

Subgreywacke, conglomerate, argillite, greywacke, and their metamorphic equivalents; quartzite.

Unconformable Contact
(Faulting)

GRANITIC ROCKS

Quartz monzonite, granite, granodiorite, and their gneissic equivalents.

Intrusive Contact

METAVOLCANIC GROUP

Amygdaloidal and porphyritic metavolcanics, amphibolite, garnet amphibolite, amphibolite schist, "hornblende syenite."

TABLE I—PREVIOUS CORRELATION OF FORMATIONS, NORTH SHORE AND SUDBURY AREAS

North Shore (Collins 1925)	Sudbury (Coleman 1914)	Sudbury (Cooke 1946)	Sudbury (Thomson 1960)
Lower Huronian	Lower Huronian	Lower Huronian	Huronian
Bruce Series:		Bruce Series:	
Serpent quartzite Espanola limestone Bruce conglomerate Mississagi quartzite Ramsay Lake conglomerate	Ramsay Lake	Serpent Espanola Bruce Mississagi Ramsay Lake McKim Copper Cliff	Serpent Espanola Bruce Mississagi
Unconformity	*Unconformity*	*Great Fault*	*Unconformity*
Pre-Huronian	Pre-Huronian	Pre-Huronian	Pre-Huronian
Sudbury Series: Wanapitei quartzite McKim greywacke Copper Cliff	Sudbury Series: Wanapitei McKim Copper Cliff	Stobie Series Hill Series Coniston Series	Sedimentary Group: McKim Ramsay Lake Wanapitei
Keewatin Series	Keewatin Series		Volcanic Group: Stobie Formation

Metavolcanic Group

Rocks of the metavolcanic group, which are the oldest in the area, are exposed in southwestern Hyman township and in Drury township south of the Nickel Irruptive. They have been metamorphosed to the greenschist and almandine amphibolite facies of regional metamorphism.

In southwestern Hyman township, mafic volcanic rocks have been metamorphosed, in the almandine amphibolite facies, to amphibolite, feather amphibolite, and garnet amphibolite. They are composed of variable amounts of hornblende, plagioclase (andesine), epidote, garnet, quartz, biotite, and ilmenite-magnetite. They are medium- to coarse-grained (1–10mm.) and commonly display a porphyroblastic texture. Amygdules, composed of feldspar and quartz, are the only primary features preserved in these rocks.

Minor amounts of impure quartzitic metasediments and greenstone-pebble conglomerate are present. The conglomerate is composed of rounded to angular pebbles of quartz and amphibolite similar to the underlying rocks. The foliated matrix is composed predominately of quartz, plagioclase, biotite, and garnet. Garnets also are found in the metavolcanic fragments. The metavolcanic group in Drury township consists of a variety of rock types, which probably represent a complex sequence of flows, intrusions, agglomerates, and sedimentary interbeds.

The most abundant rock types in Drury township are amphibolite and a rock termed "hornblende syenite." The amphibolite is medium- to coarse-grained and massive or gneissic. Amygdaloidal, porphyritic, and porphyroblastic phases are present, although the most common type is rather nondescript, foliated, dark-grey to black amphibolite, which contains fragments, the most noticeable of which are light-coloured "felsite." The "hornblende syenite" is a light-coloured rock composed of saussuritized plagioclase and chloritized hornblende. It is massive, or gneissic, and displays very rapid

"Hornblende syenite" of metavolcanic group. Dark mineral is hornblende.

changes in grain size and mineralogical composition. Pegmatitic patches, with abundant hornblende crystals up to a foot in length, are found beside fine-grained or aphanitic rocks composed almost wholly of saussuritized plagioclase. A chemical analysis (CA-5-61, Table IX) shows that this rock has a high alumina content, approximately that of a gabbroic anorthosite. Near the Nickel Irruptive, it appears to have been "bleached," and it superficially resembles an anorthosite. The "hornblende syenite" passes gradationally into medium-grained amphibolite by increase in amphibole relative to plagioclase. There are also irregular patches of dark porphyroblastic amphibolite within the "syenite."

The mineralogy of all the foregoing rock types is monotonously similar. Amphiboles, plagioclase, epidote, and chlorite are abundant, and variable amounts of potash feldspar, biotite, garnet, quartz, carbonate, white mica, ilmenite, sphene, and magnetite are also present. Two amphiboles are present—light-coloured actinolite; and dark, pleochroic, blue-green hornblende. They replace each other; actinolite is characteristic of the lower metamorphic-grade rocks, hornblende of the higher.

TABLE II—MODAL ANALYSES OF ROCKS OF METAVOLCANIC GROUP

(ac.=accessory minerals)

	Sample							
	No. 1	No. 4	No. 5	No. 6	No. 8	No. 9	No. 11	No. 12
Plagioclase	11	21	27	22	17	51	18	4
Hornblende	54	9	29	—	—	28	42	—
Actinolite	—	—	—	28	24	—	—	—
Biotite	—	42	19	—	—	—	—	10
Garnet	—	13	11	—	—	—	—	—
Epidote	13	—	—	31	48	16	34	22
Chlorite	22	4	—	8	4	ac.	4	40
White mica	—	—	ac	—	1	ac.	1	18
Quartz	—	11	14	6	6	—	—	—
Ores	ac.	ac.	ac.	1	—	—	1	—
Carbonate	—	—	—	4	—	—	—	6
Sphene	—	—	—	—	—	—	—	—
Potash feldspar	—	—	—	—	—	—	—	—
Plagioclase composition	—	$An_{40}\pm_3$	$An_{35}\pm_5$	$An_5\pm_3$	—	—	—	—

Samples:

No. 1—Amphibolite.
Nos. 4, 5—Garnet amphibolite.
Nos. 6, 8—"Hornblende syenite."
No. 11—Porphyritic amphibolite.
No. 12—Schist of intermediate composition.

Note: Modal analyses made by point-count method. Percentages are rounded to the nearest whole number; 1,000–2,000 points were counted per mode.

The original nature of many of these rock types is obscure. The porphyritic varieties probably represent hypabyssal mafic intrusions, whereas amygdules probably indicate an extrusive origin. Bedding and fragments of underlying rocks denote a sedimentary origin for some interbeds. However, the genesis of most of the rocks of this group, especially the "hornblende syenite," is not known.

Granitic Rocks

Granitic rocks occur in the northern third of the map-area. These rocks are part of the Birch Lake batholith (Collins 1936), which extends beyond the map-area to the north and west. This batholith was correlated by Collins with the "Killarnean" granitic rocks to the south. This correlation is based on the supposition that the granitic rocks intrude Huronian rocks in the area. In Hyman and Drury townships, granitic rocks of the Birch Lake batholith intrude rocks of the metavolcanic group but are overlain unconformably by, or are in fault contact with, metasedimentary rocks of probable Huronian age. Rocks of this batholith are at least 2,000 million years old, as has been shown by radiometric age-dating (Fairbairn *et al.* 1960).

The granitic rocks can be divided petrographically into several phases. The most common in this area is a massive, coarse-grained, leucocratic, porphyritic variety composed of plagioclase (albite, oligoclase), potash feldspar, quartz, and minor amounts of biotite, hornblende, chlorite, white mica, and apatite. It is mainly quartz monzonite but ranges from granodiorite to granite in composition (Ginn 1961). Equigranular varieties of similar compositions are also present. In northeastern Drury township, banded granodioritic gneiss and migmatite occur. These rocks contain abundant inclusions of amphibolitic country rock. A brick-red, coarse-grained, leucocratic granite is present in a restricted area in Hyman township.

The relations between the various phases could not be established satisfactorily. The several types appear to be completely intergradational for the most part. It is probable that they were emplaced more or less simultaneously, and that most of the variation is due to original magmatic inhomogeneities and differences in the amount and type of country rocks assimilated.

The contact between the granitic rocks of the Birch Lake batholith and the metavolcanic group is intricate. In northern Drury township near the Nickel Irruptive, there are areas of *lit par lit* injection of granitic rocks into the amphibolite of the metavolcanic group. There are abundant metavolcanic inclusions in the granite. The southern granite-metavolcanics contact occupies a zone up to 600 feet wide. Inclusions and remnants of metavolcanic rocks are especially abundant here, and there are also isolated pods of pink granitic rocks in the metavolcanic rock some hundreds of feet south of the main granitic mass. Granitic dikes extend into the metavolcanic rocks, and pink potash feldspar porphyroblasts are common in the metavolcanic rocks.

The foregoing features indicate that the granitic rocks of the Birch Lake batholith intrude those of the metavolcanic group.

The Birch Lake batholith has in turn been intruded by many mafic dikes, and both the dike rocks and the granites have subsequently been metamorphosed in the greenschist facies of metamorphism. This metamorphism has resulted in the alteration of the primary feldspars and mafic minerals to epidote, albite, white micas, and chlorite. Shearing has produced granulation of minerals and stretching of porphyroblasts to form augens and gneissic fabric. They have also been brecciated and intruded by quartz veins, especially near fault zones and basic dikes.

Metasedimentary Group

Stratigraphy

Examination of the accompanying maps will show that the main stratigraphic units of this group are quite discontinuous because of faulting, folding, and igneous intrusion. Facies changes, both sedimentary and metamorphic, also complicate correlation. Thus correlation of the stratigraphic units within the map-area must be considered tentative.

The stratigraphic units recognized in the area, and their distributions, are shown in the generalized geological and structural map. The units are, from bottom to top:

1. Lower quartzite: quartzite, feldspathic quartzite, and arkose with minor metapelite and conglomerate.

TABLE III—COMPARISON OF STRATIGRAPHIC SEQUENCE: HYMAN AND DRURY TOWNSHIPS; PORTER TOWNSHIP; AND ELLIOT LAKE AREA

Hyman and Drury Townships			Porter Township (Ginn 1961)		Elliot Lake Area (Robertson 1961)			
Lithology	Previous Correlations	Thickness (feet)	Lithology	Thickness (feet)	Lithology	Thickness (feet)	Formation	
			Quartzite, fine-grained, white-weathering......	+800	Quartzite, fine-grained, white-weathering	850	Serpent	
			Subgreywacke..........	1,200	Subgreywacke			
			Limestone, siltstone, argillite, greywacke	1,000	Limestone Greywacke Limestone	600	Espanola	
			Polymictic conglomerate.	400	Polymictic conglomerate.....	100–200	Bruce	
Quartzite	Serpent (Hyman) Mississagi (Drury)	2,000–10,000	Quartzite		Quartzite	550–1,700	Upper	Mississagi
Argillite, greywacke, and metamorphic equivalents.	Mississagi	0–600	Polymictic conglomerate.	200	Argillite, siltstone, greywacke	up to 700	Middle	Mississagi
Polymictic conglomerate	Bruce, Ramsay Lake	up to 600						
Argillite, greywacke, and metamorphic equivalents.	McKim (in south) Mississagi (in north)	1,500 (in south) 0–200 (in north)	Greywacke, argillite, siltstone		Polymictic conglomerate	200	Lower	Mississagi
					Argillite, siltstone, greywacke	up to 350 (in south)	Lower	Mississagi
Quartzite, arkose, oligomictic uraniferous conglomerate	Mississagi	600	Quartzite, arkose, oligomictic uraniferous conglomerate	up to 700	Quartzite, arkose, conglomerate, oligomictic uraniferous conglomerate	up to 700	Lower	Mississagi

2. Argillite: argillite, greywacke, subgreywacke, and their metamorphic equivalents.
3. Conglomerate: polymictic conglomerate, greywacke or metapelite.
4. Upper quartzite: quartzite, feldspathic quartzite, argillite or metapelite.

A comparison of this sequence with the sequences established to the west in Porter township (Ginn 1961) and in the Blind River area (Robertson 1961) is given in Table III.

RELATIONS OF THE GRANITIC ROCKS TO THE METASEDIMENTARY ROCKS

Knowledge of the relation of the granitic rocks of Birch Lake batholith to the metasedimentary rocks is important in making correlations. The contact is mostly a faulted one in this area. However, the unfaulted granite-metasediments contact was seen in outcrop at five localities in Hyman township. Examination of the contact shows that:

1. The granitic rocks, where they are in direct contact with country rocks, show no evidence of chilling. The feldspars below the contact are greenish and sericitized, possibly indicating pre-Huronian weathering.
2. The sedimentary rocks in contact with the granite are not thermally metamorphosed. Sedimentary rocks in direct contact with granitic rocks of the batholith include: quartzite, arkose, conglomerate, argillite, and chloritic schist. None of these rock types has been metamorphosed to any grade higher than low greenschist facies, which is the lowest "regional" grade of metamorphism.
3. The contact is gently undulating, and features indicative of igneous intrusion such as crosscutting dikes, brecciation, and granitization phenomena are entirely absent. Such phenomena are very abundant around the granite-metavolcanics contact only a few miles away.

The author concludes that the rocks lie unconformably on the older granitic rocks of the Birch Lake batholith. This conclusion is further substantiated by the radiometric age of the granitic rocks (2,000 million years), which shows that they are of approximately the same age as the granites that underlie the Huronian rocks in the Blind River area. Crossbedding studies showing that the currents that deposited the sediments came from the north; the distribution of feldspar and detrital minerals in the sedimentary rocks; and the similarity of granitic boulders in conglomerates to rocks of the batholith; all indicate that the Birch Lake batholith was being eroded in Huronian times.

RELATIONS BETWEEN THE SUDBURY SERIES AND THE HURONIAN ROCKS

A major problem is the relation of the pre-Huronian Sudbury Series to the Huronian sequence. Collins assigned the pelitic metasedimentary rocks to the Sudbury Series, and the conglomerate and quartzite to the Huronian. The polymictic conglomerate with the quartzitic matrix was assigned to the Ramsay Lake Formation, and the conglomerate with the argillaceous matrix to the Bruce Formation.

The author finds that there is apparently complete conformity throughout the metasedimentary group in this map-area. Conformable contacts between all the formations have been located in outcrop. Also, in any one area, the quartzitic rocks have been metamorphosed to the same degree as the associated pelitic metasediments. Thus in this map-area, there are no valid criteria for the division of the metasedimentary rocks into a pre-Huronian Sudbury Series and a Huronian Bruce Series. The metasedimentary rocks are tentatively assigned a Huronian age on the basis of: the similarity of the rocks to those of the Blind River area (Table III); the presence of radioactive quartz-pebble conglomerate in the basal rocks; and the approximate age-equivalence as determined radiometrically (Fairbairn *et al.* 1960).

The polymictic conglomerates probably occupy only one stratigraphic position in Hyman and Drury townships. Bodies of conglomerate are isolated by gabbroic intrusions, but the stratigraphic sequences above and below these bodies are generally identical, and the conglomerates are lithologically similar throughout the area.

The stratigraphic relations have been greatly obscured by basic intrusions, faulting, folding, and accompanying deformation. Major unconformities may have been obliterated; it is possible that a major unconformity between the metasedimentary and metavolcanic groups has been so masked.

Description of Formations

LOWER QUARTZITE

The lower quartzite formation consists mainly of quartzite but does contain some conglomeratic and pelitic material. The term quartzite is here extended to take in metamorphosed clastic arenites, which contain more than 60 percent quartz, and includes subgreywacke (60–75 percent quartz), protoquartzite (75–90 percent quartz), feldspathic quartzite (10–25 percent feldspar), and arkose (>25 percent feldspar). Orthoquartzite (> 95 percent quartz) is rare.

The quartzite is hard and light coloured, the colour varying with the composition. Argillaceous varieties are grey; feldspathic types pink or green; and "pure" varieties white. They are quite feldspathic, especially where they overlie granite, and are sericitic where sheared.

The bedding averages 2–4 feet thick but ranges up to 10 feet. Sorting is poor to moderate; crossbedding of normal and planar types, scour channels, and ripple marks are present.

There are interbeds of pelitic metasediments, polymictic conglomerate, and oligomictic quartz-pebble conglomerate. The metapelite[1] is a fine- to medium-grained, dark-green or grey, quartzose rock, which occurs as thin (1-inch to 1-foot) interbeds or partings. These commonly show grain gradation. The polymictic conglomerates are either greenstone-pebble conglomerate, similar to that of the metavolcanic group, or granite-pebble conglomerate. The oligomictic quartz-pebble conglomerate occurs as thin lenses at or near the base of the sequence. It is composed of rounded quartz pebbles in a quartzite matrix and contains uranium and thorium in the form of detrital monazite, uraninite, zircon, and thorianite.

[1]Metapelite is here used as a short term for pelitic metasedimentary rocks.

The rocks of the lower quartzite formation are variable along strike. In Hyman township, where they unconformably overlie metavolcanic rocks, metapelite and greenstone-pebble conglomerate form the basal sedimentary rocks. Where the quartzites overlie granitic rocks as in Hyman township, coarse arkose and granite-pebble conglomerate are common. To the east, in Drury township where they overlie metavolcanics, the lower quartzites are thinly bedded (3 inches to 2 feet), argillaceous interbeds are abundant, and a thick sequence of metapelite forms the basal sedimentary rocks.

The rocks of this unit have been metamorphosed and thoroughly recrystallized. They are composed of quartz, potash feldspar, plagioclase, white mica, biotite, chlorite, and rarely garnet. Accessory minerals are abundant and include monazite, zircon, magnetite, apatite, and sphene. Shearing has produced schistose or crudely foliated fabrics and stretching and granulation of the constituent minerals.

The thickness of the lower quartzite is quite variable, but is about 400 feet in southwestern Hyman township and 600 feet in Drury township.

TABLE IV—MODAL ANALYSES OF QUARTZITES

	Sample					
	No. 1	No. 3	No. 4	No. 6	No. 8	No. 10
Quartz	78	82	65	25	80	76
Potash feldspar	9	3	15	50	16	4
Plagioclase	2	3	2	10	—	—
Muscovite	10	6	19	15	4	5
Biotite	—	3	—	—	—	13
Chlorite	1	3	—	—	—	2
Accessories	—	—	2	—	—	—

Samples:
Nos. 1, 3, 4, 6—Lower quartzite formation.
Nos. 8, 10—Upper quartzite formation.

ARGILLITE

Pelitic metasedimentary rocks, which were previously assigned to the pre-Huronian McKim Formation (Collins 1936), lie conformably above the lower quartzite formation. The transition from quartzite to pelite takes place over a stratigraphic interval of about 20 feet, which is occupied by interbedded, thinly-bedded quartzite and pelite.

This group of rocks consists of argillite, greywacke, and subgreywacke, and their metamorphic equivalents. The argillite is a fine-grained, dark-green to black rock. It is commonly thinly bedded (from less than 1 inch to 3 inches) and may be laminated. The greywacke is a dark-grey to black, medium-grained rock. It is also thinly bedded (1–6 inches) and commonly displays grain gradation. The subgreywacke is a light- to dark-grey, fine- to medium-grained rock. The bedding averages 2–6 inches in thickness and is generally massive. The rock is quartzose and is probably intermediate in composition between greywacke and quartzite. The subgreywacke shows a peculiar weathering phenomenon. It has an upper leached zone, ¼–1 inch thick, followed by a dark zone, ⅛–¼ inch thick, which is apparently enriched in iron oxides from the upper zone.

The pelitic rocks have been metamorphosed and deformed but retain many primary structures even at the highest metamorphic grades. These structures are bedding, ripple marks, small-scale crossbedding, grain gradation, and mud cracks.

The bedding rarely exceeds 6 inches in thickness, and most of the unit is delicately laminated, individual laminae ranging from a millimetre to several centimetres in thickness. This bedding has the appearance of varves, and "varved" sequences show rhythmic repetitions of lithological types. The varved sequences are generally fine-grained (less than 0.5 mm.) and show little or no grain gradation. The coarser-grained metapelites or greywackes do, however, display grain gradation.

Ripple marks, both asymmetric and symmetric, are present but are not numerous. Crossbedding, apparently formed by the down-current migration of ripple marks, is present, as are mud cracks on the bedding planes of some thinly-bedded sequences.

Metamorphism in the greenschist to lower almandine amphibolite facies has produced a variety of metamorphic minerals. In the lower greenschist facies, the pelitic metasedimentary rocks contain chlorite, biotite, and albite; in the upper greenschist facies, garnet, chloritoid, and oligoclase; and in the almandine amphibolite facies, staurolite. The other minerals commonly present are muscovite, ilmenite, and sphene.

Staurolite occurs as large (up to 2 inches) porphyroblasts, many of which are euhedral twins of the cross and saddle types. These porphyroblasts are sieved with quartz and ilmenite inclusions. Chloritoid also occurs as large (up to 1 inch) euhedral porphyroblasts with abundant inclusions. Biotite and chlorite occur as ragged porphyroblasts of variable size, and both commonly contain minute inclusions of a radioactive mineral, possibly zircon or allanite. The almanditic garnet appears as small (1–5 mm.) euhedral porphyroblasts.

TABLE V—MODAL ANALYSES OF METAPELITES

	Sample						
	No. 1	No. 4	No. 5	No. 7	No. 8	No. 10	No. 12
Plagioclase	14	20	24	22	21	5	30
Muscovite	17	20	12	30	14	36	41
Biotite	8	6	10	—	—	14	—
Quartz	30	26	35	28	34	35	24
Garnet	12	0.8	2	—	3	5	—
Staurolite	18	26	16	9	—	—	—
Chlorite	—	—	—	9	11	3	3
Ilmenite	—	—	—	—	—	—	—
Sphene	1	1.2	1	2	1	2	2
Chloritoid	—	—	—	—	16	—	—

Samples:

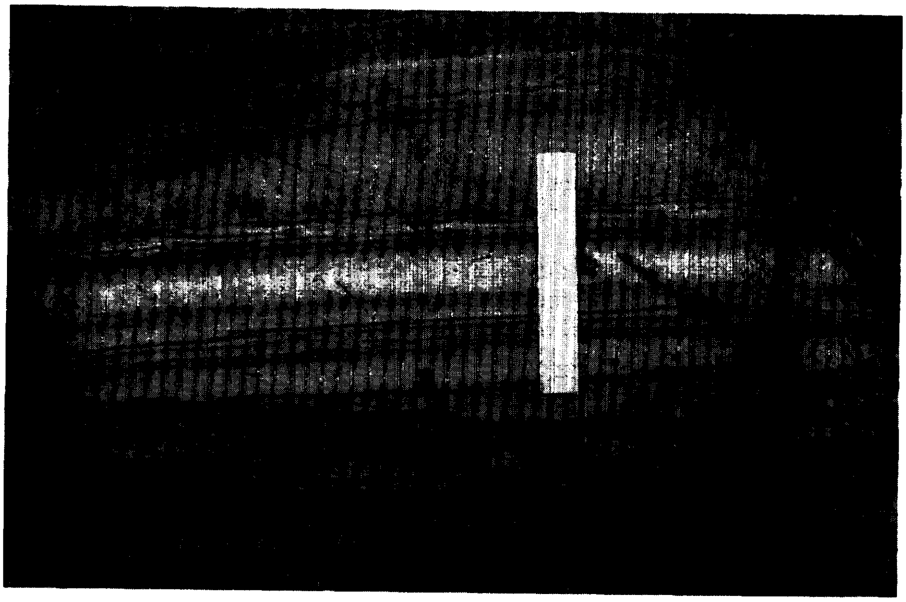
Nos. 1, 4, 5—Garnet-biotite-staurolite-muscovite-plagioclase-quartz metapelites of the almandine amphibolite facies.

No. 7—Staurolite-chlorite-muscovite-plagioclase-quartz metapelite.

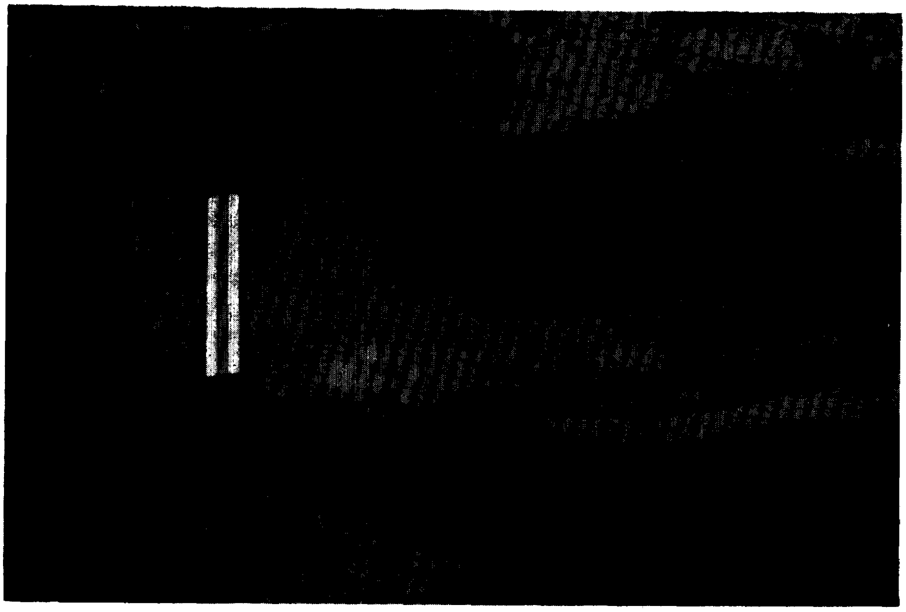
No. 8—Chloritoid-chlorite-muscovite-plagioclase-quartz metapelite of the greenschist facies.

No. 10—Garnet-biotite-muscovite-chlorite-plagioclase-quartz metapelite of the greenschist facies.

No. 12—Chlorite-muscovite-plagioclase-quartz metapelite of the greenschist facies.



Metapelite of greenschist facies. Note graded bedding.



Metapelite of almandine amphibolite facies. Note bedding. Crystals are staurolite.

Chemical analyses (Table IX, samples CA-1-61, CA-2-61, CA-3-61) show that the metapelites are rich in alumina and iron, especially ferrous iron, and are poor in Na_2O and CaO. The high alumina content is reflected in the abundant white micas of these rocks, and the iron in such phases as almandine and staurolite. There has apparently been little chemical change with advancing grade of metamorphism.

The pelitic rocks have been altered to hornfels at gabbro contacts. The commonest hornfels is a light-grey, granular rock composed of chlorite, quartz, plagioclase, garnet, and ilmenite. Hornblende and garnet hornfels also occur. There has been some contact metasomatic action by the gabbro on the pelite. Chemical analyses of a light-coloured garnetiferous hornfels and a staurolite-biotite-garnet metapelite taken a few feet away from each other on strike show these chemical changes (Table IX, samples CA-3-61, CA-4-61). The alteration consists essentially of a relative loss of K_2O and Al_2O_3 and a gain of Na_2O, CaO, and total iron, from pelite to hornfels. There has also been some reduction of the iron.

Secondary structures of several types are widely developed in the pelitic rocks but are pronounced only in southwestern Hyman township. Schistosity is developed to some degree throughout but, except in the aforementioned area, the texture of the metapelitic rocks is more hornfelsic than schistose. Lineations, afforded by the orientation of mineral grains, stretched clastic particles, and intersection of bedding and cleavage, are associated with the schistosity. Slip cleavage and crinkle lineations produced by the microfolding of the earlier planar structures by the slip cleavage are well developed in the metapelites.

CONGLOMERATE

The conglomerate formation is quite discontinuous owing to gabbroic intrusion, faulting, folding, and probable discontinuous deposition. Several rock types are present, the most abundant of which is a polymictic conglomerate with a quartzitic matrix termed Ramsay Lake conglomerate by Collins (1936). This rock is massive, and internal structures, including bedding, are rare. It consists of pebbles and boulders of granite, quartz, greenstone, and trap in a medium- to coarse-grained matrix. The matrix, which is characterized by abundant white quartz grains, is composed of angular quartz and feldspar grains with interstitial mica and quartz. The pebble content is up to 60 percent but is commonly only 10–15 percent of the rock volume. The fragments are as large as 5 feet in diameter but average about 6 inches.

Conglomerate of the Ramsay Lake type passes gradationally into polymictic conglomerate with an argillaceous matrix. The pebbles are generally more abundant in the polymictic conglomerate than in that of the Ramsay Lake type. The poorly sorted matrix is fine- to medium-grained and consists of quartz, feldspar, and micas.

There are minor amounts of quartzite and metapelite in this unit, and the conglomerate passes gradationally upwards into metapelites and then quartzites of the overlying unit. This transition zone is about 50 feet thick in Hyman township and several hundred feet thick in southeastern Drury township. The conglomerate member is several hundred feet thick in this map-area.

Metamorphism has brought about extensive recrystallization and the growth of metamorphic minerals such as biotite, garnet, and staurolite. Foliation is well developed only in the argillaceous conglomerates.

TABLE VI—MODAL ANALYSES OF CONGLOMERATES

	Sample						
	No. 1	No. 2	No. 4	No. 5	No. 6	No. 8	No. 9
Quartz	74	81	87	76	61	73	37
Potash feldspar	18	8	4	8	18	8	3
Plagioclase	2	—	—	—	6	4	2
Muscovite	5	8	2	13	11	7	36
Biotite	—	—	—	—	4	6	18
Chlorite	—	—	—	—	—	2	4
Accessories	1	3	7	3	—	—	—

Samples:
Nos. 1, 2, 4, 5—Oligomictic quartz-pebble conglomerate.
Nos. 6, 8—Conglomerate formation; quartzitic matrix.
No. 9—Conglomerate formation; argillaceous matrix.

UPPER QUARTZITE

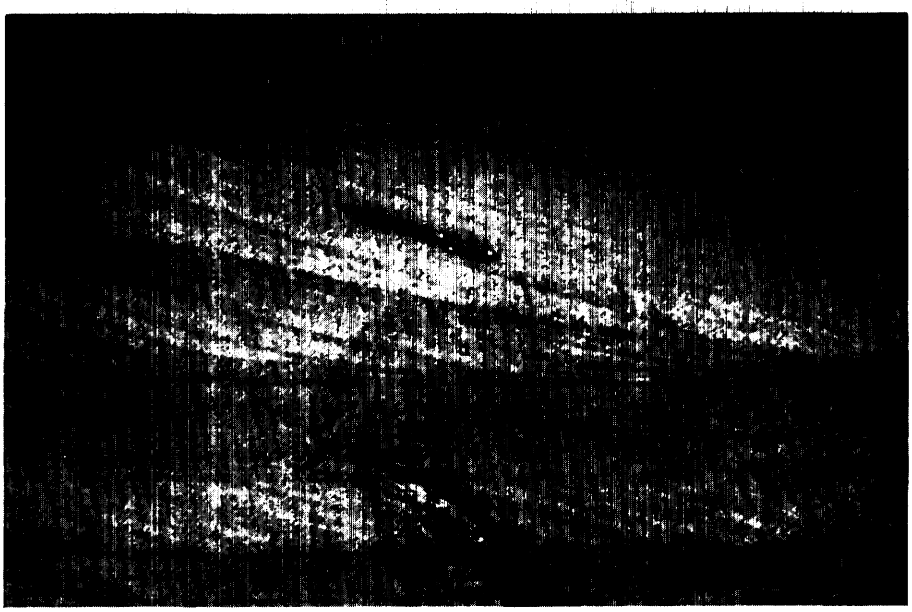
Rocks of the upper quartzite formation are exposed in Hyman township and in southeastern Drury township. The rocks are lithologically similar to those of the lower quartzite formation but are more argillaceous, thinner bedded, finer grained, and have more abundant crossbedding. The quartzites may be characterized as pure, feldspathic, or argillaceous depending on the relative amounts of quartz, feldspar, and micaceous minerals. Pyrite is abundant, and its weathering gives rusty spots.

In Hyman township, rocks of this unit consist of well-bedded, medium-grained, feldspathic quartzite and numerous interbeds of quartzose metapelite. The quartzite beds are from a few inches to 4 feet thick, whereas the metapelite partings or interbeds are from a fraction of an inch to about 1 foot. Crossbedding, of both planar and simple types, is abundant in the quartzite, and some metapelite beds show grain-gradation. Ripple marks and scour channels are also present.

Rocks of the upper quartzite formation conformably overlie conglomerate in southeastern Drury township. The basal rocks are thin-bedded (3 inches to 2 feet) metapelites, which give way upward to interbedded metapelite and quartzite and eventually to pink-and-grey, medium- to thick-bedded (2–10 feet), feldspathic quartzite. Crossbedding is very abundant, especially in the lower 500 feet.

The upper quartzite member is about 3,000 feet thick in Hyman and Drury townships.

The effects of metamorphism are similar to those of the lower quartzites. Argillaceous interbeds contain metamorphic porphyroblasts of biotite and display a fair schistosity. The quartzites also have crude foliation and lineation defined by stretched clastic grains.



Crossbedding in upper quartzite.

Gabbroic Rocks

General

Hornblende metagabbro and amphibolite, with remnants of unaltered pyroxene gabbro and pyroxenite, are present throughout the map-area in the form of sills, dikes, and irregular bodies. The sills, which are up to 500 feet thick, are mostly conformable to the bedding in the country rock but are locally transgressive. Contact metamorphic effects are slight and breccias uncommon. A crude fabric in both the metagabbro and country rocks near the contacts was observed in several localities.

The dikes average about 100 feet in width, whereas the more irregular bodies, which show both conformable and transgressive relations to the bedding in the country rocks, attain much greater dimensions. Contact metamorphic effects are more pronounced, and breccias are more common, around dikes and irregular bodies than around the sills.

Pyroxene Gabbro and Pyroxenite

The pyroxene gabbro and pyroxenite, which occur as remnants in the interior portions of some sills, are brown-weathering, dark-grey, medium-grained rocks composed of pyroxenes (augite, bronzite), plagioclase (labradorite-bytownite), and minor amphibole, biotite, ilmenite, quartz, and potash feldspar.

The ratio of pyroxene to plagioclase ranges from about 50:50 to 90:10 and averages 70:30. In the more feldspathic rocks, the plagioclase and hypersthene are idiomorphic towards augite, which commonly occurs as large (1-inch) crystals poikilitically enclosing the other minerals. In the more pyroxenitic rocks, hypersthene and augite are idiomorphic towards plagioclase.

ALTERATION OF THE GABBROIC ROCKS

The unaltered remnants are traversed by narrow ribs, which stand out on the weathered surface and are mineralogically similar to the surrounding metagabbro. The contacts between metagabbro and unaltered gabbro are sharp. Under the microscope it is common to see partially altered grains that are pyroxene on one side and amphibole on the other. Orthopyroxene appears to be the most susceptible to alteration, followed by clinopyroxene and plagioclase.

The alteration of pyroxene gabbro to metagabbro is essentially replacement of the pyroxenes and plagioclase by amphiboles, albite, and epidote. The first amphibole produced is a light-coloured actinolite. Reactions that probably involve plagioclase lead to the change from actinolite to blue-green hornblende. Actinolite is not found in the higher-grade, regionally metamorphosed, gabbroic rocks of the garnet and staurolite zones; here its place is taken by hornblende. The higher-grade metagabbro also contains garnet, and andesine rather than albite.

The alteration of pyroxene gabbro to metagabbro involves little chemical change (Table IX, samples CA-6-61 and CA-7-61). There has been a significant increase in the water content, reflected in the change from pyroxene to amphibole, and possibly a decrease in SiO_2, which could account for the presence of quartz veins in the metagabbro.

Hornblende Metagabbro and Amphibolite

The hornblende metagabbro is a medium- to coarse-grained, dark-green to black rock with a remnant gabbroic or diabasic texture. It is composed of porphyroblasts of amphibole (hornblende, actinolite), saussuritized plagioclase, clinozoisite, epidote, magnetite, and quartz. The hornblende-to-plagioclase ratio ranges from about 50:50 to 70:30.

The amphibolite is a black, coarse-grained rock composed mainly of amphibole (hornblende, actinolite), with minor saussuritized plagioclase, magnetite, and chlorite. There is every gradation from hornblende metagabbro to amphibolite, and this probably reflects compositional variations in the original rock from pyroxene gabbro to pyroxenite. Schistose metagabbro, composed of hornblende, biotite, chlorite, plagioclase, and quartz, is common as a sheared border phase of the basic bodies. Garnet amphibolite is also found but is not common.

Layering, consisting of thin (½–1 inch), alternating light layers rich in saussuritized plagioclase and dark layers rich in amphibole and chlorite, is present in the metagabbro. In southwestern Drury township, two intersecting sets of layers are present. The layers are roughly parallel to the major directions of the alteration "ribs" in nearby pyroxene gabbro. Thus the layering in the metagabbro is not original magmatic layering but was probably produced by metamorphic differentiation.

TABLE VII—MODAL ANALYSES OF GABBROIC AND METAGABBROIC ROCKS

(ac.=accessory minerals)

	Sample						
	No. 1	No. 2	No. 3	No. 5	No. 6	No. 8	No. 9
Plagioclase	53	30.8	22.5	10.7	15	38	20
Orthopyroxene	10	21.8	33.3	42.8	—	—	—
Clinopyroxene	36	47.0	43.5	46.4	—	—	—
Actinolite	—	—	0.7	ac.	83	—	—
Hornblende	—	—	—	—	—	57	68
Biotite	—	—	ac.	ac.	1	—	5
Chlorite	—	—	—	—	—	2	ac.
Sericite	—	—	ac.	—	—	ac.	—
Micropegmatite	ac.	—	—	—	—	—	—
Quartz	—	—	—	—	ac.	2	—
Opaque minerals	1	0.4	ac.	—	1	ac.	1.5
Epidote	—	—	—	—	ac.	ac.	—
Garnet	—	—	—	—	—	—	4.5
Plagioclase composition	An_{63}	An_{66}	An_{66}	An_{75}	An_{3}	$An_{27} \pm_{3}$	$An_{35} \pm_{5}$

Samples:
- Nos. 1, 2, 3—Pyroxene gabbro.
- No. 5—Feldspathic pyroxenite.
- No. 6—Amphibolite; lower greenschist facies.
- No. 8—Metagabbro; upper greenschist facies.
- No. 9—Metagabbro; almandine amphibolite facies.

SEGREGATIONS IN THE METAGABBRO

Light-coloured segregations are common in the metagabbro. The bodies are found as white or greyish pods, dikelets, and irregular masses. They are composed of coarse-grained feldspar (sodic plagioclase and potash feldspar), quartz, chlorite, rutile, apatite, green chrome micas, and amphibole. Sulphide minerals are commonly associated with these bodies. Most bodies consist of coarse crystals of feldspar in a fine-grained groundmass of quartz, chlorite, and micas. Others have sharp contacts, a central zone of quartz and a wall zone of plagioclase, and contain angular inclusions of metagabbro. The origin of the light bodies is not known, although many are probably metamorphic segregations.

Worthington Offset, Gabbro–Diorite Breccia

The Worthington Offset is a narrow irregular breccia dike, which trends northeast across the southeast corner of Drury township. It is from 125 to 220 feet wide. It dips vertically to steeply southeast, its contacts are irregular, and there is local shearing and brecciation of the adjacent country rock. The dike is discontinuous; there is a gap about 100 feet wide northeast of the village of Worthington.

The dike is composed of fragments of amphibolite and country rock in a fine- to medium-grained, gabbroic to dioritic groundmass. The groundmass is also brecciated, especially in the central parts of the dike. The relative volumes of these phases vary along and across the trend of the dike. Country rock fragments are confined to a narrow zone along the borders, whereas the amphibolite fragments are concentrated in the centre. Amphibolite fragments comprise 10–60 percent of the dike, and the volume of fragments varies greatly from place to place along the dike.

The groundmass is a dark-grey, fine- to medium-grained gabbro or diorite, composed of hornblende, biotite, zoned plagioclase (andesine-labradorite), chlorite, quartz, carbonate, and sulphides. The amphibolite fragments are composed of actinolite, chlorite, and ilmenite. The actinolite has a bladed habit.

The dike contains abundant, disseminated to massive pyrrhotite, pentlandite, and chalcopyrite. These minerals have replaced the groundmass material, and the amphibolite fragments are generally unmineralized.

Nickel Irruptive

Rocks of the Nickel Irruptive occur in northern Drury township. Three major divisions are distinguished: a lower gabbroic or dioritic member, here termed "norite"; a middle member, the "transition zone"; and an upper member, the "granophyre."

Norite

The norite intrudes granitic and metavolcanic rocks in northern Drury township. The norite-metavolcanic contact is exposed east of the Fairbank Lake road. This contact is sharp, but there are projections of norite extending into the country rock, and screens of country rock in the norite. The dip of the contact is steep in this area, probably nearly vertical.

The norite intrudes amphibolite and granitic rocks of the Birch Lake batholith in north-central Drury township. There is large-scale development of breccia here, both in the lower part of the norite and in the adjacent country rocks.

The various phases of the norite distinguished are as follows.

1. Norite Breccia

This is a polymictic breccia composed of fragments of country rock and gabbroic rock in a gabbroic matrix. The country-rock inclusions are mainly amphibolite, granite, rhyolite, and "hornblende syenite." The inclusions are rounded to angular, average 1–6 inches in diameter but range up to 5 feet, and constitute up to 70 percent of the rock by volume. The matrix is medium to dark grey in colour, fine- to medium-grained, and is composed of plagioclase (andesine-labradorite), potash feldspar, uralitized pyroxene, amphibole, biotite, sulphides, and quartz. The plagioclase has been extensively saussuritized. The rock is massive, or locally foliated. Pink aplite dikes are common. The breccia is extensively mineralized with pyrrhotite and chalcopyrite.

2. Grey Norite

Grey norite is in gradational contact with norite breccia in northern Drury township and in intrusive contact with "hornblende syenite" in northeastern Drury township.

The rocks of this unit are extensively altered. The plagioclase, which was originally labradorite or andesine, is saussuritized. The original pyroxenes—augite and hypersthene—have been largely replaced by amphiboles. Chlorite, biotite, and sulphide minerals are also present, and there are highly variable amounts of interstitial quartz and potash feldspar. The ratio of light to dark minerals is variable but averages about 70:30. The amount of quartz and potash feldspar (micropegmatite) is up to about 25 percent by volume. The distribution of micropegmatite is very irregular.

3. Dark Norite

Massive or foliated, dark-grey to black, medium-grained gabbroic rocks are present within the norite east of the Fairbank Lake road. They are composed of hornblende, biotite, and saussuritized plagioclase and contain varying amounts of micropegmatite.

Transition Zone

Rocks of the Nickel Irruptive containing about 20–50 percent micropegmatite, which occur between recognizable norite and recognizable granophyre, were mapped as part of this unit. They range in colour from light grey to black and are pinkish owing to the presence of abundant micropegmatite. They are medium-grained and generally massive but are locally foliated.

The light-coloured transition rocks are found mainly in the lower part of the transition zone adjacent to the norite. They consist of saussuritized plagioclase, amphibole, biotite, and micropegmatite.

The dark-coloured transition rocks occur in the upper part of the transition zone adjacent to the micropegmatite. They are composed of hornblende and biotite with lesser amounts of plagioclase, quartz, and potash feldspar. The contact between the dark transition rocks and the granophyre appears to be quite abrupt. There are many dikelets similar in composition to the granophyre in the transition rocks.

Granophyre

The granophyre is exposed in only a few outcrops in this map-area. A light-pink aplitic phase with abundant epidote is commonly present at the base of the granophyre. The bulk of the granophyre, however, is a reddish, medium- to coarse-grained rock composed of quartz, potash feldspar, oligoclase, amphibole, and chlorite. It is equigranular or porphyritic, with potash feldspar tablets up to an inch long. The rock commonly displays a foliation.

Late Basic Intrusive Rocks

Olivine Diabase

Northwest-trending olivine diabase dikes intrude all other rocks in the map-area. The dikes range in width from 6 inches to 500 feet and average 150 feet; they are quite straight and dip steeply. Some dikes end abruptly in shear zones. Single dikes or dike swarms are regularly spaced at from 2- to 2½-mile intervals across the area. They give pronounced magnetic anomalies, which vary in intensity along the strike of a single dike.

TABLE VIII—MODAL ANALYSES OF OLIVINE DIABASE
(ac. = accessory minerals)

	Sample				
	No. 1	No. 2	No. 3	No. 4	No. 5
Plagioclase	65.2	65.6	67.2	67.3	68.0
Olivine	12.8	12.6	12.1	14.2	12.0
Augite	11.7	10.5	12.3	10.8	7.6
Magnetite-ilmenite	6.4	7.5	5.0	4.6	9.5
Biotite, chlorite	2.3	2.1	1.8	1.4	1.3
Apatite	1.6	1.5	1.6	1.7	1.6
Sericite	ac.	ac.	———	———	ac.
Plagioclase composition	An_{70}	An_{70}	An_{72}	An_{70}	An_{74}

The diabase is dark grey to black and weathers reddish brown. It is medium- to coarse-grained and has a distinct ophitic texture. Porphyritic phases, with large phenocrysts of plagioclase and less commonly of olivine, are present, and many dikes have porphyritic margins.

The diabase is composed of zoned plagioclase (labradorite-bytownite) laths, equant grains of olivine, and large anhedral augite grains. Ilmenite-magnetite grains are abundant, and apatite and rutile are also present. Local alteration of olivine and plagioclase has produced biotite, chlorite, and sericite.

Pink granophyre segregations are present in one dike in southwestern Hyman township, on Agnew Lake. They are composed of pink feldspar and hornblende, and several have rims of pyroxene and plagioclase.

Breccia

Breccias of various kinds and ages are found in all rocks of the map-area except olivine diabase.

Intrusion breccia occurs near metagabbro contacts, and breccias of the Worthington Offset and the Nickel Irruptive may be of this type. Fold or competency breccias have been formed in folded metapelite-quartzite sequences where the metapelite flowed around broken blocks of quartzite. Fault breccias occur in and around fault zones that cut relatively competent rocks such as quartzite, conglomerate, and granite.

Breccias apparently unrelated to any of the foregoing types are very abundant in the area. These are the "Sudbury breccias." They are found in all rocks outside the Nickel Irruptive except olivine diabase. Sudbury-type breccias are found in an area about 80 miles long and 30 miles wide but are most abundant near the Nickel Irruptive.

Individual breccia bodies range from a few inches to more than a mile in width. The breccia consists of rock fragments in a fine-grained matrix. The fragments, which constitute up to 90 percent of the rock and average 60 percent, are mainly of nearby country rocks, but exotic blocks do occur. The fragments range from microscopic to several hundred feet in size and are generally angular with rounded corners. The matrix is composed of comminuted rock fragments or rock flour, and its colour and composition vary with the composition of the host rock. The matrix of breccia occurring in quartzite is grey and quartzose, whereas those breccias cutting argillaceous rocks or metagabbros have dark-green to black, biotitic or chloritic matrices. The breccia matrix was apparently quite mobile since it fills minute cracks in fragments.

Formational boundaries are not significantly offset by breccias. In mapping Drury township, where breccia is very abundant, it was found that if breccia outcrops were mapped on the basis of the most abundant rock-type occurring as fragments, the lithological units could be traced through readily. The fragments are commonly thrown together in a chaotic jumble; however, where the fragment-to-matrix ratio is high, as in the brecciated quartzite in southeastern Drury township, many blocks have not been moved far out of place. It is possible to trace-out folds in such areas by noting the dominant bedding attitudes.

The origin of the breccias is unknown. They appear to have been formed by an event or events of relatively short duration. Possibly, explosive volcanism and associated diatreme activity is the most reasonable mechanism for the production of such breccias.

Pleistocene and Recent

In this area, the Pleistocene was mainly a period of erosion, as is shown by the abundant glacial striae and grooves, which trend S.30°–50°W. Large, scattered erratics, the most noticeable of which are Onaping tuff boulders, are probably glacial deposits. Several small gravel deposits on the lee sides of steep hills, a gravel hill in Drury township, and several esker-like sand ridges at the east end of Agnew Lake are possibly of glaciofluvial origin.

There are several large sand plains in the area. These deposits consist of crossbedded sand and gravel overlain by varved clay, fine sand, and soil. Low ridges, composed of boulder and pebble gravels, medium- to coarse-grained sand, and minor varved clay, are found in northern Drury township. They show features such as pebble imbrication, ripple marks, crossbedding, slump structures, rapid lensing, and high initial dips. These sediments may be glaciolacustrine deposits. They may also have been deposited during the post-glacial stages of Lake Huron. The ridges in Drury township could represent beach deposits of this lake.

Recent sediments consist of silt, sand, and gravel in stream beds, and fine silt and mud in stream floodplains and swamps. These deposits represent reworked Pleistocene sediments.

Metamorphism

There have been several periods of metamorphism in this area. The older volcanic rocks were probably metamorphosed before the sedimentary rocks were laid down. The main period of metamorphism occurred some 1,600–1,700 million years ago as is shown by radiometric age-dating of metamorphic minerals. The gabbroic and sedimentary rocks, as well as all older rocks, were affected. It is not known whether the Nickel Irruptive rocks were also metamorphosed at this time. There has been later retrograde metamorphism, possibly connected with the Grenville orogeny to the south.

The terrane can be divided into various metamorphic zones on the basis of the metamorphic minerals such as biotite and staurolite developed in the rocks. The metamorphic zones recognized here are:

1. Chlorite-biotite zone.
2. Garnet zone.
3. Chloritoid zone.
4. Staurolite zone.

The first three belong to the greenschist facies and the last to the almandine amphibolite facies of regional metamorphism.

The metamorphosed rocks can be divided into three lithological groups:

1. Mafic igneous rocks; metagabbro, amphibolite, mafic volcanic rocks.
2. Quartzo-feldspathic rocks; quartzite, conglomerate, granitic rocks.
3. Pelitic rocks; metamorphosed argillite, greywacke, subgreywacke.

TABLE IX—CHEMICAL ANALYSES OF ROCKS

(Analyses by Laboratory Branch, Ontario Department of Mines)

	Sample						
	CA-1-61	CA-2-61	CA-3-61	CA-4-61	CA-5-61	CA-6-61	CA-7-61
SiO_2	55.07	60.73	57.14	57.75	48.76	50.61	48.60
Al_2O_3	21.50	21.18	25.61	19.19	23.59	7.24	9.16
Fe_2O_3	2.72	3.23	2.33	2.98	4.26	4.39	4.65
FeO	6.04	4.16	4.17	7.86	3.24	7.18	6.48
CaO	0.98	0.79	1.01	2.27	11.78	9.69	9.57
MgO	3.00	2.75	2.39	2.44	3.78	18.47	18.41
Na_2O	1.43	0.90	1.01	2.34	2.81	0.71	0.53
K_2O	3.01	2.30	2.66	0.98	0.49	0.24	0.20
H_2O+	3.53	2.61	2.02	2.48	1.32	0.24	1.29
H_2O-	0.02	—	—	0.02	—	—	—
P_2O_5	0.11	0.09	0.09	0.11	0.06	0.03	0.03
TiO_2	0.98	0.74	0.71	0.82	0.09	0.34	0.32
Cr_2O_3	0.02	0.01	0.01	0.01	0.01	0.27	0.30
MnO	0.05	0.04	0.05	0.07	0.07	0.22	0.25
V_2O_3	0.01	0.01	0.01	0.01	0.01	0.02	0.02
CO_2	0.12	0.20	0.12	0.02	0.08	0.05	0.07
Totals	98.59	99.74	99.33	99.35	100.35	99.70	99.88
Specific gravity	2.80	2.82	2.89	2.75	2.91	3.21	3.06

Samples:

CA-1-61—Greenschist facies metapelite. Lot 8, concession I, Drury township. Muscovite-chlorite-quartz-albite-sphene-ilmenite.

CA-2-61—Almandine amphibolite facies metapelite. Lot 8, concession II, Hyman township. Staurolite-biotite-garnet-andesine-quartz-muscovite.

CA-3-61—Almandine amphibolite facies metapelite. Lot 9, concession II, Hyman township. Staurolite-biotite-(garnet)-andesine-quartz-muscovite.

CA-4-61—Garnet hornfels. Lot 9, concession II, Hyman township. Garnet-andesine-muscovite-chlorite-quartz-ilmenite-rutile. Compare with sample CA-3-61.

CA-5-61—"Hornblende syenite." Lot 3, concession V, Drury township. Hornblende-plagioclase-(chlorite, epidote).

CA-6-61—Pyroxene gabbro. Lot 10, concession II, Drury township.

CA-7-61—Metagabbro derived from pyroxene gabbro. Lot 10, concession II, Drury township.

The mafic meta-igneous rocks are composed essentially of actinolite, albite, biotite, epidote, chlorite, and quartz in the chlorite-biotite zone. In the garnet, chloritoid, and staurolite zones they consist of blue-green hornblende and plagioclase (oligoclase-andesine) with variable amounts of quartz, biotite, and garnet.

The quartzitic rocks consist of quartz, muscovite, biotite, plagioclase, and potash feldspar, in all the metamorphic zones.

The pelitic rocks undergo the most pronounced mineralogical and textural changes with advancing metamorphic grade, thus they are the most useful as indicators of grade of metamorphism. Metapelites of the chlorite-biotite zone are grey-to-black "argillite," and small porphyroblasts of chlorite or biotite are rarely discernible. The essential minerals are quartz, chlorite, biotite, muscovite, and albite. In the garnet, chloritoid, and staurolite zones, porphyroblasts of garnet, chloritoid, and staurolite are abundant, and the plagioclase is oligoclase or andesine.

The metapelites are not greatly deformed, and delicate primary structures such as laminated bedding are well preserved. Locally, however, secondary foliations are developed to such a degree that the rocks are phyllitic or schistose.

Chemical analyses of rocks from the various metamorphic zones (Table IX, samples CA-1-61, CA-2-61, CA-3-61) show that there was probably little chemical change on metamorphism. Delicate bedding is generally well preserved, and the only evidence for significant movement of material during metamorphism is the presence of concentrations of staurolite and chloritoid.

STRUCTURAL GEOLOGY

General

Structural data, such as attitudes of bedding, foliations and lineations, and the location of faults and fold axes, are plotted on the accompanying maps. The accompanying figure is an interpretation of the structure of the area.

Regional Structure

The major structure of the region is poorly known but, as can be seen on Geological Survey of Canada map No. 155A (Lake Huron sheet), probably consists of a system of major domes and basins, the Elliot Lake basin being an example. Smaller folds of several magnitudes are superimposed on these. Faults of regional extent, notably the Worthington–Murray fault, pass through the map-area.

Folds

A series of synclines and anticlines trend northeast to east across the area, and on these are superimposed smaller folds of various magnitudes. These structures are deformed and interrupted by faulting and gabbroic intrusions.

A major anticline, the Agnew anticline, trends northeast to east across the map-area. In southwestern Hyman township, rocks of the metavolcanic group are exposed in the core of this anticline. The anticline plunges northeast. To the south there is a faulted synclinal structure outlined by conglomerate and gabbro; an anticline in the bend of the Spanish River; and a syncline in rocks of the upper quartzite member in southwestern Drury township. These folds also plunge northeast. North of the Agnew anticline there are several poorly defined folds; the nose of the Porter syncline, which plunges southwest; and a syncline in the lower quartzites adjacent to the granite.

The faults are approximately parallel to fold axes and simply truncate the limbs of folds. It is probable that faulting accompanied folding. However, faulting outlasted the folding, since some faults transect and displace fold axes.

Faults

The rocks of this map-area are extremely faulted. There have apparently been several periods of faulting: the first, accompanying folding before the intrusion of gabbroic rocks; the second, following the intrusions of gabbroic rocks; and possibly a third, minor post-olivine diabase period of movement on at least some of the faults.

The faults can be divided into three groups on the basis of their strike orientation. Several faults have variable orientations along their courses and thus belong to two of the groups. One major system strikes N.60°E. to east-west; the other major system strikes N.30°–45°E.; and a third, minor system trends north-south to N.30°W.

The major faults dip vertically to steeply south. The little evidence available, in the form of dragfolds, slickensides, and contact displacements, indicates that these are steep reverse faults on which there has been significant vertical as well as horizontal displacement.

The surface expression of the faults depends to a large extent on the nature of the country rock. Faults cutting relatively competent rocks such as the gabbro, granite, and quartzite are generally well-defined, narrow zones. Breccia and quartz veins are common in these areas. Faults cutting pelitic metasedimentary rocks are generally not narrow zones, but instead the former discrete faults break up into a multitude of small shears, which occupy wide areas.

Sealine and Hunter Lake (North) Faults

These faults, and nearby parallel faults, strike about N.60°E. in western Hyman township where they cut quartzite. Brecciation, shearing, and granulation of the quartzite; displacement of fold axes; and truncation and displacement of lithological units have been produced by these faults. In the granite, both faults join to form a single fault zone trending N.45°E., which is surrounded by extensive areas of brecciation and quartz-veining. The granite-metasediments contact is displaced by these faults, the north side having moved 1,000–1,200 feet west relative to the south side in both cases.

Cut-off Fault

This fault trends N.30°W., approximately parallel to an olivine diabase dike. It has produced minor shearing and brecciation in the quartzite, has displaced several sedimentary units, and also forms the west boundary of a fault block of the granite "basement"; the southern boundary of this block is the Cygnet fault.

Cameron Creek Fault

In northwestern Drury township, this fault strikes N.45°E. and separates granite on the east from norite on the west. The apparent horizontal displacement of the norite contact is about 2 miles, the north side having moved west relative to the south side; but this may not be accurate since the norite occurrence in northwestern Drury is probably a small subsidiary intrusion. Recent drilling[1] indicates that there is no connection between this body and the main Nickel Irruptive mass to the north. The fault displaces the metasediments-granite contact about 2,500 feet but in the opposite direction. It passes through the pond in central Hyman township causing local shearing and brecciation and displacement of units, and it truncates the north limb of the central anticline in southwestern Hyman township.

Fairbank Lake Fault (North)

This fault strikes N.55°E. in northern Drury township, where it displaces the norite contact about 1,300 feet, the north side having moved west with respect to the south. Where the fault cuts rocks of the metavolcanic group and the lower quartzites, there are large areas of breccia. Sheared, brecciated, drag-folded pelitic metasediments mark this fault zone in western Drury and eastern Hyman townships. This fault probably trends through Agnew Lake at about N.60°E. and continues into Baldwin township.

Fairbank Lake Fault (South)

This fault, striking N.40°E., displaces the norite contact, possibly by as much as 3,300 feet, again the north side having moved west. It displaces stratigraphic units and has produced abundant shearing, brecciation, and quartz-veining in the metasediments. One branch of this fault continues into southeastern Drury township; but another branch swings abruptly westward into Hyman township, where it strikes about N.70°E. and probably rejoins the north branch of the Fairbank Lake fault.

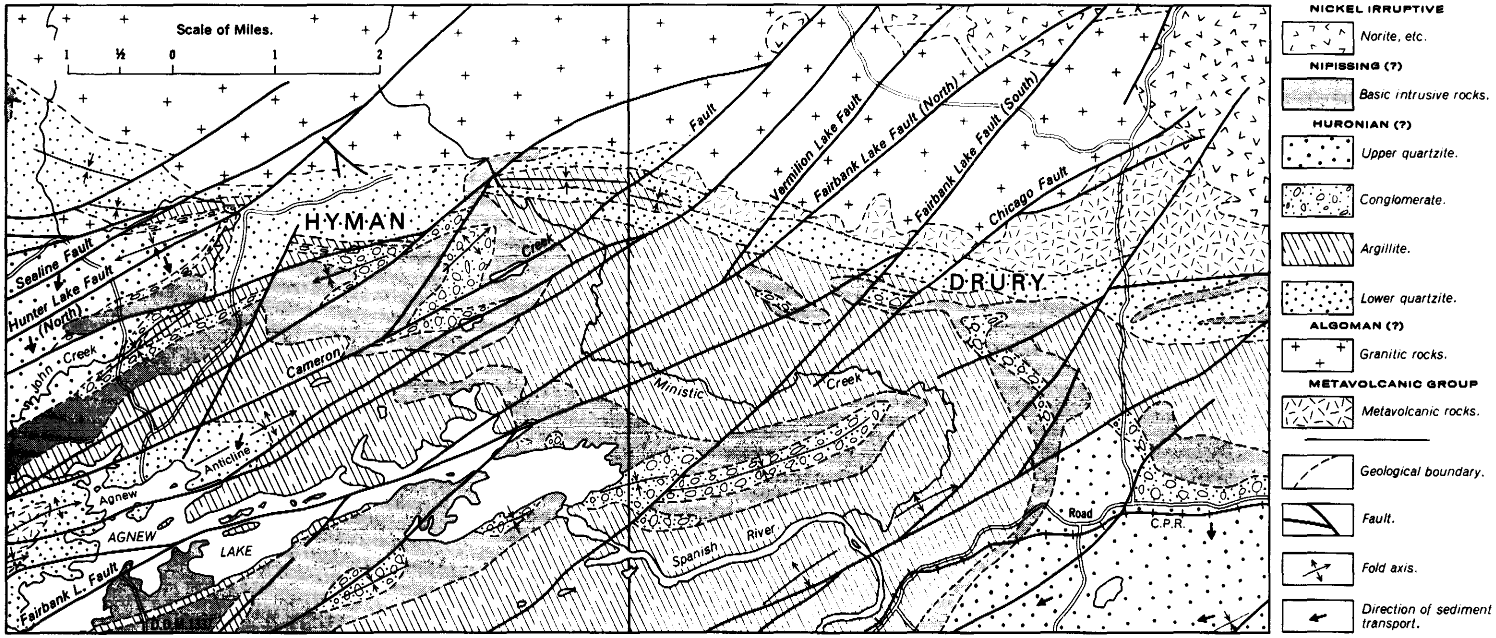
Chicago Fault

The Chicago fault strikes N.55°–60°E. across central Drury township, where it offsets the granite-metavolcanics contact. It splits, one branch running south and the other north, of the Chicago mine. The north branch is interpreted as offsetting the norite contact about 600 feet, the north side having moved west, whereas the south branch offsets this contact about 2,300 feet in the opposite direction.

Vermilion Lake and Creighton Faults

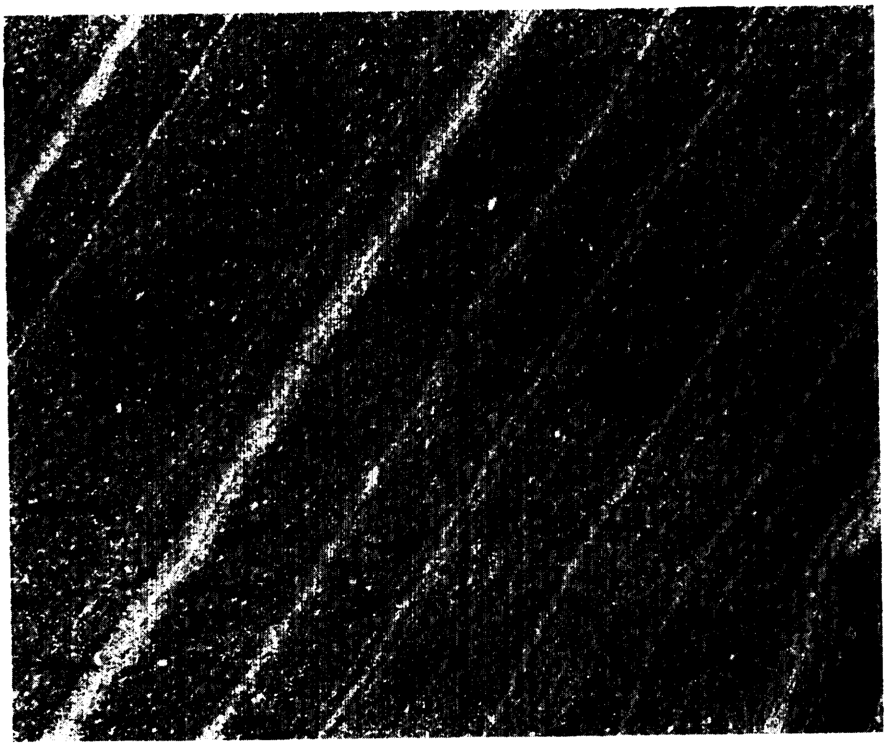
A fault that is correlated with the Vermilion Lake fault displaces the Nickel Irruptive–metavolcanics group contact in northern Drury township. The apparent horizontal displacement is about 2,000 feet, the north side having moved west relative to the south side. The Vermilion Lake fault probably joins faults of the Fairbank Lake system to the southwest.

[1]P. Potapoff, geologist, Falconbridge Nickel Mines Ltd.; personal communication.



Interpretive geological, stratigraphic, and structural map of Hyman and Drury townships.

Direct evidence for the Creighton fault is absent in Drury township. However, immediately to the east in Denison township, it is a well-defined structure. The author believes that this fault does not continue west across Drury township but instead either swings southwest or is cut off by southwest-trending faults.



Bedding-schistosity relations in the metapelite. Bedding is inclined; schistosity (and lineation) defined by oriented ilmenite-sphene grains. (X 10 magnification.)

Minor Structures

Schistosity, gneissosity, lineation, and cleavage are well developed in various rock types in this area. A regional schistosity or gneissosity appears in all rock types but is best developed in pelitic metasediments and in metavolcanics. This foliation trends east, ranging from northeast to east to slightly south-of-east. It trends parallel to major faults and fold axes in general and thus is approximately parallel to the bedding for the most part. However, it does cut sharply across the bedding in the noses of folds.

Associated with the schistosity are several types of lineation:

1. Mineral lineation; given by preferred orientation of elongate minerals such as micas and chlorite.
2. Pebble lineation; preferred orientation of stretched pebbles and smaller clastic grains.
3. Minor fold axes.
4. Intersection lineation; given by the intersection of bedding and schistosity.

Most of the lineations are congruent with the major folds. The most prominent lineations—oriented minerals and minor fold axes—are parallel to the major fold axes. These lineations plunge congruently with the major structures.

Slip-cleavage is present in the pelitic rocks. It appears as closely spaced, subparallel fractures on which there has been movement, generally of small magnitude. Microscopic examination shows that generally there is little or no orientation of minerals parallel to the cleavage planes. It is not a penetrative foliation. The bedding and schistosity are displaced and contorted by movement on the cleavage planes; this gives rise to small-scale folds and crinkles, which define another lineation.

Gash fractures occur in quartzite, gabbro, and conglomerate. They are filled with quartz, and some contain minor amounts of sulphide minerals.

Tectonic Synthesis

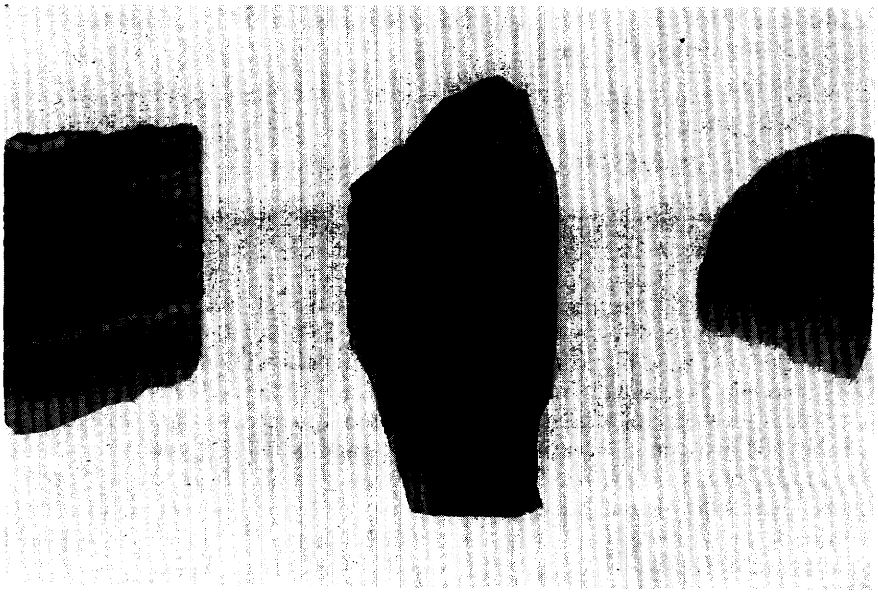
Detailed study of the textural relations of the metamorphic porphyroblasts, and the minor structures, leads to the following conclusions.

1. During the first phase of deformation, which may be characterized as "plastic," the major folds and associated minor structures were formed. Throughout most of the area, only low-grade metamorphic minerals such as chlorite and muscovite grew during deformation. Only in southwestern Hyman township, where the schistosity is well developed, is there evidence that higher-grade metamorphic minerals such as biotite, garnet, and staurolite grew while deformation proceeded.

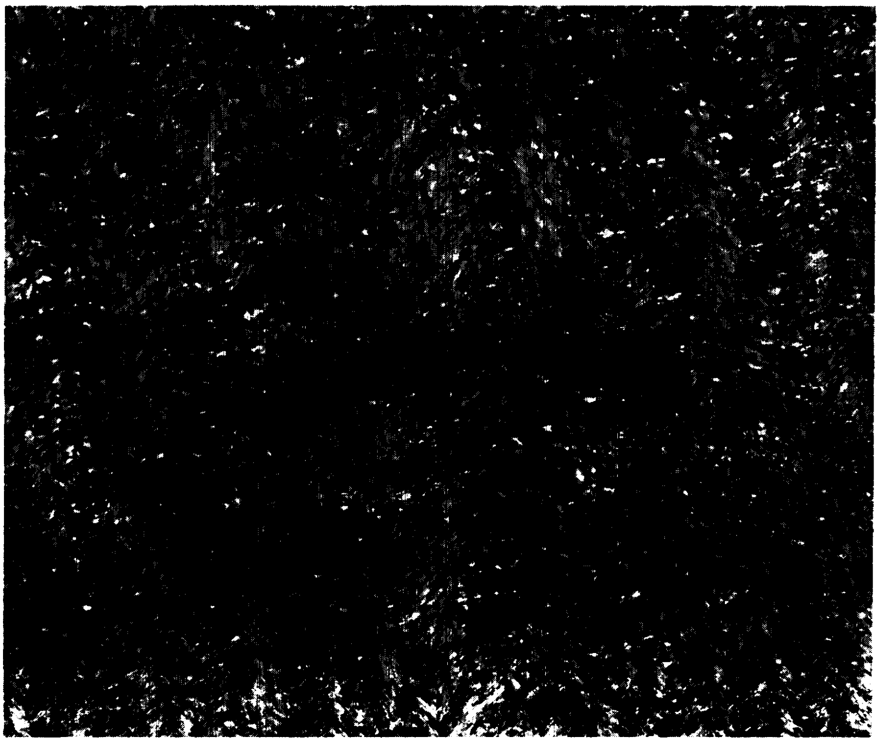
2. The "plastic" deformation was followed by a period of high-grade metamorphism, during which minerals such as biotite, garnet, and staurolite grew in an essentially static environment.

3. The final event was a period of "brittle" deformation, during which slip cleavage and associated structures were formed, earlier structures were deformed, and metamorphic minerals such as garnet and biotite were destroyed. These events are probably all phases of the same orogenic event and are probably closely associated in time and genesis.

The orientation of the folds and associated minor structures, and the character and orientation of the faults, would indicate that the major deformative forces acted in a northwest-southeast direction. Possibly an active "shove" from the southeast, which pushed the younger rocks against and over the granitic "buttress" to the north, would be one cause for this deformation.



Bedding–slip cleavage relations. Bedding is contorted and displaced by subparallel cleavage. (Approximately natural size.)



Schistosity–slip cleavage relations. Schistosity, as outlined by oriented minerals, is contorted by the slip cleavage. Note that there is little reorientation of minerals parallel to the cleavage planes. (X 30 magnification.)

ECONOMIC GEOLOGY

General

Sulphide mineralization is present in or associated with every rock type in the area except olivine diabase. The more important areas of sulphide mineralization are shown on the accompanying map (No. 2055, back pocket). Chalcopyrite and pyrrhotite occur along bedding and joint planes in the pelitic metasediments. Copper and nickel sulphides are widely distributed in shear zones and silicified zones in the gabbro, metavolcanics, quartzite, and granite. The most important areas of sulphide mineralization are in and around the lower part of the Nickel Irruptive and in the Worthington offset. Uranium minerals occur in oligomictic quartz-pebble conglomerate lenses in the lower quartzite formation.

There has been some production of nickel and copper from Drury township. Some thousands of tons of ore were taken from the Worthington mine, and about 3,500 tons from the Chicago mine. In 1961–63 there were no producing mines, but the area was being actively explored.

An airborne-magnetometer survey was made in 1952, and copies of the aeromagnetic maps (Nos. 55 and 56) are available from the Ontario Department of Mines.

Description of Properties[1]

NICKEL-COPPER DEPOSITS

Kordol Explorations Limited, Hyman Township (4)

This company held and explored a group of claims south of Agnew Lake in Hyman township, in 1959. Exploration work consisted of geological mapping, a ground magnetometer survey, surface trenching and sampling, and diamond-drilling. The main showings lie in alteration zones in a large metagabbro body and consist of pockets of disseminated or massive pyrrhotite, pyrite, and chalcopyrite. A chip sample, taken by the company over a width of 17 feet, gave the following assay: copper, 1.03 percent; nickel, 0.45 percent; cobalt, 0.12 percent; palladium, trace.

Several shallow diamond-drillholes intersected 5–12 feet of sulphide mineralization averaging 1–1½ percent combined copper and nickel.

Keba Property, Hyman Township (3)

Two small zones of sulphide mineralization along the Nairn-Hyman township line were explored by surface trenching and sampling and by a geophysical survey by Falconbridge Nickel Mines Limited, in 1957. Nickel and copper are present as disseminated sulphides in metagabbro.

Pond Showings, Hyman and Drury Townships (6, 18)

Sulphide minerals occur in sheared metagabbro and adjacent metasediments at the west end of the pond in Hyman township, and to the east in lot 12, concession IV, Drury township. These showings were investigated by T. Tamminen

[1]Bracketted figures following names of properties refer to location Nos. on map No. 2055 (back pocket).

in 1958. The mineralization consists of disseminated-to-massive pyrrhotite, chalcopyrite, and pyrite in quartz veins and in the adjacent rock.

Copper Showing, Drury Township (12)

A silicified shear zone at the contact between brecciated metasediments to the south and metavolcanics to the north contains disseminated chalcopyrite where it is exposed in the northwest quarter of lot 9, concession IV, Drury township. The silicified zone trends east-west, dips steeply south, and can be traced west for about 500 feet. No sulphide mineralization was noted in the westward extension. The mineralized zone is exposed by trenching over a width of about 50 feet. The distribution of chalcopyrite is quite irregular. Similar silicified zones are found to the north and east, and some of these contain minor amounts of sulphide.

Copper-Nickel Showings, Drury Township (9)

Pockets of disseminated to massive sulphide mineralization occur on the top of a hill of altered, brecciated metagabbro in the south half of lot 10, concession IV, Drury township. The sulphide minerals recognized are pyrrhotite, chalcopyrite, and pyrite. A branch of the Fairbank fault is interpreted to run through this area. The mineralization has been explored by several shallow test-pits.

Copper-Nickel Showings, Drury Township (10)

The claims, located in the southeast quarter of lot 5, concession III, and in lot 6, concession III, Drury township, have been actively explored by means of several shallow shafts and test-pits. The sulphide occurrences consist of disseminated pyrrhotite and chalcopyrite in sheared, silicified metagabbro. Another mineralized zone is present in conglomerate about 900 feet southwest; this zone can be traced for about 100 feet and averages a few feet in width; the mineralization is similar to that in the gabbro.

Copper-Nickel Showings, Drury Township (11)

On these claims, which occupy the southeast quarter of lot 7, concession I, Drury township, several test-pits have been opened on short, irregular zones of sulphide mineralization in metagabbro. Pyrrhotite and chalcopyrite are the most abundant sulphide minerals. Some diamond-drilling has been done, but the results are not known.

Deposits of the Worthington Offset (15, 16, 17)

Sulphides, including pyrrhotite, pentlandite, chalcopyrite, gersdorffite, and niccolite are abundant throughout the Worthington Offset dike. These minerals are concentrated in localized areas, in the central parts of the dike, which contain abundant breccia fragments and appear to have been subjected to the most intense crushing. The ore minerals occur as disseminations, as small veinlets or pods, and as more massive bodies cementing rock fragments. Some small late veinlets of calcite, quartz, and galena, and olivine diabase dikes cut the mineralized bodies.

Mines located on this dike that have produced in the past include the Worthington mine (16), which in 1927 caved-in after producing 129,000 tons of ore; the Worthington No. 2 pit (17); and the Totten mine (15) to the southwest. Descriptions of these occurrences can be found in the Report of the Royal Ontario Nickel Commission (Royal Nickel Commission 1917).

Deposits Associated with the Nickel Irruptive

Sulphide minerals, mainly chalcopyrite, pyrrhotite, pentlandite, and pyrite, are very abundant in both the footwall rocks and in the basal "norite breccias" near the contact of the Nickel Irruptive. The more important occurrences are shown on the geological map (No. 2055, back pocket) and are described briefly in the following section.

CHICAGO (INEZ) MINE, DRURY TOWNSHIP (13)

This deposit, in northeastern Drury township, was worked intermittently from 1891 to 1897, and about 3,500 tons of ore was removed and smelted. The workings consist of an open cut about 25 feet wide and 250 feet long with a shaft at the bottom, and another, shallow shaft just west. The mineralization occurs in a west-trending shear zone in brecciated metavolcanic rocks including "hornblende syenite," mafic schist, and amphibolite. The gossan zone can be traced for about 200 feet and ranges in width from about 5 to 20 feet. The norite to the east is light-coloured, gneissic, and difficult to distinguish from the "hornblende syenite." The norite is apparently in fault contact with the metavolcanic rocks. Another zone of sulphide mineralization was found about ½ mile southwest along the supposed extension of this fault. The ore minerals are pyrrhotite, pentlandite, and chalcopyrite, and some fibrous amphibole is associated with sulphides in waste material on the dump.

SULTANA MINE, NORTHERN DRURY TOWNSHIP (14)

Sulphides are present in various amounts near the norite contact in concession IV, Drury township. They occur in brecciated footwall metavolcanics and in "norite breccia" ("quartz diorite breccia") and consist of disseminated pyrrhotite, pentlandite, and chalcopyrite. The Sultana (south) body (No. 12 on the map) is located in brecciated, sheared amphibolite and chloritic schist immediately below the "altered norite" breccia contact. The mineralized zone is possibly 1,000 feet long and is highly irregular and discontinuous. A shallow shaft or deep pit is located on this body, and to the north, in Trill township, more extensive workings are present on the main showings.

URANIUM OCCURRENCES (5, 2, 1, 8, 7)

Radioactive quartz-pebble conglomerate lenses are present, with arkose, quartzite, and argillite, at or near the base of the sedimentary sequence in the area. The lenses are quite discontinuous and average 1–2 feet thick. In most occurrences there are several conglomerate beds at different stratigraphic horizons, and the intervening sedimentary rocks may or may not be radioactive. The radioactive minerals occur as very small grains in the matrix and include monazite, thorianite, uraninite, "brannerite," and a variety of alteration products of these minerals. Zircon, apatite, ilmenite, and magnetite grains are closely associated with the radioactive minerals.

The more important occurrences are: the Noranda Mines Limited (5) and Chemical Research Corporation (Canada) Limited (2) showings in southwestern Hyman township; the Canadian Thorium Corporation Limited (1) showing in north-central Hyman township; and the Alford Explorations Limited (8) and Alanen and Maki showings (7) in western and central Drury township. These occurrences are described in some detail by Thomson (1960).

GOLD OCCURRENCES

There has apparently been little or no exploration for gold in this area in recent years. Moore (1930, pp. 36, 37) described gold prospects in Drury township as given below.

Dwyer Mine

Moore (1930) gives the location of the Dwyer property as lot 6, concession IV, Drury township. The old workings could not be found at this location during the present survey. Numerous old pits and shallow shafts were located to the north, in lot 6, concessions IV and V, and to the southeast in lots 3 and 4, concessions III and IV.

Moore (1930, pp. 36, 37) describes the occurrences as follows:

. . . Two shallow shafts were sunk many years ago, and at the southwest shaft there is quite a large vein formed of stringers of quartz running through a dike of granite. This vein, which is exposed for 5 chains up the side of a hill and has a maximum width of 20 feet, ends rather abruptly at the west end and disappears under drift to the east, where a shaft has been sunk. The quartz contains specks of galena. An average sample taken from the vein was assayed by the Provincial Assayer and showed neither gold nor silver.

The other shaft is on a vein that starts as blotches and stringers of quartz in a squeezed and brecciated greenstone. It widens out to 40 feet but maintains this width for only about 60 feet, and this lens is followed by a section of barren rock with only stringers of quartz, until the shaft is reached. The total length of the vein exposed is about 400 feet. In the bottom of the shaft, which is 38 feet deep, the lode is about 8 feet wide, and at the top from 12 to 15 feet. Much interest has been attached to the vein in this shaft because an old report by Aaron Slaght for the Ontario Bureau of Mines[1] states that values up to $24.00 in gold per ton were obtained from the bottom of the shaft, which was then not so deep as it is now. Other assays from this property are reported to have run as high as $26.00 a ton in gold and over $2.00 in silver. The quartz is greenish in colour and contains a small quantity of chalcopyrite. A sample containing some chalcopyrite was taken across the lode near the bottom of the shaft and assayed by the Provincial Assayer but gave no gold or silver.

There are several other veins on this property, but they are either practically unmineralized or of limited extent and not of economic interest. One of these is a large lens of slightly mineralized quartz occurring at the granite contact northwest of the shaft.

Other Properties

Moore (1930, p. 37) writes as follows:

A number of claims were visited in lot 9, concession III, and lot 12, concession IV, Drury township. The veins occur in Nipissing diabase and greywacke of the Sudbury series. Some of them are of good size and they mostly contain a little chalcopyrite. Development work has been done on some of the veins, and they are regarded by prospectors as gold properties. Several samples were collected by the writer as representative of these veins, and they were assayed by the Provincial Assayer. No gold was found in any of them, and since the veins do not carry enough copper to be of interest they cannot be regarded as having economic importance.

[1] *See* Slaght (1898, p. 87).

Suggestions for Further Exploration

Sulphide minerals, mainly pyrrhotite, pentlandite, pyrite, and chalcopyrite, are closely associated with gabbroic rocks in this area. The deposits associated with the Nickel Irruptive are, of course, excellent examples, but there are numerous showings in the metagabbro or "Sudbury gabbro" bodies. The sulphides here are generally found in altered zones accompanied by such minerals as chlorite, amphibole, quartz, plagioclase, and green chrome micas.

Petrographic examination shows that there are essentially no sulphide minerals in the fresh pyroxene gabbros, but that on alteration of pyroxene to amphibole, a great deal of very fine-grained opaque material is formed as a "dust" throughout the rock. With increasing grade of metamorphism, this material lumps together to form large patches of sulphides. It is possible that the copper and nickel for these sulphides were originally present in trace amounts in the pyroxene and were released on alteration of the pyroxene to amphibole.

All alteration zones in and around gabbroic bodies should be prospected carefully for sulphides. Abundance of minerals such as chlorite, quartz, and green micas mark the areas most promising for investigation.

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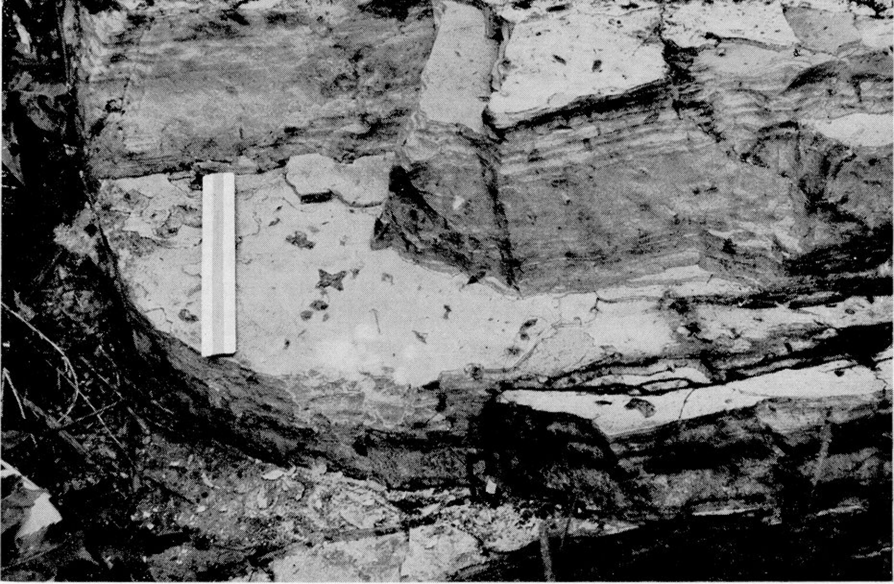
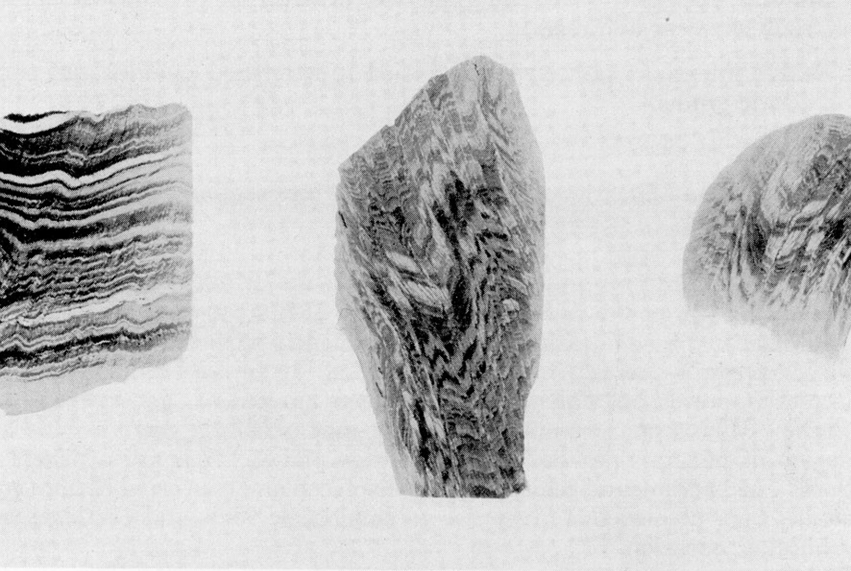
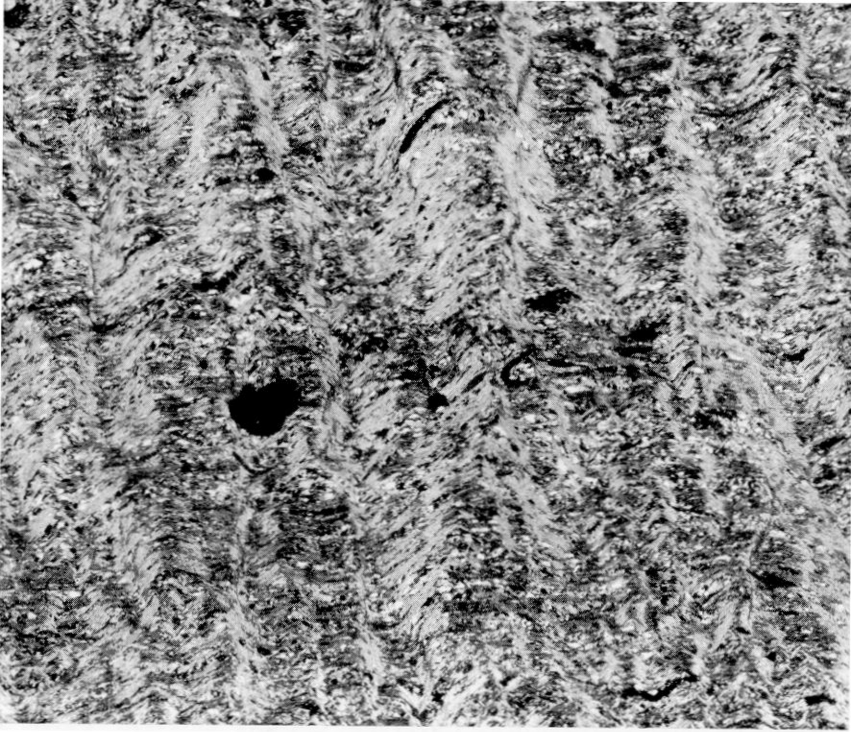
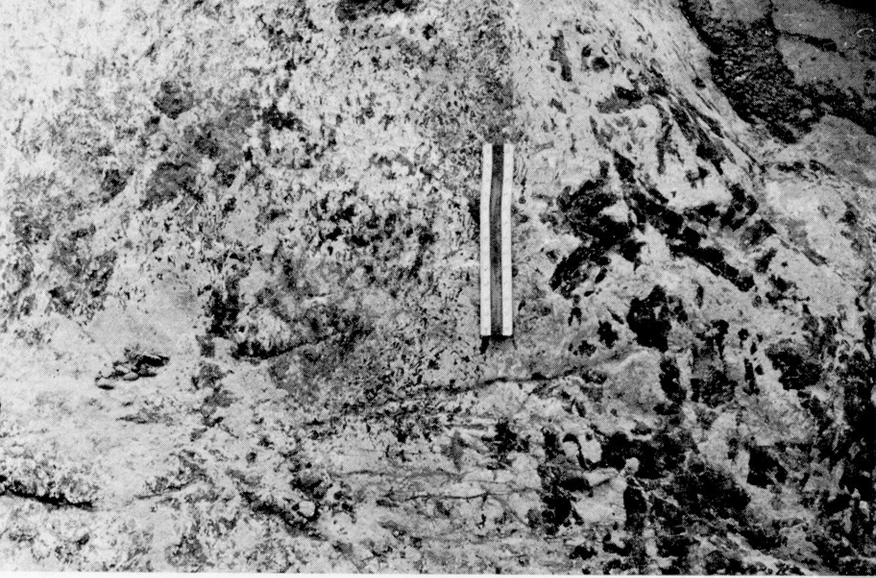


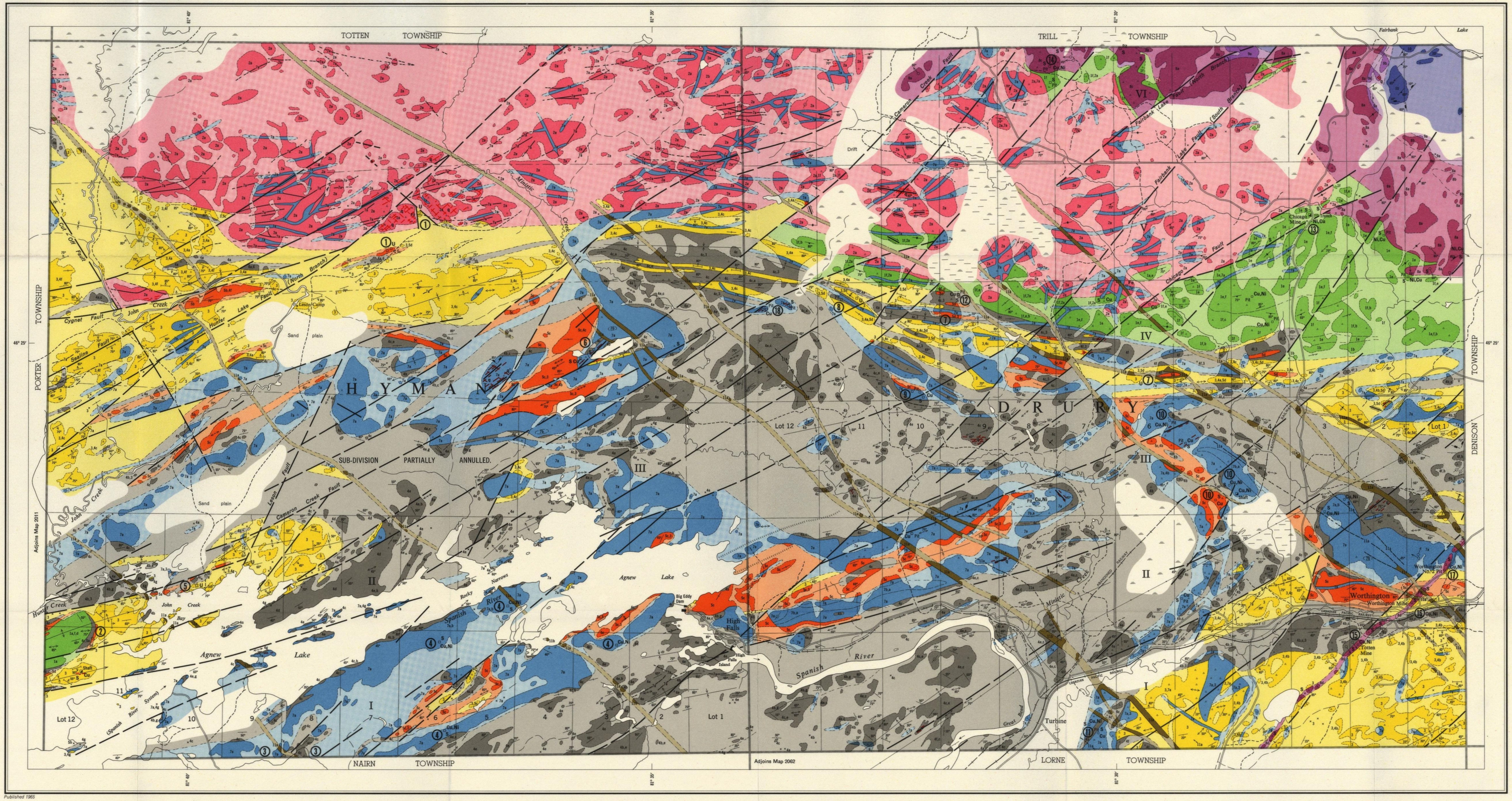


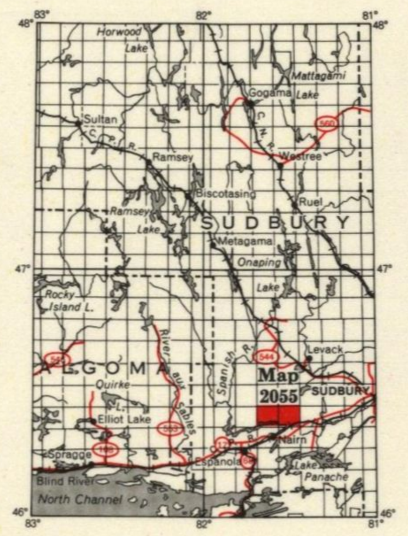




ONTARIO
DEPARTMENT OF MINES
HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2055
Hyman and Drury Townships





Scale, 1 inch to 50 miles
N.T.S. reference 41 I/5, 41 I/6

SYMBOLS

- *Glacial striae.*
- *Esker.*
- *Small rock outcrop.*
- *Boundary of rock outcrop.*
- *Geological boundary, defined.*
- *Geological boundary, approximate.*
- *Geological boundary, assumed.*
- *Geological boundary as indicated by geophysical data.*
- 55° *Strike and dip; direction of top unknown.*
- *Strike and vertical dip; direction of top unknown.*
- 60° *Folded bedding, with dip.*
- 60° *Direction (arrow) in which inclined beds face as indicated by graduation in grain size.*
- *Direction (arrow) in which vertical beds face as indicated by graduation in grain size.*
- *Direction (arrow) in which inclined beds face as indicated by cross bedding.*
- *Direction (arrow) in which vertical beds face as indicated by cross bedding.*
- *Direction (arrow) in which overturned beds face as indicated by cross bedding.*
- *Synclinal axis.*
- *Anticlinal axis.*
- *Direction of plunge of fold axis, crest line or trough line.*
- 30° *Strike and dip of schistosity.*
- *Strike of vertical schistosity.*
- *Strike of schistosity, dip unknown.*
- 30° *Strike and dip of gneissosity.*
- *Strike of vertical gneissosity.*
- 50° *Stratiform foliation, inclined.*
- *Stratiform foliation, vertical.*
- 30° *Lineation (plunge known, plunge unknown).*
- 45° *Jointing, inclined.*
- *Jointing, vertical.*
- 45° *Drag-folds. (Arrow indicates direction of plunge).*
- 55° *Fault, defined, with dip; arrows indicate horizontal movement.*
- *Fault, indicated or assumed.*
- *Vein, vein network.*
- *Open muskeg, swamp or marsh.*
- *Muskeg or swamp.*
- *River, creek, stream. Arrow indicates direction of flow.*
- *Electric power transmission line.*
- *Motor road.*
- *Other road.*
- *Trail, portage, winter road.*
- *Building.*
- *Shaft, vertical.*
- *Test pit.*
- *Open cut, quarry, gravel pit.*
- *Trench.*
- *Drill hole, vertical, inclined.*
- *Township boundary, approximate position only.*
- *Survey line, approximate position only.*
- *Picket line, approximate position only.*
- 3 *Location of properties and mineral occurrences.*

LEGEND

CENOZOIC*

PLEISTOCENE AND RECENT
Sand, gravel, clay, silt.

UNCONFORMABLE CONTACT

PRECAMBRIAN**

LATE BASIC INTRUSIVE ROCKS

11 — *11a Olivine diabase.*
11b Porphyritic olivine diabase.

INTRUSIVE CONTACT

NICKEL IRRUPTIVE

10 — *10 Granophyre.*

9 — *9a Light transition rocks.*
9b Dark transition rocks.

8 — *8a Grey norite.*
8b Dark norite.
8c Norite breccia.
8d Gabbro-diorite breccia (Worthington offset).

INTRUSIVE CONTACT

GABBROIC ROCKS

7 — *7a Hornblende metagabbro, amphibolite.*
7b Pyroxene gabbro, pyroxenite.

INTRUSIVE CONTACT

METASEDIMENTARY GROUP

6 — *6 Subgreywacke.*

5 — *5a Polymictic greenstone-pebble conglomerate.*
5b Polymictic conglomerate, argillite or greywacke matrix.
5c Polymictic conglomerate, quartzitic matrix.
5d Oligomictic quartz-pebble conglomerate.

4 — *4a Argillite, slate.*
4b Biotite metapelite.
4c Sericite metapelite, chlorite metapelite.
4d Staurolite-biotite-garnet metapelite.
4e Staurolite metapelite, chloritoid metapelite.
4f Greywacke.
4g Garnet metapelite.

3 — *3 Quartzite, feldspathic quartzite, arkose.*

UNCONFORMABLE CONTACT

GRANITIC ROCKS

2 — *2a Medium to coarse-grained porphyritic and equigranular quartz monzonite, granite, granodiorite and their gneissic equivalents.*
2b Coarse-grained red granite.

INTRUSIVE CONTACT

METAVOLCANIC GROUP

1 — *1a Amygdaloidal and porphyritic metavolcanic rocks.*
1b Acid metavolcanic rocks, tuff.
1c Chloritic, biotitic, amphibolitic schist and gneiss.
1d Garnet amphibolite.
1e "Hornblende syenite".
1f Amphibolite.

Breccia

Cu	*Copper*
Fe	*Iron*
Ni	*Nickel*
q	*Quartz*
S	*Sulphide mineralization*
U	*Uranium*

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

***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.*

Rocks of the various groups are subdivided lithologically and the order does not imply age relationships within the groups.

Published 1965

PROPERTIES AND MINERAL OCCURRENCES.

HYMAN TOWNSHIP

1. *Canadian Thorium Corp. Ltd.................U*
2. *Chemical Research Corp. Ltd................U*
3. *Keba Property........................Cu, Ni*
4. *Kordol Explorations Ltd................Cu, Ni*
5. *Noranda Mines Ltd........................U*
6. *Pond showings........................Cu, Ni*

DRURY TOWNSHIP

7. *Alanen and Maki showings..................U*
8. *Alford Explorations, Ltd....................U*
9. *Copper-nickel showing................Cu, Ni*
10. *Copper-nickel showing................Cu, Ni*
11. *Copper-nickel showing................Cu, Ni*
12. *Copper showing..........................Cu*

International Nickel Company of Canada Ltd.
13. *Chicago mine........................Cu, Ni*
14. *Sultana (south) mines................Cu, Ni*
15. *Totten mine........................Cu, Ni*
16. *Worthington mine....................Cu, Ni*
17. *Worthington No. 2 pit................Cu, Ni*

18. *Pond showings........................Cu, Ni*

Map 2055

HYMAN AND DRURY TOWNSHIPS

SUDBURY DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

SOURCES OF INFORMATION

Geology by K. D. Card and assistants, 1960, 1961. Geology is tied to survey lines in part; west boundary of Hyman Township; Hyman-Drury boundary from concession I to concession V.

Maps and plans of mining companies.
Geological Survey of Canada Maps 291A (Espanola Sheet) and 292A (Copper Cliff Sheet).

Preliminary maps, P. 133, Hyman Township and P. 134, Drury Township, scale 1 inch to ¼ mile, issued 1962.

Cartography by R. E. Curtis and E. Davis, Ontario Department of Mines, 1964.

Base map derived from Ontario Forest Resources Inventory maps and air photographs, with additional information by K. D. Card, 1960, 1961.

Magnetic declination approximately 7°W. 1961.