MARGINAL NOTES

LOCATION AND ACCESS

The map-area covers approximately 276 km^2, comprising Cascaden, Dowling and Trill Townships. The eastern extremity of the map-area is located about 23 km west of Sudbury. Mapping was done at a scale of 1:15 840 (1 inch to ¼ mile), with more detailed examinations in areas of extensive bedrock exposure.

Major and secondary roads, logging roads, power lines, the Canadian Pacific Railway track, lakes, rivers and trails, provide access to all parts of the map-area.

MINERAL EXPLORATION

Information on exploration activity was obtained from the Resident Geologist's Files, Ontario Ministry of Natural Resources, Sudbury, or from the Source Mineral Deposit Record Files, Ontario Geological Survey, Toronto.

Mineral exploration in the map-area, during the latter part of the last century, led to the discovery of two major showings, the Sultana and Trillabelle Properties, in Trill Township, along what is now known as the nickel-copper-bearing sublayer zone. Early work on both properties consisted of trenching and the sinking of exploratory shafts within the main gossan zones. Both properties are presently held by Inco Limited.

Most of the recorded base-metal exploration in the map-area was done in the 1950s and 1960s, by Falconbridge Nickel Mines Limited and Inco Limited. Both companies have undertaken extensive geological and geophysical surveys, and diamond drilling in all three townships. Falconbridge completed more than 16 500m (total length) of drilling from 1951 to 1972 (last year submitted), whereas Inco completed more than 29 000m from 1950 to 1973. However, since the 1920s, other companies and individuals submitted results from diamond drilling, assay sampling, and geophysical and/or geological surveys from the Sudbury Irruptive Complex and the Onaping Formation (Table 1).

During the 1981 field season, diamond drilling by Inco was in progress in Trill Township (concession V, lot 7).

GENERAL GEOLOGY

Published geological maps of the map-area consist mostly of compilation maps by Collins (1938), Cook (1946), Thomson (1956), Card (1969, 1978), Burwasser (1977), and Card and Lumbers (1977).

The oldest rocks (basement rocks) are Early Precambrian in age and comprise the Levack Gneiss Complex, the Birch Lake Batholith and the Cartier "Granite". The Levack Gneiss consists of moderately to highly deformed and metamorphosed para- and ortho-gneisses with migmatitic affinities (commonly garnet and/or pyroxene bearing), containing leucosome fractions composed of coarse-grained dioritic to trondhjemitic material. In addition, there is the presence of weakly foliated to gneissic, leucocratic quartz diorite to tonalite (containing xenoliths of the former), and amphibolite as metamorphosed supracrustal remnants (metavolcanic in origin) and/or mafic intrusive bodies (amphibolitized gabbro).

The Birch Lake Batholith is a leucocratic, massive to weakly foliated, medium- to coarse-grained, microcline porphyroblastic body ranging in composition from monzonite to syenite. It contains xenoliths of amphibolite and gneissic to migmatitic material, possibly from the Levack Gneiss. The Cartier "Granite" resembles, and appears to be genetically related to, the Birch Lake Batholith, but is notably less porphyroblastic and more equigranular, lacks a syenitic phase, and averages granodiorite in composition. The basement rocks have been crosscut by pegmatitic, aplitic and felsite dykes, which were, in turn, intruded by equigranular to plagioclase porphyritic diabase.

The Early Precambrian rocks are crosscut by Sudbury-type breccias (pseudotachylite breccias), from veinlets to dykes in size, with no preferred orientation and often exceeding 30 m in exposed surface width. The breccias are prominent in proximity to the Sudbury Irruptive Complex and to well-defined lineaments in the basement rocks. The breccias consist of an aphanitic to fine-grained glassy-looking matrix, which may in part be crushed rock derived from the milling of local and foreign fragments. In places, the matrix appears to have flowed around fragments, and the presence of breccia dykes with a granular, coarser-grained matrix suggests recrystallization of primary igneous material. The fragments show evidence of not only brittle fracturing and rotation, but are plastically deformed.

The Whitewater Group of Middle Precambrian age is entirely located within the Sudbury Basin and overlies the Irruptive Complex. It consists of the Onaping, Onwatin and Chelmsford Formations.

Muir (1981) distinguished four phases of mainly pyroclastic breccias in the Onaping Formation, these are the Basal, Grey, Green and Black Members. The volcanic classification is also adopted here for correlation purposes with Muir's North Range mapping, since there is continuity of the major phases across the present map-area. Thus, the Onaping Formation is subdivided into:

a) A discontinuous Basal Member (lowermost phase) which consists of coarse breccias with variations in fragment/matrix proportion across, and along strike. The fragments are mostly granitoid in origin, although quartzite (bedded), gabbro, and rhyolite (flow banded) are also present. The matrix is in part composed of fine-grained pulverized breccia material from the larger fragments, and in part of granular, fine-grained (acicular) amphibole-rich material of igneous appearance representing either granophyre from the Irruptive Complex or recrystallization products from the pulverized portion of the matrix.

b) A discontinuous Grey Member occurs within the lower portions of the Formation. Outcrop distributions, particulary in Dowling Township, form lobe-like projections extending into the Basin. Based on the fragment/matrix composition, there are at least two varieties of this phase. The first consists of massive, igneous-textured, fine-grained, siliceous grey flows containing mostly whitish quartzite (?) fragments (cm to more than 40m in diameter). The second variety, equivalent in part to Muir's Green Member, is classified as a lapilli tuff, with minor coarse breccias, containing irregularly shaped aphanitic volcanic glass (?) fragments, shards, cored bombs, accretionary lapilli and a mixture of accidental fragments ranging from quartzite to volcanic or subvolcanic rock of felsic and mafic compositions.

c) A Green Member, and

d) a Black Member. They are interlayered, and consist of crystal and lapilli tuffs, lapillistone, and coarse breccias containing simple and complex (multi-generation) volcanic glass fragments, vesicular pumice, shards, cored bombs, and accidental fragments of varying types. The main difference between the phases is the siliceous green to greenish grey matrix of the Green Member as opposed to the carbon-rich black matrix of the Black Member.

The Onwatin Formation is present in only a few small outcrops, and consists of finely laminated black slate. The Chelmsford Formation consists of a repetitive sequence of thinly to thickly bedded wacke and thinly laminated siltstone (turbidite sequence) containing abundant primary sedimentary structures and secondary carbonate-rich concretions.

The Sudbury Irruptive Complex of Middle Precambrian age was emplaced between the basement rocks and the Onaping Formation. It is divided into a discontinuous Sublayer Zone breccia, locally containing Ni-Cu-Fe mineralization, and texturally and mineralogically varied norite and granophyre. The granophyre is locally hybridized along its contact with the Onaping Formation.

The leucocratic and gabbroic-noritic breccias are the most common Sublayer Zone breccias, and field evidence suggests a younger age for the latter. The leucocratic breccia consists of partially remobilized basement rock fragments set in a heterogeneous, leucocratic, igneous-textured matrix; whereas the gabbroic-noritic sublayer contains inclusions ranging from ultramafic to dioritic in composition, including anorthosite, set in an equigranular gabbro-diorite matrix. The sublayer offshoot breccia (Ministic Lake Offset), in Cascaden Township, is a dyke-like body of similar composition to the gabbroic-noritic breccia.

Late Precambrian, northwest trending, rusty weathering, olivine diabase dykes crosscut the map-area.

Quaternary deposits of till, ice contact deposits, glaciofluvial and glaciolacustrine material, and alluvium overlie central and northwestern Dowling Township, northeastern Cascaden Township, and west central Trill Township.

STRUCTURAL GEOLOGY

The gneissic and migmatitic rocks of the Levack Gneiss Complex feature recumbent and upright isoclinal folds, and an upper amphibolite to granulite grade of metamorphism as indicated by the garnet-pyroxene mineralogy. The gneissosity strikes northeast to southeast, and dips subhorizontally to vertically.

The contacts between the Irruptive and the Gneiss Complex, and the Irruptive with the Onaping Formation, are generally considered to dip inwards, towards the Sudbury Basin. The Onaping Formation possesses a gross internal layering, but primary depositional attitudes cannot be accurately determined because of a lack of local bedding structures.

Bedding attitudes in the sediments of the Chelmsford Formation have been compressed to form open folds whose axes approximately parallel the northeast trend of the Basin. Bedding dips, in both the Onwatin and Chelmsford Formations, average less than 35°, whereas dips from the subparallel schistosity are generally steeper.

Two major fault-lineaments transect the map-area: the north-trending Fecunis Lake Fault, in Dowling Township, and the northeast-trending Cameron Creek Fault, in Trill Township. Considerable offset has occurred on both faults, particularly along the latter, where the observed lateral displacement exceeds 3 km.

ECONOMIC GEOLOGY

Nickel-copper and copper-lead-zinc mineralizations have been the target of mineral exploration in the map-area. All significant showings and occurrences are associated with the Sublayer zone and the Onaping Formation.

Mineralization in the Sublayer zone includes pyrrhotite, pentlandite, chalcopyrite, pyrite and minor magnetite.

North- to northwest-trending, rather continuous, narrow quartz veins in the Onaping Formation, commonly contain disseminated chalcopyrite, galena, sphalerite, pyrrhotite and pyrite. Samples taken by field party personnel from two quartz veins within an old adit in Dowling Township (concession IV, lot 8), gave assay values of trace to 8.88% Zn, trace to 11.80% Pb, and trace to 0.42% Cu (analyses by the Geoscience Laboratory, Ontario Geological Survey, Toronto, 1981).

In addition, very fine to coarse fragments of sulphide mineralization (<0.5 mm to 1.5 cm) occur in all members of the Onaping Formation, although the Black Member contains a greater abundance (up to 5%). Identifiable fragments include chalcopyrite, pyrrhotite and pyrite.

The Onwatin Formation features abundant pyrite cubes, some with carbon-rich (anthraxolite) cores, and stratabound pyrite-rich lenses.

The Levack Gneiss contains numerous pyritiferous gossan zones, and even though copper mineralization has been found in the brecciated granitic gneisses of Levack Township, (Dressler 1981) there is no mineralization of this type observed on the surface in the map-area.

REFERENCES

Burwasser, G.J.
1977: Sudbury, Quaternary Geology; Map 2397, Ontario Geological Survey. Scale 1:50 000.

Card, K.D.
1969: Sudbury Mining Area; Map 2170, Ontario Department of Mines. Scale 1:63 360 or 1 inch to 1 mile.

1978: Sudbury-Manitoulin; Map 2360, Ontario Geological Survey. Scale 1:126 720 or 1 inch to 2 miles.

Card, K.D. and Lumbers, S.B.
1977: Sudbury-Cobalt; Map 2361, Ontario Geological Survey. Scale 1:253 440 or 1 inch to 4 miles.

Collins, W.H.
1938: Copper Cliff Sheet; Map 292A, Canada Department of Mines and Resources. Scale 1:63 360 or 1 inch to 1 mile.

Cooke, H.C.
1946: Chelmsford; Map 871A, Canada Department of Mines and Resources. Scale 1:63 360 or 1 inch to 1 mile.

Dressler, B.O.
1981: Precambrian Geology of Levack Township, Sudbury District; Ontario Geological Survey Preliminary Map P. 2428, Geological Series, Scale 1:15 840 or 1 inch to ¼ mile. Geology 1979 and 1980.

Muir, T.L.
1981: Geology of the Capreol Area, District of Sudbury; Ontario Geological Survey, Open File Report 5344, 168p., 4 figures, 21 photographs, 6 tables and 4 maps.

Thomson, Jas. E.
1956: Sudbury Basin Area; Map 1956-1, Ontario Department of Mines. Scale 1 inch to 1 mile.

LIST OF PROPERTIES

1. Aird, J. B.
2. Airnorth Mines Limited.
3. Arcadia Nickel Mines
4. Callinan Flin-Flon Mines (1939) Limited (includes Trans-Northern Nickel and Copper Mines Limited)
5. Eastview Mines (1957) Limited (includes Mining Corporation of Canada Limited)

*6. Hollinger Consolidated Gold Mines Limited

7. New Fortune Mines Limited
8. Nickel Rim Mines Limited (Martin, H.E.)
9. Noranda Mines Limited (includes Cryderman, J.R.)
10. Rosen, A.E.
11. Sudbury Exploration and Mining Limited

*Only this property is present in Dowling Township.

TABLE 1 - Summary of Assessment Work

NAME	PROPERTY NO. ON MAP	LAST YEAR WORKED	TOWNSHIP	TYPE OF WORK	ROCK UNIT	REFERENCE
Aird, J.B.	1	1954	Trill	Mag	SZ, Bas	AF
Airnorth Mines Ltd.	2	1967	Cascaden	Mag,DD,Em	SZ	AF
Arcadia Nickel Mines	3	1957	Cascaden	DD,Em	Bas	
Callinan Flin-Flon Mines (1939) Ltd. (includes Trans-Northern Nickel & Copper Mines Ltd.)	4	1957	Trill	Mag,DD,Geol	SZ,Bas	AF
Eastview Mines (1957) Ltd. (includes Mining Corporation of Canada Ltd.)	5	1957	Cascaden, Dowling	DD,Geol, Res, As	SZ	AF
Hollinger Consolidated Gold Mines Ltd.	6		Dowling	Geol	OF	AF
New Fortune Mines Ltd.	7	1955	Trill	Mag,Em,Res	OF	AF
Nickel Rim Mines Ltd. (Martin, H.E.)	8	1956	Trill	DD	SZ	AF
Noranda Mines Ltd. (includes Cryderman, J.R.)	9	1956	Cascaden Trill	Mag,DD,Geol	SZ,Bas	AF
Rosen, A.E.	10	1957	Cascaden	Em	Bas	AF
Sudbury Exploration & Mining Ltd.	11	1953	Trill	DD, Em	Gran	AF

- AF — Assessment work from Resident Geologist's Files, Sudbury
- Mag — Magnetometer Survey
- Em — Electromagnetic Survey
- DD — Diamond Drilling
- Geol — Geological mapping
- Res — Resistivity Survey
- As — Assay analysis
- SZ — Sublayer Zone
- OF — Onaping Formation
- Bas — Basement rocks
- Gran — Granophyre

[1]Falconbridge Nickel Mines Ltd. (includes Sandcherry Mines Ltd. and Westfield Minerals Ltd.) and Inco Ltd. are not included.

PATENTED and LEASED MINING CLAIMS

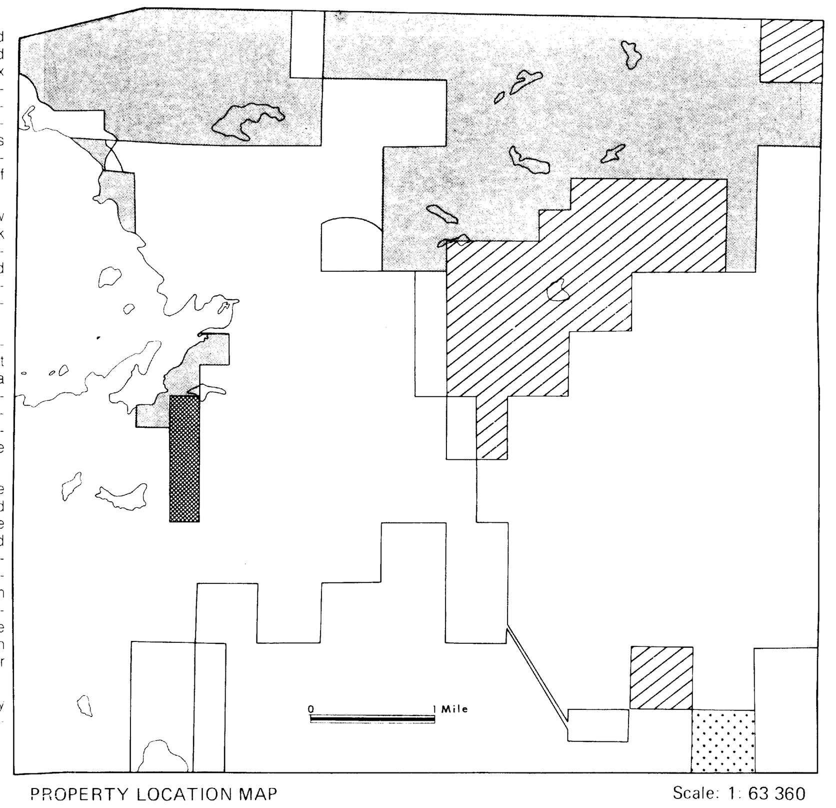
(Licences of Occupation Under Water)

CASCADEN, DOWLING and TRILL TOWNSHIPS.

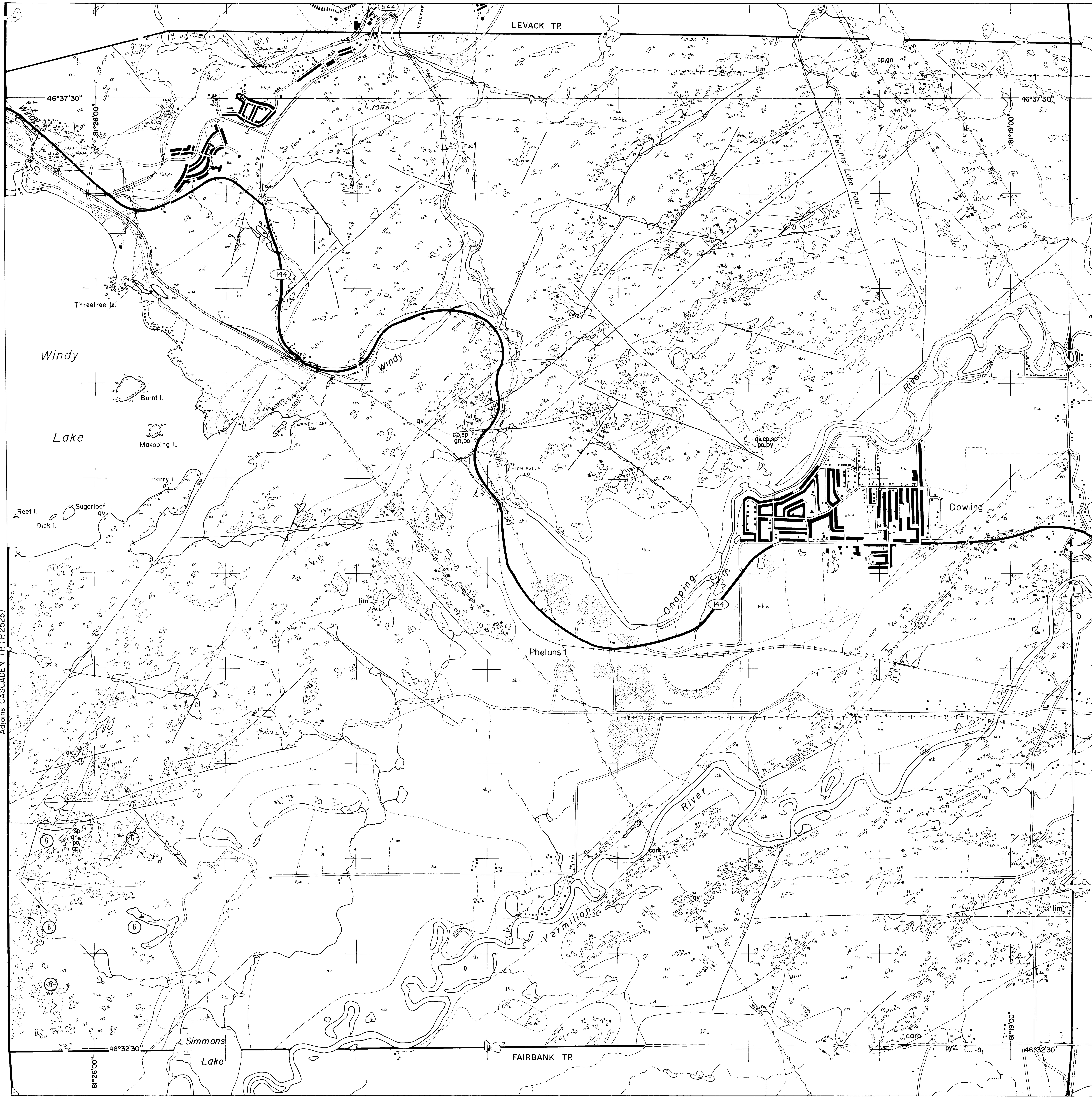
District of Sudbury, Sudbury Mining Division.

- FALCONBRIDGE NICKEL CO.
- INCO. Ltd.
- ONAPING MINES LTD.*
- SANDCHERRY MINES LTD.*
- WESTFIELD MINERALS*

* only present in Dowling Twp.



PROPERTY LOCATION MAP Scale: 1: 63 360



LEGEND[a,b]

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

16
- 16a Swamp, bog, and mud deposits
- 16b Alluvium, silt, sand, gravel

PLEISTOCENE

15
- 15a Glaciolacustrine deposits: sand, silt, and sandy silt
- 15b Glaciofluvial sand, minor gravel; outwash channel deposits and deltaic deposits transitional to lacustrine deposits
- 15c Till: bouldery sand and gravelly, silty sand; ice contact deposits: gravel, sand, moraines, eskers

UNCONFORMITY

PRECAMBRIAN
LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS

14
- 14 Unsubdivided
- 14a Olivine diabase

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN
FELSIC DYKES

13
- 13 Aplite, felsite

INTRUSIVE CONTACT

SUDBURY IRRUPTIVE COMPLEX
GRANOPHYRE

12
- 12 Unsubdivided
- 12a Granophyre, leucocratic granophyre
- 12b Transitional granophyre
- 12c Hybrid granophyre

NORITE

11
- 11 Unsubdivided
- 11a Norite, leucocratic norite
- 11b Transitional norite
- 11c Melanocratic norite

Sublayer Zone[c]

10
- 10 Unsubdivided
- 10a Leucocratic breccia
- 10b Mixed breccia
- 10c Gabbroic - noritic sublayer breccia
- 10d Sublayer offshoot ("Offset") breccia
- 10e Megabreccia

INTRUSIVE CONTACT

WHITEWATER GROUP[c]
CHELMSFORD FORMATION[c]

9
- 9 Unsubdivided
- 9a Wacke, locally with concretions
- 9b Interbedded wacke and siltstone; locally with any combination of concretions, rip-up clasts, convolute bedding, flame structures, scour channels, and cross bedding

ONWATIN FORMATION

8
- 8 Unsubdivided
- 8a Slate

ONAPING FORMATION

7
- 7 Unsubdivided

Black Member[c]
- 7a Tuff
- 7b Lapilli-tuff
- 7c Lapillistone
- 7d Tuff breccia, pyroclastic breccia

Green Member[c]
- 7e Tuff
- 7f Lapilli-tuff
- 7g Lapillistone
- 7h Tuff breccia, pyroclastic breccia

Grey Member[c]
- 7i Lapilli-tuff
- 7j Tuff breccia, pyroclastic breccia
- 7k Siliceous, massive flows

Basal Member[c]
- 7l Fragment-supported, annealed felsic breccia
- 7m Matrix-supported felsic breccia

SUDBURY TYPE BRECCIA

6
- 6 Unsubdivided
- 6a Dykes (pseudotachylite)
- 6b Large, irregularly-shaped breccia bodies, pseudotachylite matrix

INTRUSIVE CONTACT

MAFIC INTRUSIVE ROCKS[f]

5
- 5 Unsubdivided
- 5a Gabbro, diorite (Nipissing type)

INTRUSIVE CONTACT

EARLY PRECAMBRIAN
METAMORPHOSED MAFIC INTRUSIVE ROCKS

4
- 4a Diabase
- 4b Plagioclase-porphyritic diabase

INTRUSIVE CONTACT

METAMORPHOSED MAFIC ROCKS

3
- 3 Unsubdivided
- 3a Gabbro, amphibolitized
- 3b Anorthositic gabbro

METAMORPHOSED FELSIC TO INTERMEDIATE GRANITIC ROCKS[c]

2
- 2 Unsubdivided
- 2a Microcline porphyroblastic, hornblende-quartz monzonite, monzonite, syenite (massive to weakly foliated), termed Birch Lake Batholith
- 2b Hornblende-quartz monzonite, granodiorite, granite (massive to weakly foliated), termed Cartier "Granite"
- 2c Pegmatite, aplite, felsite

METAMORPHOSED GNEISSIC COMPLEX (LEVACK GNEISS[g])

1
- 1 Unsubdivided
- 1a Biotite-hornblende-quartz-plagioclase gneiss (paragneiss)
- 1b Hornblende-quartz-plagioclase gneiss (orthogneiss)
- 1c Migmatite[h]
- 1d Biotite-hornblende-quartz diorite, diorite, trondhjemite, tonalite (weakly foliated to gneissic)
- 1e Amphibolite (metavolcanic)

NOTES

a) This is a field legend for Cascaden, Dowling and Trill Townships, and may be changed as a result of subsequent laboratory investigations.

b) Not all lithologic types are found on this map sheet.

c) Rocks in these units are subdivided lithologically and order does not imply age relationships within these units or members.

d) Order implies lithologic age relationships among these formations.

e) The Sublayer Zone is locally poorly defined. It is composed of up to several ages and types of breccia which contain fragments of many different rock types, its complexity cannot be fully indicated at this map-scale.

f) Found as inclusions within rocks of units 1 and 2.

g) Lithologic subdivision not only applies to the Levack Gneiss, but may also describe other gneisses in the map-area.

h) Contains greater than 40% leucocratic mobilizate of dioritic - trondhjemitic composition; the material may be derived from *in situ* melting, and/or injection from an external source.

1. Outcrops that have been examined have been coded appropriately. All others are shown from air photograph interpretation and are coded singly or in groups as "unsubdivided".
2. Where more than one rock type is listed (separated by a comma), the order is in decreasing predominance and (or) decreasing age as the appropriate case may be.

Ontario
Ministry of Natural Resources
Hon. Alan W. Pope, Minister
W.T. Foster, Deputy Minister

ONTARIO GEOLOGICAL SURVEY
MAP P.2526
GEOLOGICAL SERIES—PRELIMINARY MAP

PRECAMBRIAN GEOLOGY OF DOWLING TOWNSHIP

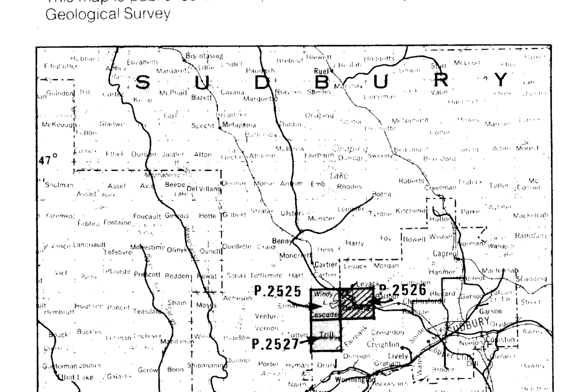
SUDBURY DISTRICT

Scale 1:15 840

Mile ¼ 0 ¼ ½ Mile

Metres 100 0 0.2 0.4 0.6 0.8 1 Kilometre

NTS Reference: 41I/11
ODM-GSC Aeromagnetic Map: 7067G
OGS Geological Compilation Map: 2361



LOCATION MAP Scale 1:1 584 000

SYMBOLS

- Glacial striae
- Small bedrock outcrop
- Area of bedrock outcrop
- Bedding, top unknown: (inclined, vertical)
- Schistosity; (horizontal, inclined, vertical)
- Gneissosity; (horizontal, inclined, vertical)
- Foliation; (horizontal, inclined, vertical)
- Lineation with plunge
- Geological boundary, observed
- Geological boundary, position interpreted
- Lineament
- Jointing; (horizontal, inclined, vertical)
- Shaft; depth in feet
- Pit
- Adit

Not all symbols may be present on this map sheet.

ABBREVIATIONS

- **carb** .... Carbonate
- **cp** .... Chalcopyrite
- **ep** .... Epidote
- **gn** .... Galena
- **gt** .... Garnet
- **lim** .... Limonite
- **pent** .... Pentlandite
- **po** .... Pyrrhotite
- **px** .... Pyroxene
- **py** .... Pyrite
- **qc** .... Quartz-carbonate
- **qv** .... Quartz vein
- **sp** .... Sphalerite

Not all minerals will be present in this township.

SOURCES OF INFORMATION

Base maps derived from the Forest Resource Inventory maps, Lands and Waters Group, Ontario Ministry of Natural Resources, with additional information by J. Lafleur.

Assessment work data obtained from the Regional Geologist's Files, Ontario Ministry of Natural Resources, Sudbury, and from the Source Mineral Deposit Records files, Ontario Ministry of Natural Resources, Toronto.

Sudbury, Quaternary Geology; Ontario Geological Survey, Map 2397, by G.J. Burwasser, 1977. Scale 1:50 000.

Sudbury Mining Area, Sudbury District; Ontario Department of Mines, Map 2170, by K.D. Card, 1969. Scale 1:63 360 or 1 inch to 1 mile.

Sudbury - Manitoulin, Sudbury and Manitoulin Districts; Ontario Geological Survey, Map 2360, by K.D. Card, 1978. Scale 1:126 720 or 1 inch to 2 miles.

Sudbury-Cobalt, Geological Compilation Series; Ontario Geological Survey, Map 2361, by K.D. Card and S.B. Lumbers, 1977. Scale 1:253 440 or 1 inch to 4 miles.

Copper Cliff Sheet, Sudbury District; Canada Department of Mines and Resources, Map 292A, by W.H. Collins, 1938. Scale 1:63 360 or 1 inch to 1 mile.

Chelmsford Sheet, Sudbury District; Canada Department of Mines and Resources, Map 871A, by H.C. Cooke, 1946. Scale 1:63 360 or 1 inch to 1 mile.

Dowling Area, Sudbury District; Ph.D. Thesis, University of Toronto, Map No. 1, by W.V. Peredery, 1972. Scale 1 inch to 800 feet.

Sudbury Basin Area, Sudbury District; Ontario Department of Mines, Map 1956-1, by Jas. E. Thomson, 1956. Scale 1 inch to 1 mile.

Sudbury, Ontario; Geological Survey of Canada, Aeromagnetic Map 7067G, 1965. Scale 1:253 440 or 1 inch to 4 miles.

Geology is not tied to survey lines.

Magnetic declination in the area was approximately 7°45′ West in 1981.

CREDITS

Geology by Jean Lafleur, N. Maerz, B.O. Dressler, and assistants, 1980, 1981.

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Natural Resources does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Resident or Regional Geologist's office and the Mining Recorder's office nearest the map-area.

This project was funded by the Ontario Ministry of Northern Affairs through the Northern Ontario Geological Survey (NOGS) Program.

Issued 1982.

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Lafleur, Jean, Maerz, N., and Dressler, B.O.
1982: Precambrian Geology of Dowling Township, Sudbury District; Ontario Geological Survey Map P.2526, Geological Series - Preliminary Map, Scale 1:15 840 or 1 inch to ¼ mile. Geology 1980, 1981.