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ONTARIO DEPARTMENT OF MINES

Geological Report No. 35

Nairn and Lorne Townships

By

R. M. GINN

1965

ONTARIO
DEPARTMENT OF MINES

HON. G. C. WARDROPE, *Minister* D. P. DOUGLASS, *Deputy Minister*
M. E. HURST, *Director, Geological Branch*

Geology of Nairn and Lorne Townships

District of Sudbury

By
R. M. GINN

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GEOLOGICAL MAP
(back pocket)

Map No. 2062 (coloured)—Nairn and Lorne townships, District of Sudbury. Scale, 1 inch to ½ mile.

ABSTRACT

Semi-detailed mapping of Nairn and Lorne townships, southwest of Sudbury, was carried out in 1958. Using air photographs, the rocks were mapped for lithology, primary structural features, mineralization, and the nature and degree of deformation.

The sedimentary rocks of the area are present in a conformable sequence similar in many respects to the Bruce group of Proterozoic rocks of the Blind River area. Quartzites, polymictic conglomerates, greywackes, siltstones, argillites, and calcareous rocks are found in Nairn and Lorne townships. These include such metamorphic rocks as staurolite schist and cordierite-anthophyllite hornfels previously mapped as of Archean age.

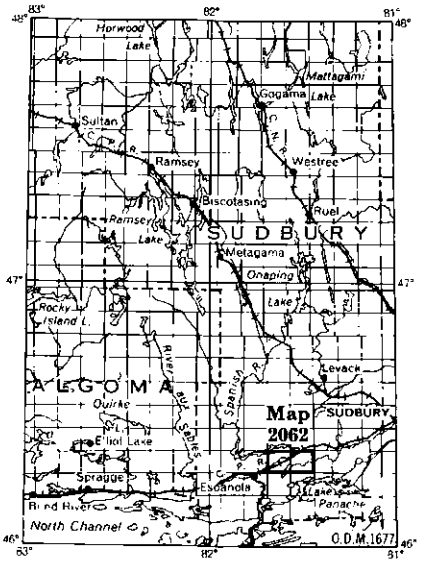

Figure 1 — Key-map showing the location of the Nairn and Lorne map-area. Scale, 1 inch to 50 miles.

Metamorphism is the contact effect of intrusion of basic sills, known as "Nipissing diabase." Later basic intrusions include a discontinuous sill and numerous northwest-trending dikes of olivine diabase.

Sedimentation involved the transportation of detritus from the north and northeast, presumably from the Birch Lake granite a few miles north of the map-area. Deposition of these sediments was in an actively subsiding miogeosyncline with an approximately east-west shoreline.

Generally the rocks are gently folded, although local steep dips were measured. For the most part the rocks are on the south limb of the Baldwin anticlinorium striking north of east. The dominant fold in Lorne township is a gently southwest-plunging anticline crossing the middle of the township.

The abundant faults are divided into the following sets:

1. East-west—the major fault of this set is the Murray fault.
2. Northeast cross-over faults.
3. Northwest dilational zones occupied by discordant masses of metagabbro.
4. North faults—of minor importance.
5. Auxiliary random faults.

Of the many prospects in the area, only base-metal mineralization in northeast faults is known to be of any appreciable extent.

Geology of Nairn and Lorne Townships

By

R. M. Ginn[1]

INTRODUCTION

Nairn and Lorne townships are east of the town of Espanola in the District of Sudbury. Nairn township is bounded on the west by Baldwin township (mapped for the Ontario Department of Mines by Jas. E. Thomson in 1952) and on the east by Lorne township. The area is approximately between Long. 81°26′ and 81°41′W. and Lat. 46°17′ and 46°22′N. Figure 1 shows the location of the map-area.

Both townships are readily accessible by either road or water. Highway No. 17 crosses the area in a northeast direction. The north half of Lorne township is easily accessible by good motor roads. The south half, south of the Vermilion River, is accessible by boat via Ella Lake. Nairn township is well-serviced by motor roads and trails. Almost all of the township can be reached by less than one hour's walking from a road.

Both of the major rivers crossing the area are navigable by canoe. Dams at Nairn Falls near the Nairn-Lorne boundary on the Spanish River and at Lorne Falls in lot 8, concession III, Lorne township on the Vermilion River, necessitate short portages. Rapids and shallows in lots 4, concessions III and IV, Lorne township, require short portages or dragging. Float-equipped aircraft can land on Lake Agnew in northwestern Nairn township and on Wabagishik, Ella and Margaret lakes in the southern part of the area.

The Sudbury–Sault Ste. Marie branch of the Canadian Pacific Railway crosses the two townships close to highway No. 17. The only established station within the map-area is at Nairn Centre.

High-voltage power lines of the Ontario Hydro-Electric Power Commission cross the area north of the railway. Powerhouses at each of the dams on the Spanish and Vermilion rivers are owned and operated by International Nickel Company of Canada Limited.

The inhabitants of Nairn township are concentrated in Nairn Centre, and are employed in the paper mill at Espanola or by International Nickel Company of Canada Limited, at nearby powerhouses or at mines and smelters near Sudbury. Other residents maintain tourist facilities or are merchants. Only one farm was under cultivation in Nairn township at the time of mapping. Lorne township, by contrast, is largely a farming area. Most of the inhabitants of Lorne township, of Finnish extraction, successfully engage in general farming.

No mining or prospecting activity was in progress at the time of mapping. Numerous old pits are evidence that economic mineralization has been actively sought in the past.

The mapping of these townships was carried out during a five-month period in the summer of 1958. Three of the four party members had had previous mapping experience in this area.

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[1]Postgraduate student, University of Toronto, 1957.

Mapping Methods

The Baldwin-Nairn boundary, resurveyed in 1949–50, is the only township boundary easily followed in the area.

Mapping was carried out by pace-and-compass methods using air photographs and such topical features as roads, power lines, and buildings as control. Work was compiled at a scale of 1 inch to 1,320 feet on basemaps prepared by the Cartography Unit of the Ontario Department of Mines from Forest Resources Inventory sheets of the Ontario Department of Lands and Forests. The air photographs used had been taken in 1946. The location of new roads was taken from topographic maps supplied by the Department of National Defence.

Traverses were run at right angles to the local structure as much as possible. Traverses were planned at intervals of 1,000 feet. A very few were separated by a greater distance than 1,000 feet, and many were spaced more closely. Outcrop shapes were taken from the air photographs. No contacts or linears were interpreted from the photographs alone. Linears were commonly visible on photographs and, after being investigated in the field to determine their nature, they were plotted and projected from the air photographs.

The field map-sheets were issued as a preliminary (uncoloured) geological map, P. 48, in 1960. For the final map (No. 2062, *back pocket*) on the scale of 1 inch to ½ mile, it was necessary to generalize the geological and topographic information. For more detailed information the reader is referred to the preliminary map.

Acknowledgments

To acknowledge the assistance and co-operation of individual inhabitants of Nairn and Lorne townships would be a lengthy, although pleasant, task. Particular thanks are due Rolf Jantti and Max and Les Pomfrey for their many kindnesses to the party members.

The author is indebted to D. P. Rogers, senior assistant, and E. J. Leahy and W. E. McCrindle, junior assistants, for their assistance in the field.

Discussions on points of geology with Jas. E. Thomson of the Ontario Department of Mines, and W. W. Moorhouse of the University of Toronto, were particularly helpful.

Previous Geological Work

Although no previous reports have discussed the geology of Nairn and Lorne townships, there are a few published references to mineral occurrences in the area. The map accompanying Memoir 102 of the Geological Survey of Canada by T. T. Quirke shows the geology of concession I of Nairn township. The Lake Panache map accompanying Memoir 143 of the Geological Survey of Canada by W. H. Collins covers the south half of Nairn and Lorne townships. There is no reference to the bedrock geology of these townships in either memoir. The geology of the two townships is shown in considerable detail on the Espanola Sheet (Map 291A) and the Copper Cliff Sheet (Map 292A) of the Geological Survey of Canada prepared by W. H. Collins. The Ontario Department of Mines reports on Baldwin township by Jas. E. Thomson (1952), and Porter township

An air photograph of part of Lorne township, west of Margaret Lake. The Red Pine syncline is evident in the bottom left corner of the photograph. Note the differences in appearance of quartzite (white), argillaceous sediments (banded grey) and gabbro (elephant-hide appearance).

(Air photo 46-164/15-32, courtesy Ont. Dept. Lands and Forests.)

by R. M. Ginn (1961), consider the rocks and stratigraphic problems of the region.

Aeromagnetic maps of these townships were issued by Ontario Department of Mines in 1952. Areas of magnetic anomaly are underlain by diabase dikes and masses of magnetic gabbro.

A number of mineral prospects in Nairn and Lorne townships have been described in early reports of the Ontario Department of Mines. A. Slaght commented upon a nickel "showing" in lot 11, concession V, Lorne township, from which 500 tons of ore grading 2 percent nickel had been removed by 1891. A. P. Coleman in his report on the Sudbury nickel field in 1905, noted that "ore containing 1.95 of nickel is reported from lots 1 and 2, concession III, of Nairn. The deposits here and in Lorne may really be connected with the Worthington offset though the ore found in them is much lower in nickel." In the Report of the Ontario Nickel Commission, 1917, it is noted that nickel occurrences in Drury, Lorne, and Nairn townships are found in country rock, and are not marginal or offset deposits similar to those of economic importance in the Sudbury area.

E. S. Moore (1929) described a small low-grade copper occurrence in lots 8 and 9, concession V, Nairn township, and a copper-zinc deposit in lot 10, concession II, Lorne township. These are discussed later in this report.

Topography

As can be seen from the accompanying geological map (No. 2062, *back pocket*) there is considerable outcrop in Nairn and Lorne townships. Only in central Nairn township along highway No. 17 is there relatively little visible rock.

The elevation of the Spanish River below Nairn Falls is about 650 feet above sea level. Wabagishik Lake and Ella Lake are about 670 feet and 750 feet above sea level respectively. The elevation of the Canadian Pacific Railway track at Nairn Centre Station is 721 feet above sea level.

The topography is largely controlled by bedrock lithology. Hills of resistant quartzite rise to elevations of 1,000 feet in south-central Nairn township and 1,150 feet in the northwestern part of Nairn township. Small cuesta ridges are common in areas of quartzite. Areas underlain by greywacke generally have lesser elevations. Gabbro and conglomerate are exposed as moderately high, rounded hills and ridges. The rounded hill in western Nairn township at Rock Lake is caused by a resistant gabbro sill in a dome structure.

Quartzite hills have little soil cover, and so tree growth is generally poor. Sumac, scrub oak, and soft maple are the trees most common in quartzitic and gabbroic areas. One excellent stand of red pine trees was observed on the south shore of Ella Lake in Lorne township. Poplar and birch trees are more common on hills of conglomerate and argillaceous rocks. Jackpine is plentiful on the sand plain in central Nairn township. Poison ivy is present in abundance on or near outcrops of gabbro in Nairn and Lorne townships, but is not common in the region.

Faults and olivine diabase dikes are commonly the cause of small valleys in areas of outcrop.

Drainage is generally well developed in this area. There are no large areas of swamp or muskeg, and the only barriers to easy travel by foot are lakes and rivers.

GENERAL GEOLOGY

The bedrock in Nairn and Lorne townships consists of Precambrian sedimentary and mafic intrusive rocks. Following the precedent set by Thomson in Baldwin township, the author prepared lithologic maps of Nairn and Lorne townships. The stratigraphic interpretation of the geology is presented in Figure 2.

Collins considered that the quartzitic, conglomeratic, and limy rocks belong to the Bruce series. The metamorphosed argillaceous rocks in northern Nairn and northwestern Lorne townships are assigned to the pre-Huronian Sudbury series on Collins' Espanola Sheet. Thomson (1952) considered these rocks to be conformable, and to be of Timiskaming age.

The regional structural feature is an anticlinorium called by Thomson the Baldwin anticline. The gently east-plunging axis of this structure strikes at about N.70°E., and passes out of Nairn township in the northeast corner. Thus the oldest rocks in the map-area are quartzites south of Agnew Lake on the boundary of Baldwin and Nairn townships.

Many of the rocks are quite fresh and relatively unmetamorphosed. The intrusion of a series of flat-lying basic sills in the northern part of Nairn township has metamorphosed the argillites and greywackes of that area to garnet and staurolite schists. This is contact metamorphism, however, and not regional metamorphism.

The northern part of the area is interrupted by a series of faults striking almost east-northeast, and belonging to the Murray–Baldwin Creek–Fairbank Lake–Cameron Creek(?) fault system. Faults trend north-northeast in the southern part of the townships, particularly in southeastern Lorne township. This is about the same as the trend of the Grenville Front, which is located about 16 miles east. The faulting principally occurred prior to gabbro intrusion, although some post-gabbro movement has taken place.

The youngest rocks in the area are northwest-trending olivine diabase dikes, which do not appear to have suffered any faulting.

A detailed consideration of rock types and structural features follows the map-legend. The rock types are presented in order of decreasing age as indicated by the stratigraphic succession.

The numbers before rock names in the map-legend refer to the symbols designating these rocks on the accompanying map No. 2062.

Map-Legend

CENOZOIC

RECENT
Muck; lake and stream deposits.

PLEISTOCENE
Sand, gravel, clay.

Unconformity

PRECAMBRIAN

KEWEENAWAN (?)

7a Olivine diabase.
7b Porphritic olivine diabase.

Intrusive Contact
Faulting

POST-SEDIMENTARY INTRUSIVE ROCKS

Nickel Irruptive
6 Gabbro-diorite breccia (Worthington offset).

Intrusive Contact

Basic Intrusive Rocks
5 Undifferentiated.
5b Olivine diabase (possibly Keweenawan).
5a Metagabbro.

Intrusive Contact
Folding and Faulting

SEDIMENTARY ROCKS

Upper Quartzite Unit
3b Feldspathic quartzite, fine-grained, white-weathering.
3a Subgreywacke, calcareous.

Upper Argillite Unit
4 Undifferentiated.
4f Arenaceous greywacke.
4a Calcareous argillite, calcareous siltstone, argillaceous greywacke.
4d Argillaceous limestone.
4e Cordierite-anthophyllite hornfels, feldspar-quartz-amphibole-epidote hornfels.
4c Sericite schist.

Upper Conglomerate Unit
2 Undifferentiated.
2c Polymictic boulder conglomerate, greywacke matrix.
2b Polymictic boulder conglomerate, subgreywacke matrix.

Middle Quartzite Unit
3 Feldspathic quartzite, medium-grained.
3a Subgreywacke.

Middle Greywacke Unit
4 Undifferentiated.
4a Argillite, argillaceous greywacke.
4f Arenaceous greywacke.
4c Sericite schist.

Lower Conglomerate Unit
2 Undifferentiated.
2b Polymictic boulder conglomerate, subgreywacke matrix.

Lower Argillite Unit
4 Undifferentiated.
4a Argillite, argillaceous greywacke, siltstone.
4f Arenaceous greywacke.
4b Biotite schist, chloritoid schist.
4c Sericite-chlorite schist.
4g Garnet schist.
4s Staurolite schist.

Lower Quartzite Unit
3a Subgreywacke.
3 Feldspathic quartzite, medium-to coarse-grained.

Sedimentary Rocks

LOWER QUARTZITE UNIT

Quartzite (3)

Although this rock unit occurs in considerable quantity in Baldwin township, it is found in limited amounts in only two areas in Nairn township. The larger outcrop area is in lots 10, 11, and 12, concessions IV, V, and VI, and forms the

highest hills in the map-area. The other exposure of lower quartzite is in the central part of the Rock Lake dome in the northwest corner of lot 10, concession III, Nairn township.

The lower quartzite is poorly bedded and is commonly massive. Near the contact with the overlying argillite unit the bedding is better developed, and the beds are only a few inches thick. Trough crossbedding is common in this unit, but planar or torrential crossbedding is found only within the top 100 feet of the formation.

The rock is composed generally of well-rounded quartz and potassic feldspar grains measuring 2–5 millimetres in diameter. Accessory minerals include magnetite, sphene, apatite, and zircon. The rock is less obviously granular near the basic intrusions, and argillaceous intercalations are metamorphosed to garnet hornfels. Such metamorphic zones are of minor extent in this formation in Nairn township.

A few thin beds of quartz-pebble conglomerate are present within this formation in Nairn township. Neither sulphide nor uranium mineralization was observed in such beds.

LOWER ARGILLITE UNIT

Argillite (4a), Greywacke (4f), Staurolite Schist (4s), Garnet Schist (4g), and Chloritoid and Biotite Schists (4b)

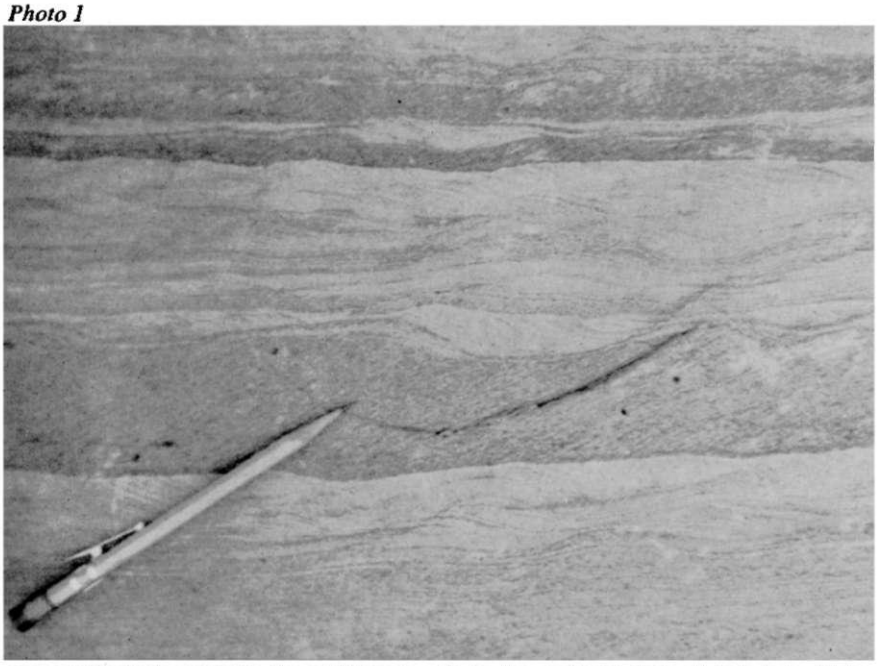
As seen in the Rock Lake dome in Nairn township the lower quartzite grades into the overlying argillite unit through about 50 feet of subgreywacke (3a). This unit is composed dominantly of argillaceous greywacke. At the base of the formation in the Rock Lake area the argillite is locally dolomitic or ankeritic. The carbonate mineral weathers as limonite and does not react with cold hydrochloric acid. The usual major constituents of this rock and their abundance, as indicated by study of several thin sections, are as follows: quartz—64 percent; plagioclase (albite and orthoclase)—4; chlorite—19; white mica—13 percent.

A few intercalations of more arenaceous subgreywacke occur within the formation.

No bedding exceeding 6 inches in thickness was seen by the author in this formation. Thicknesses of ¼–½ inch are usual. Ripple marks of small amplitude and wavelength are not uncommon. The only crossbedding seen in the formation is shown in Photos 1 and 2, and is the result of the downstream migration of asymmetric ripple marks.

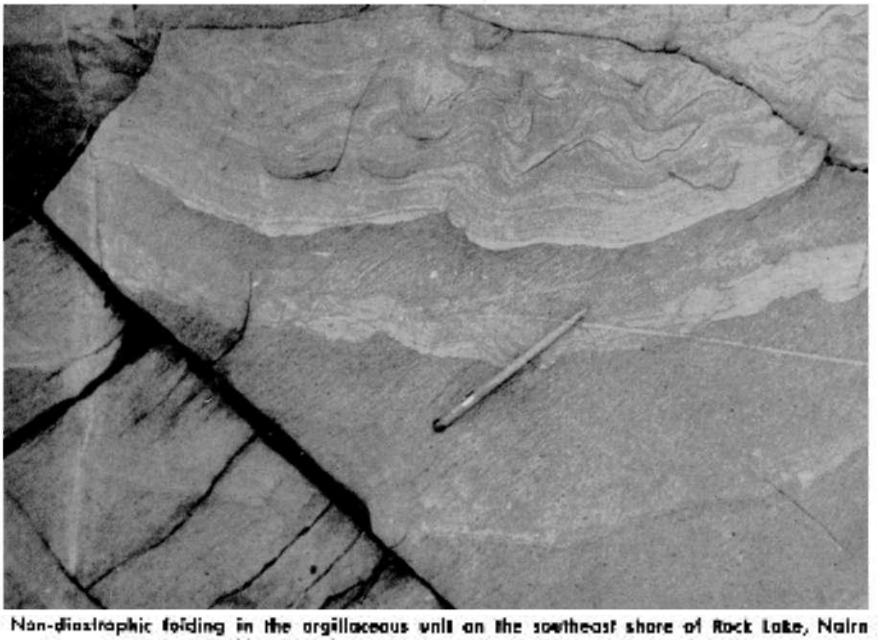
A number of metamorphic minerals are found locally in this formation; but, as Thomson (1952) observed in Baldwin township, these are in the vicinity of, and related to, basic sills. Staurolite and garnet schists are present above metagabbro sills in the east-central part of Baldwin township. Books of biotite and sericite are found beneath the sills of the Rock Lake area in western Nairn township. Staurolite crystals up to 2 inches long are present, above the sills in central and north-central Nairn township, in this argillaceous formation. Above the staurolite zone there are garnets measuring up to ½ inch in diameter. In the northeast corner of Nairn township and the northwest corner of Lorne township are chlori-

Photo 1



Asymmetric ripple marks in the argillaceous unit on the southeast shore of Rock Lake, Nairn township. Note crossbedding resulting from downstream migration of ripple marks.

Photo 2

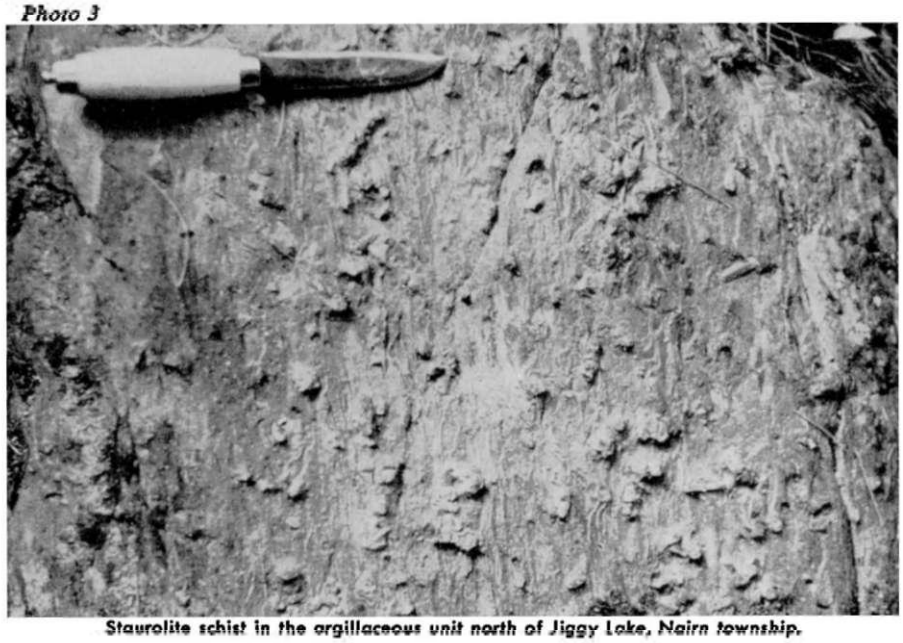


Non-diastrophic folding in the argillaceous unit on the southeast shore of Rock Lake, Nairn township. Note the shear planes parallel to the pencil, developed in the less competent beds.

toid-bearing rocks. Local interruptions of this zoning of metamorphic minerals are caused by other sills and dikes in the generally flat-lying rocks of this formation.

In areas of faulting the incompetent argillaceous rocks are altered to micaceous schists. In such areas as along the Baldwin Creek fault zone (mostly along highway No. 17) in Baldwin and Nairn townships the primary nature of the rocks has been destroyed. This metamorphism of the rocks in the most accessible parts of the area has led many observers to consider these to be old rocks, of Archean age.

Photo 3



Staurolite schist in the argillaceous unit north of Jiggy Lake, Nairn township.

The contact between the argillite unit and the overlying boulder conglomerate is largely obscured by a long sill of basic rock extending across Nairn and Lorne townships. As seen in lot 1, concession III, Nairn township, and as reported by Thomson (1952) in Baldwin township, this contact is completely conformable.

Because of faulting of this unit, no accurate determination of its thickness could be made. A maximum thickness of 1,600 feet was calculated within a fault block in central Nairn township.

LOWER CONGLOMERATE UNIT

Polymictic Boulder Conglomerate (2b)

This unit is the lower of two almost similar polymictic boulder conglomerates in this conformable sequence of sedimentary rocks. Thomson (1952) described a conglomerate 2a lower in the sequence in Baldwin township. As noted by Ginn (1961) there is reason to believe that the older type 2a conglomerate belongs to a group of rocks unconformably overlain by younger sedimentary rocks includ-

ing those of Nairn and Lorne townships. An uraniferous quartz-pebble conglomerate occurs in Porter and Baldwin townships at the surface of unconformity separating the two groups of sedimentary rocks.

The bottom of the lower boulder conglomerate unit is usually marked by a gritty greywacke with small quartz pebbles, though granite pebbles are found locally at the base. Higher in the member it becomes cleaner, more quartzitic, and with larger angular to subrounded pebbles and cobbles of quartz and granite. South of Bell Lake in Lorne township, boulders of granite measuring up to 3 by 2½ feet were found.

Photo 4

Lower boulder conglomerate (2b) in lot 11, concession IV, Lorne township. Fragments include granite, argillite, fine-grained basic rock, and quartz.

Although boulders of granite are most common, other rock types found in the lower boulder conglomerate include argillite, quartzite, and fine and coarse-grained basic igneous rocks. This diversity of rock types is shown in Photo 4. Characteristic of the rock is the varying degree of roundness displayed by the pebbles, and the gritty nature of the buff-coloured matrix. This rock unit is very massive, with no internal bedding.

At the top of the lower boulder conglomerate the matrix is very clean, and the formation there consists of a white, medium-grained quartzite with sparse pebbles of vein quartz. This does not exceed 80 feet in thickness, passing within a few feet through pebble-free subgreywacke to the overlying upper argillite unit. This member is indicated on the accompanying geological map No. 2062 as 3, 2b.

This formation was called the Ramsay Lake conglomerate by Collins on map No. 291A of the Geological Survey of Canada, and was considered to be the basal member of the Bruce series. The complete conformability of this unit, as determined in Baldwin township by Thomson, and its lithologic nature, would deny that it is a basal conglomerate.

At two localities on, and west of, the north end of Wabagishik Lake in Nairn township, large ripple marks were observed in the quartzitic top of the lower boulder conglomerate. These megaripples have a maximum amplitude of 6 inches and a maximum wavelength of 2 feet, and are symmetric or slightly asymmetric.

Photo 5

Megaripples on a dip slope near the top of the lower boulder conglomerate in lot 4, concession III, Nairn township. Note the small patches of fine material in the troughs of the ripples, at the knife and above it in the next trough.

Near the contact with the large basic sill separating the lower argillite and lower boulder conglomerate units, the conglomerate is spotted brown because of the development of granoblasts of biotite.

This conglomerate measures 600 feet thick in Nairn township.

MIDDLE GREYWACKE UNIT

Greywacke (4f) and Argillite (4a)

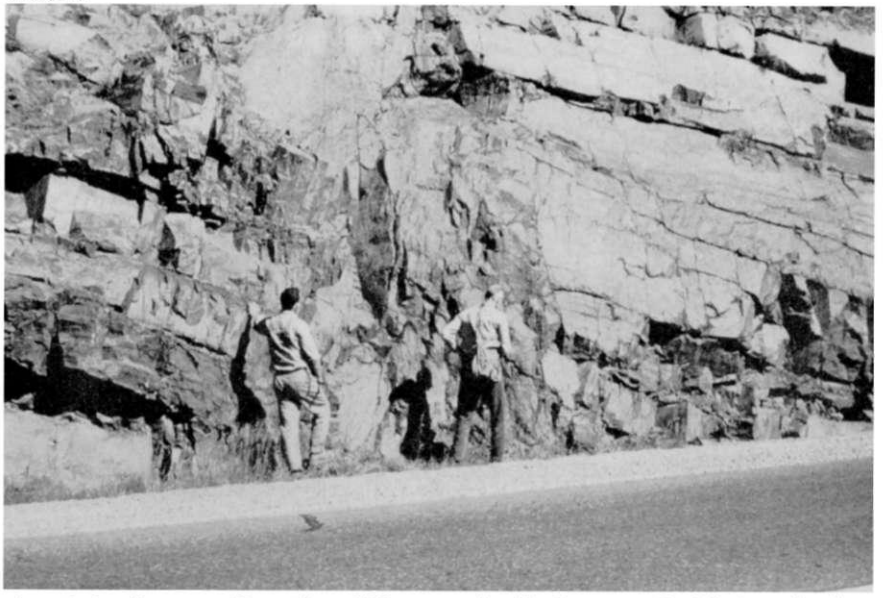
As already noted, the contact between the lower boulder conglomerate and the overlying argillaceous rocks is transitional across a few feet. The middle greywacke unit is almost similar to the lower argillite unit below the lower boulder conglomerate. However, whereas the principal rock types within the lower argillite unit are siltstone and argillite with minor greywacke intercalations, the middle unit is composed dominantly of greywacke with only minor interbeds of fine-grained clastic rocks.

The greywacke commonly consists of a granular mixture of quartz (25 percent) and feldspar (10 percent) measuring 0.12–1.0 millimetres in diameter, in

a silty argillaceous matrix. Sphene and magnetite were observed as accessory minerals. A few cordierite porphyroblasts were observed in the middle greywacke in contact with basic intrusive rock on the west shore of Wabagishik Lake in Nairn township.

Beds of greywacke are up to 1½ feet thick but are more common at about 8 inches thick. No crossbedding was observed in this unit. Ripple marks are present within this stratigraphic unit.

Photo 6



A vertical sedimentary dike cutting middle greywacke. Mr. Rogers, on the left, has a hand on one contact of the dike; the other contact is to the right of Professor Moorhouse. Lot 11, concession IV, Lorne township.

At the top of the middle greywacke unit there is a gradual decrease in the fine-grained fraction of the greywacke so that the rock becomes a subgreywacke. Designated as 3a, this rock type was recognized by a weathered surface, lighter in colour than the fresh rock, with a dark zone separating the bleached and the fresh rock. Unlike the greywacke, which can be scratched easily with a knife or pick, the subgreywacke is hard and can be scratched only with difficulty or not at all.

A sedimentary dike was found to cut the middle greywacke unit south of Bell Lake in Lorne township. Although reported by Collins (1925), Quirke (1917), and Pettijohn (1957), to cut overlying rocks (the Espanola and Serpent formations), dikes have not been reported to cut other formations in this area. During the mapping of Porter township, similar dikes were found cutting the granite west of Porter Lake. The greywacke of these dikes is very similar to that of the matrix of the lower boulder conglomerate.

The middle greywacke unit has a minimum thickness of 1,600 feet in Nairn township.

MIDDLE QUARTZITE UNIT

Quartzite (3)

Most of the quartzite in this area that had previously been mapped as Mississagi quartzite (G.S.C. 1938) is here referred to as the "middle quartzite". This stratigraphic unit is widespread in Porter township. The quartzite in Baldwin and northwestern Nairn townships is, however, much lower in the stratigraphic succession.

The subgreywacke (3a) described in the preceding section is a transitional rock between the middle greywacke and the middle quartzite. The appearance of both normal and planar crossbedding commonly coincides with the appearance of the subgreywacke unit. The subgreywacke unit ranges in thickness in these townships up to 600 feet.

The contact between the subgreywacke and middle quartzite is abrupt in Nairn township, and interfingering in Lorne township. The subgreywacke can be considered a member of the middle quartzite unit.

The feldspathic quartzite, which forms the principal member of the middle quartzite unit, is very well-bedded, the beds ranging in thickness from less than 1 to 6 feet. Because of intercalations of softer argillite, the quartzite commonly is exposed as a series of cuesta-like ridges, the dimensions of which are controlled by the dip of the strata and the thickness of the resistant beds.

As has been mentioned previously crossbedding, which is typically planar or torrential, is abundant in this formation. Planar crossbedding was observed outside the middle quartzite only rarely at the very top of the lower quartzite unit.

Grain gradation was noted at many places in this unit, both in planar cross-beds and in beds exhibiting no cross-lamination. Ripple marks are rare in this unit, and those seen are of such large dimensions that the term "megaripple" is applicable. Local disconformities in the form of channel scours were observed at several locations.

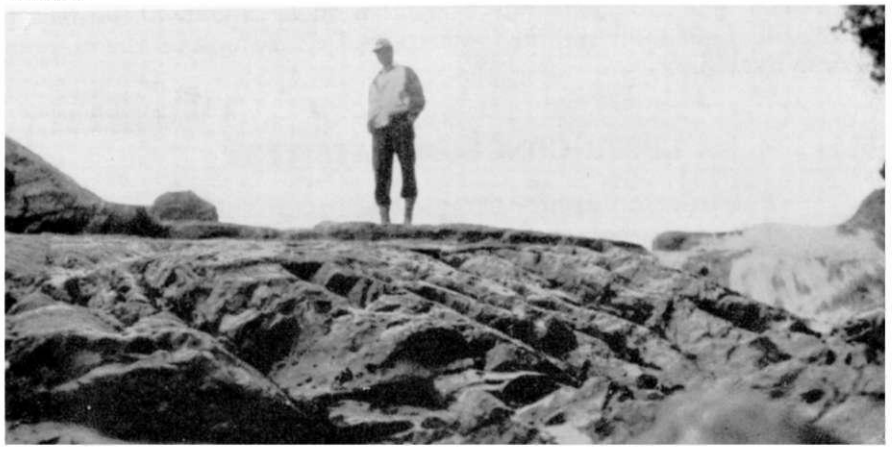
The fresh rock was commonly observed to have a greenish cast and a faintly pink-weathered surface. A common feature of this unit is the presence of widely disseminated pyrite cubes measuring up to ¼ inch across. Such cubes are so widespread, and are not restricted to bedding planes or joints, that they are believed by the author to be authigenic. Because of the presence of such sulphide crystals, the weathered surface of the middle quartzite unit commonly has a slightly pitted surface, with rusty haloes about the pits.

Pebble beds are found throughout the upper portions of this unit, but are not common. Most commonly of quartz, the pebbles are well-rounded and well sorted, usually measuring about ½–1 inch in diameter. A few granite pebbles were seen in such beds, but are rare.

As seen in thin section, the quartzite has a granular texture. In some localities the rock has not been seriously recrystallized, and the grains exhibit sutured boundaries where replaced by siliceous cement. More commonly the rock has been completely recrystallized, destroying the original outlines of the grains and the nature of the cement.

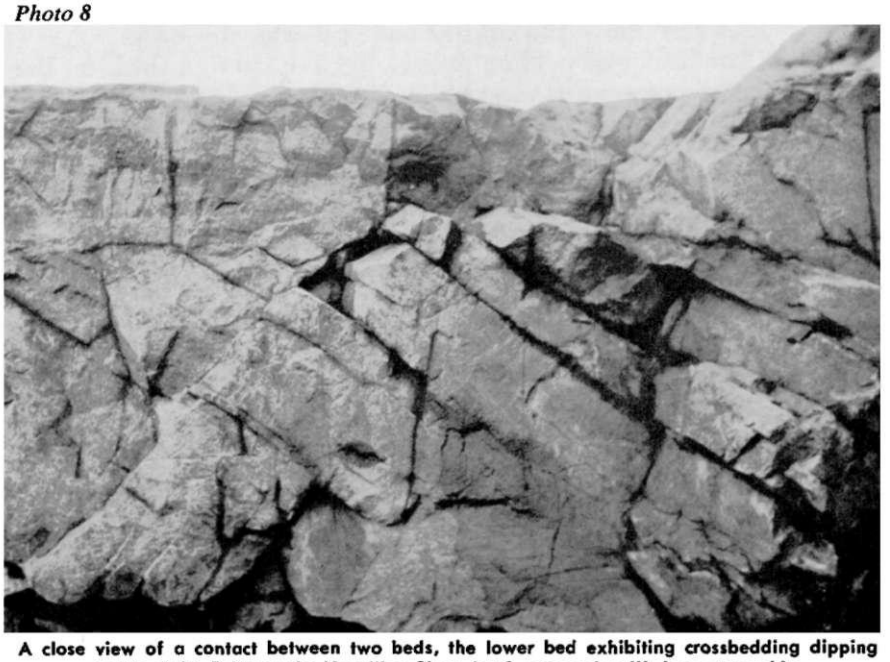
Accessory minerals other than pyrite are present in very small amounts and include tourmaline, apatite, magnetite, and sphene.

Photo 7



View of a horizontal bed of middle quartzite bounded above and below by dip slope surfaces. Note the planar crossbed planes to the right within the bed. Falls on the Vermilion River, lot 8, concession III, Lorne township.

Photo 8



A close view of a contact between two beds, the lower bed exhibiting crossbedding dipping to the right. Falls on the Vermilion River, lot 8, concession III, Lorne township.

The upper contact of this quartzite unit in Lorne township is marked by a darkening of colour and the appearance of pebbles and boulders within 1 or 2 feet. There is no evidence of disconformity at this contact.

The middle quartzitic unit was calculated to be about 10,700 feet thick between the Ella Lake fault and the lower contact of the unit on the east boundary of Lorne township.

UPPER CONGLOMERATE UNIT

Polymictic Boulder Conglomerate (2b) and (2c)

These two lithologic units are grouped as a single stratigraphic unit that was mapped by Collins (G.S.C. 1938) as Bruce conglomerate. Thomson (1952) recognized a Bruce-type conglomerate, designated 2b, in Baldwin township. As noted by Ginn in Porter township, on the basis of lithology, both the Bruce-type 2c, and the Ramsay Lake-type 2b, are found at this stratigraphic position.

As described in a previous section, type 2b conglomerate is characterized by a gritty, buff-coloured subgreywacke matrix enclosing angular to rounded cobbles and boulders. This rock type occurs at the bottom of the upper boulder conglomerate unit in Lorne township, grading upward into type 2c conglomerate. The latter rock has an argillaceous greywacke matrix and commonly contains more, larger, and better-rounded boulders than the 2b conglomerate. The 2c conglomerate characteristically has a rusty-weathered surface. No bedding was observed within this unit in Lorne township. The boulders are up to 2 feet long and are dominantly of granite. A few quartzite cobbles were observed. Larger boulders were found by the author in this unit in Porter township.

The upper boulder conglomerate unit is about 1,150 feet thick on the limb of the Red Pine syncline southeast of Ella Lake.

UPPER ARGILLITE UNIT

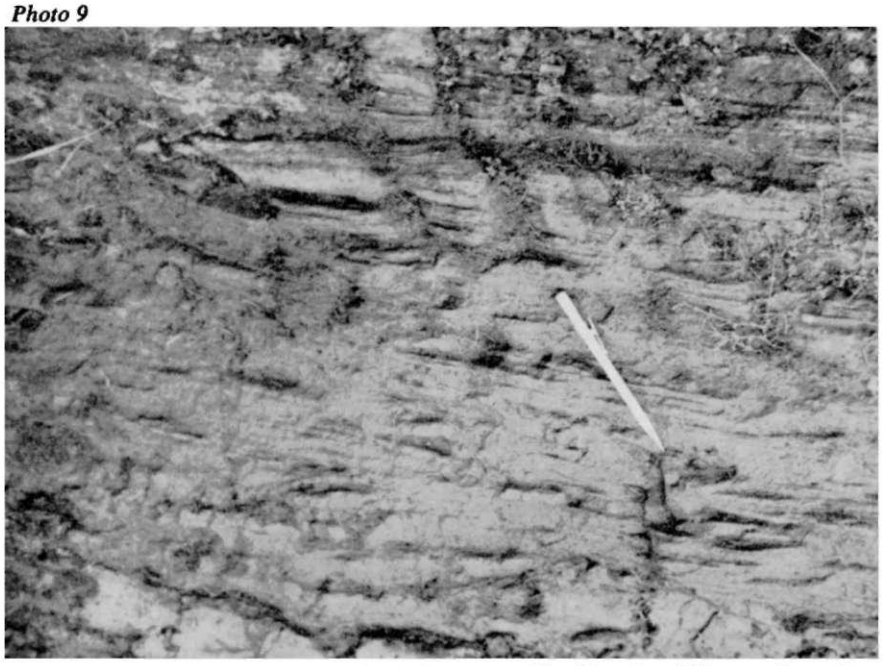
Argillaceous Limestone (4d), Calcareous Argillite and Siltstone (4a), Hornfels (4e)

The upper argillite unit differs from the two lower units of fine-grained sedimentary rock in that it is calcareous throughout. Calcareous material was detected in the lower argillite unit at only one location, and not at all in the middle greywacke unit.

The lowermost member of the upper argillite unit, mapped by Collins as the Espanola formation, is a rusty-weathering, bone-white limestone with narrow silty intercalations. The silty layers are more resistant to weathering, so that outcrops of this rock are characteristically ribbed. The limestone member most commonly occurs immediately upon the upper boulder conglomerate. The conglomerate is calcareous at the top of the formation, and at the west end of Margaret Lake in Lorne township some limestone occurs within the conglomerate either as an intercalation or as a downfold. The limestone has deformed readily and is commonly tightly crenulated.

Limestone beds occur throughout the upper argillite unit. The argillaceous and silty rocks are well-bedded, but only rarely exhibit ripple marking. Autoclastic breccia was observed in a bed of argillite between undeformed beds west

Photo 9



Argillaceous limestone, lot 2, concession I, Lorne township. Note the ribbing on the surface resulting from the more readily weathered limy bands.

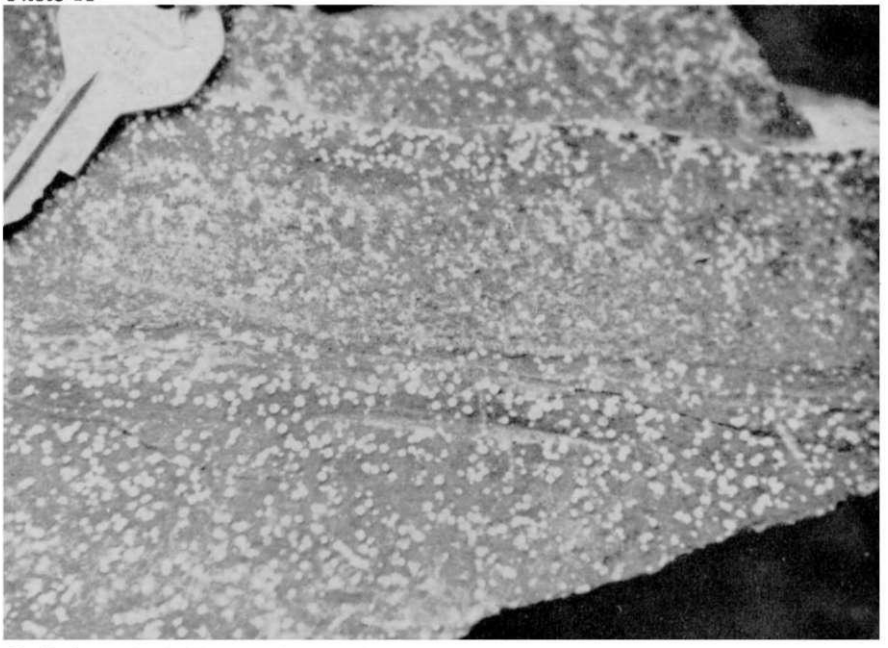
Photo 10

Concretions in calcareous siltstone, lot 2, concession I, Lorne township.

of Margaret Lake. Concretions in the calcareous siltstone were seen at several localities in southeastern Lorne township.

Cordierite-anthophyllite hornfels was found in the upper argillite unit close to a gabbro sill west of Margaret Lake. The light-grey cordierite porphyroblasts are up to ¼ inch in diameter and give the rock a spotted appearance. In thin section the cordierite is poikiloblastic, with inclusions of plagioclase and quartz, and exhibit characteristic radial twinning with 120 degrees between composition faces. The remainder of the rock is composed of columnar to fibrous anthophyllite, oligoclase feldspar, quartz, and biotite. Of limited occurrence in this unit in

Photo 11



Cordierite-anthophyllite hornfels developed from argillaceous rocks by metamorphism by a gabbro sill in lot 3, concession II, Lorne township.

Lorne township is feldspar-quartz-amphibole-epidote hornfels, a rock relatively common in Porter township. This rock is hard, tough, fine-grained, and finely banded in black, green, pink, and white. Both of these metamorphic rocks belong to the cordierite-anthophyllite subfacies of the amphibolite facies. The orthoclase-hornblende hornfels has an excess of K_2O, and the cordierite-anthophyllite hornfels is deficient in K_2O.

Assuming that the gabbro sill west of Margaret Lake did not assimilate any of the upper argillaceous rocks, this unit is calculated to be 1,060 feet thick.

UPPER QUARTZITE UNIT

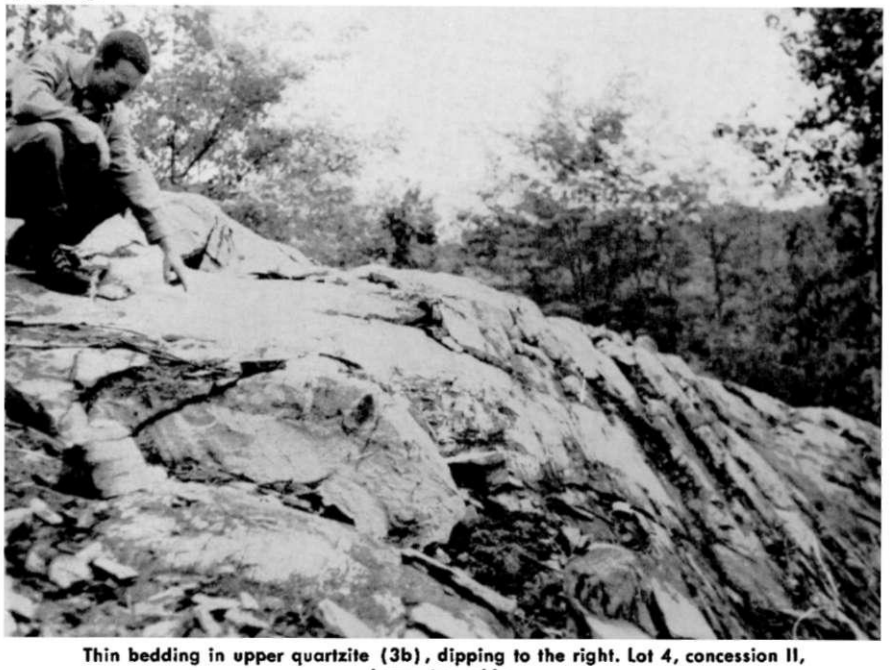
Subgreywacke (3a) and Quartzite (3b)

As with the middle greywacke and middle quartzite the upper argillite is separated from the upper quartzite by a light-weathering, hard subgreywacke. The upper subgreywacke is slightly finer in grain than the subgreywacke lower in

the stratigraphic sequence. Characteristically, it is calcareous and exhibits relatively thin bedding, the beds being up to ½ inch thick. This rock is exposed only in southeastern Lorne township in this map-area.

The upper quartzite, mapped by Collins as Serpent quartzite, grades from the upper subgreywacke by a gradual decrease in the amount of carbonate, silt, and clay in the rock. A sample from lot 6, concession I, Lorne township is composed of 60 percent quartz, 34 percent potassic feldspar, and 6 percent plagioclase feldspar, with trace amounts of sericite and chlorite. This rock is usually easily recognized by its characteristic narrow banding within beds several feet thick and

Photo 12



Thin bedding in upper quartzite (3b), dipping to the right. Lot 4, concession II, Lorne township.

by its dull-white porcellaneous-weathered surface. The fresh rock is usually translucent and pale grey or pale green in colour.

This formation is not uniformly fine-grained. Lenses of grit and fine-grained conglomerate were observed in lot 5, concession I, Lorne township. Layers of pebbles only one pebble thick were noted. The elliptical pebbles are dominantly of chert, though some granitic pebbles are found, which are up to ½ inch in length.

Crossbedding, ripple marks (with maximum wavelengths of 1½ inches) and channel scours were seen in this formation. Channel scours commonly are 1½-4 feet wide and 3–8 inches deep.

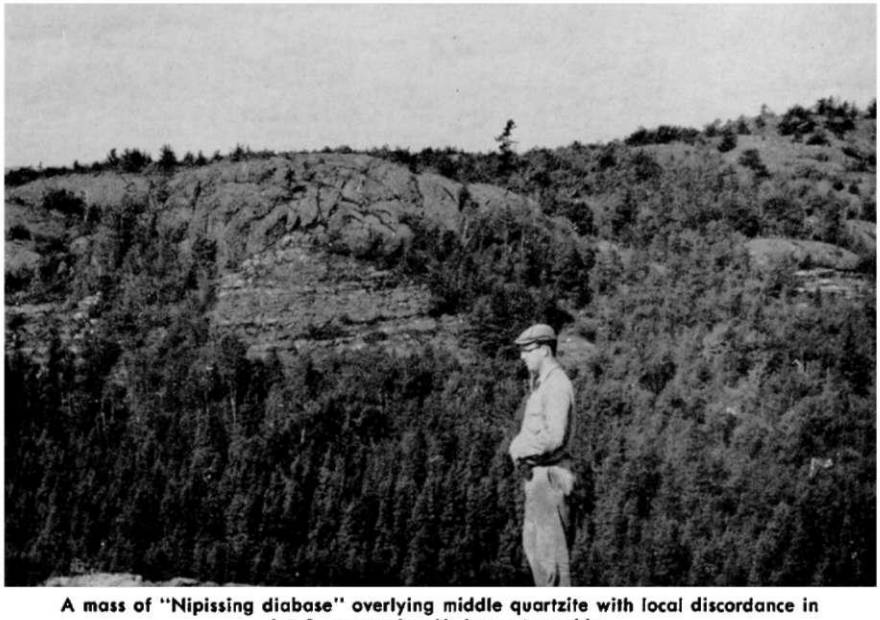
Because there is no upper contact of the upper subgreywacke and upper quartzite unit, a minimum thickness of only 3,570 feet was calculated in Lorne township.

Post-Sedimentary Intrusive Rocks

BASIC INTRUSIVE ROCKS

Three major types of basic intrusive rock occur in Nairn and Lorne townships. The youngest rock in the area, olivine diabase (7), forms northwest-trending dikes. Perhaps related to these dikes is the second type of basic rock, also an olivine diabase, but occurring as two pods within a sill of metagabbro. This second type of rock, commonly referred to as Nipissing diabase, is the most abundant basic intrusive rock in the two townships, and indeed in the whole area.

Photo 13



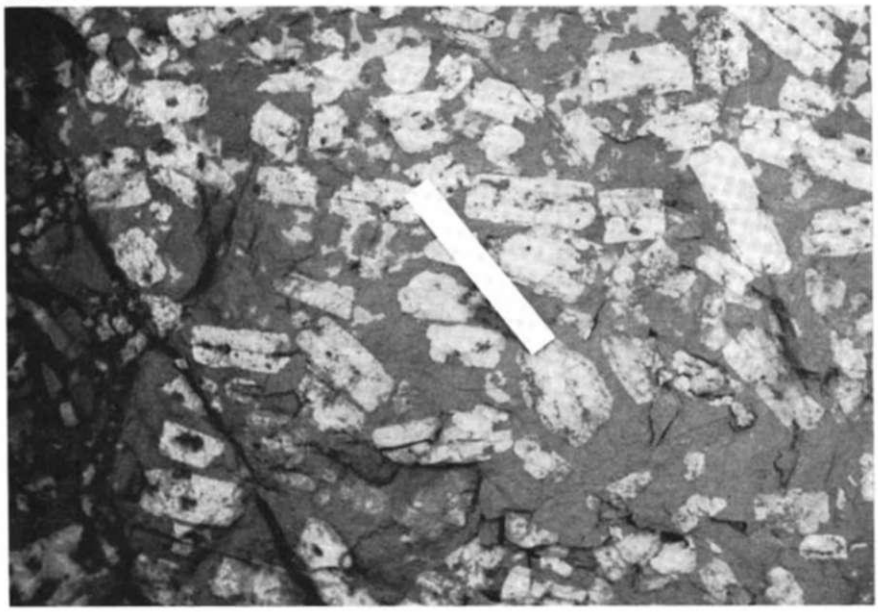
A mass of "Nipissing diabase" overlying middle quartzite with local discordance in lot 8, concession V, Lorne township.

Nipissing diabase, designated 5a on the accompanying lithologic maps, commonly occurs as concordant masses within the sedimentary rocks. Where it is seemingly discordant, the basic rock occupies fault planes or zones. The rock is medium- to coarse-grained and, on the weathered surface, is characterized by a grey-white and green-black, salt-and-pepper texture. In some of the samples studied the slightly saussuritized plagioclase grains are euhedral and enclosed by hornblende or uralite. In most of the samples the plagioclase grains are anhedral and equigranular, with femic minerals. Felted chlorite and sericite are common, and clinozoisite and epidote are abundant. The hornblende is usually green and tattered, with associated irregular grains of magnetite. The freshest plagioclase observed was zoned, with the composition of the core An_{70}, and that of the rim An_{36}. Other samples contained plagioclases of compositions An_{56}, An_{50}, and An_{51}. Quartz grains, though not abundant, are common within this rock.

A few occurrences of granophyre were observed within masses of metagabbro. More common within the basic rock is a light cream-coloured rock in contact

zones with greywacke. The rock is common in Nairn township near the lower boulder conglomerate, and is indicated to be the result of assimilation of the sedimentary material by gabbro. Supporting this explanation is the common presence of pebbles within the acid rock. As seen in thin section such rock has a decidedly metamorphic texture, being a granoblastic aggregate of plagioclase, quartz, chlorite, poikiloblastic hornblende, sphene, clinozoisite, and carbonate. Only clinozoisite and sphene were observed to be euhedral. No potassic feldspar was detected in the rock. The amount of plagioclase present varies from sample to sample, but this mineral always occurs as large anhedral grains containing

Photo 14



Coarsely porphyritic olivine diabase (7a) in a rockcut on highway 17, one mile east of Nairn Centre. The rule shown is 6½ inches long. Note the dark books of biotite included by feldspar phenocrysts.

abundant, rounded grains of quartz. No quartz grain was seen to be in optical continuity with its neighbours.

The concordant olivine diabase was seen to be chilled against the Nipissing metagabbro all west and east of Jacobi Lake in Nairn township. Many contacts between the two basic rocks were so indistinct and poorly defined that the younger diabase could not be well outlined by mapping. Designated 3b on the accompanying lithologic map of Nairn township (No. 2062, *Sudbury*), this rock has a chocolate-brown weathered surface, a dark brown to black fresh surface, and has a greater specific gravity than the Nipissing metagabbro. In texture and composition this rock is identical to the late diabase dikes, of which some were seen to cut the concordant diabase (3b). However, the rock is exposed as large smooth outcrops dissimilar to the spheroidal-weathering diabase dikes.

The olivine diabase dikes, designated 7 on the accompanying map, are of the type commonly known as Keweenawan diabases, and are the youngest Precambrian rocks in the area. They exhibit the jointing and spheroidal weathering

to rusty-granular soil that are characteristic of such dikes. The surface expression of these dikes is commonly as linear valleys. Anhedral grains of olivine occur within pigeonite and zoned labradorite in the rock. Many of the plagioclase laths are enclosed by grains of pigeonite. Magnetite and apatite are accessory minerals. Except for minor chloritic alteration along fracture walls, the rock is extremely fresh. Several dikes to the east of Nairn Centre are porphyritic (7a), with phenocrysts of plagioclase up to 6 by 2 inches. Associated with these large crystals are books of biotite mica, as shown in Photo 14. There is no evidence that any of these dikes have been faulted.

Flesh-pink to brick-red granophyre was observed within diabase dikes cutting subgreywacke in lot 9, concession II, and lot 2, concession V, Lorne township. Quartz exists as graphic intergrowths in badly kaolinized and sericitized feldspar. Much of the biotite has been altered to penninite and magnetite. Although some plagioclase was identified as albite, some feldspar is so altered that it could not be identified as either orthoclase or plagioclase. Sphene and clinozoisite occur as accessory minerals.

NICKEL IRRUPTIVE

Worthington Offset Dike

The Worthington quartz-diorite offset dike has definitely been traced southwest from the Victoria mine in Denison township to just north of the Lorne-Drury township boundary, along a length of over 5 miles. At its south end it appears to pass beneath a small lake in lots 3 and 4, concession I, Drury township.

A dike of metagabbro represented by 6 on the accompanying geological map of Lorne township was found to continue southwest along the projected trend of the Worthington offset. The dike passes without interruption across the Murray fault, but appears to stop at the Bell Lake fault in lot 5, concession VI, Lorne township.

It would seem logical to name this dike the Worthington offset. It contains inclusions of country rock, as do the offset dikes; however, it does not contain appreciable sulphide minerals, and is different in mineralogical composition from recognized offset quartz diorite. The accompanying table, modified after Collins (1934), illustrates this compositional difference:

ROSIWAL ANALYSES—CALCULATED MASS

	Sp. Gr.	I	II	III	IV
		percent	percent	percent	percent
Hornblende	3.1	27.7	37.9	36.2	65.7
Biotite	2.9	14.0	11.6	5.4	4.88
Plagioclase	2.65	43.9	34.8	45.6	17.6
Quartz	2.65	12.0	10.9		1.75
Micrographic intergrowth	2.6	0.5	1.0	6.3	——
Titaniferous magnetite	5.0	1.0	3.2	4.7	5.05
Apatite	3.2	0.2	0.05	1.0	——
Sulphide	4.5	0.7	0.5	0.7	——
Sphene	3.2	0.2	0.2	0.1	4.30
Chlorite	2.85	——	——	——	0.94
Total		100.2	100.15	100.0	100.22

I—Copper Cliff offset, west of Lady MacDonald Lake.
II—Copper Cliff offset, west of Copper Cliff townsite.
III—Foy offset, lot 6, concession III, Bowell township.
IV—"Worthington offset?", lot 4, concession VI, Lorne township.

Sample IV, from Lorne township, contains much more hornblende and sphene than the three samples of quartz diorite. The plagioclase content of the Lorne rock is also less than half that of the quartz diorite. The Lorne rock resembles samples of "Nipissing" metagabbro studied from Porter, Baldwin, Nairn, and Lorne townships. Furthermore, Collins (1934) describes the hornblende of the quartz diorite as a primary constituent, not secondary after pyroxene, and of deep brown colour. The hornblende in the sample of rock under discussion is pale-to medium-green, tattered and uralitized, with associated chlorite. Thus it is concluded that the metagabbro dike in lots 4 and 5, concession VI, Lorne township is not the continuation of the Worthington offset dike.[1]

After the author left the field in 1958, International Nickel Company of Canada Limited, staked a number of claims north of Bell Lake, and drilled five holes, totalling about 5,830 feet. These drillholes explored a quartz diorite dike believed to be the Worthington offset. No such dike was recognized north of Bell Lake by the author or his senior assistant, D. P. Rogers.

Cenozoic

The areas between outcrop are commonly covered by glacial sand, silt, and clay, which were probably deposited during the Valders substage of the Wisconsin stage of Pleistocene glaciation. Much of the plain flanking the Spanish River is at an elevation of 650–750 feet above sea level, and consists of silty sand. There are several deposits of well-washed gravel on this plain, but no attempt was made during the mapping of Nairn and Lorne townships to relate these deposits to any geological feature. In Lorne township, at elevations between 750 and 800 feet, much of the soil is silty clay. Several areas of muck were found along poorly drained watercourses. The two largest areas of muck are in lots 8, 9, and 10, concession VI, Lorne township, and in lots 2, 3, and 4, concession IV, Nairn township.

STRATIGRAPHY

The stratigraphic problems of the area east of Cutler, including the sedimentary rocks south of Sudbury, have been well discussed by Thomson (1952; 1960b) and Phemister (1956). The age of these sedimentary rocks is the subject of some controversy in this area. The stratigraphic succession and lithologic nature of the rocks led Collins (1925) to assign them to the Bruce and Cobalt series deposited during the Huronian period. The principal difficulty with this interpretation is that the surface of unconformity obviously separating the Bruce sedimentary rocks from the Archean rocks in the Blind River–Bruce Mines region could not be located in the Espanola–Sudbury region. Collins believed that the Ramsay Lake conglomerate (the lower conglomerate 2b of this report) was the basal formation of the Bruce series in this area. Cooke (1946) offered a solution to the unconformity problem by indicating that a large fault separated the Ramsay Lake conglomerate and higher stratigraphic formations from the older rocks in

[1] In 1961, K. D. Card traced the Worthington offset southwesterly through Drury township (O.D.M. Map P-134) to join this dike in Lorne township. In order to fit together the geology of Drury and Lorne townships, this dike is shown as a continuation of the Worthington offset on the accompanying map (No. 2062) and the map-legend is revised to show this rock unit.

the Sudbury area. Phemister (1956, pp. 112, 116) has since reported that the evidence of such a fault is not at all conclusive, and in fact he claims "there is no justification for Cooke's great fault within the area mapped."

In the course of mapping Baldwin township Thomson found, as others had found closer to Sudbury, that the Ramsay Lake conglomerate overlies the rocks, called by Collins the "Sudbury series", with complete conformability. Thomson (1953, p. 18) has concluded that: "If it were agreed that the volcanics [in Baldwin township] are Keewatin in age, then the entire sedimentary series would be pre-Huronian or roughly equivalent to the Timiskaming series of other parts of northern Ontario."

Ginn (1961) agreed with Thomson that in Porter township, as in Baldwin, two groups of layered rocks are recognizable. The older group consists dominantly of lavas, with interbedded garnetiferous schist, immature conglomerate, and quartzite. The younger group consists of sedimentary rocks, which have been locally metamorphosed by basic intrusions and sheared in fault zones. Ginn believes that the younger group unconformably overlies the Birch Lake granite and the older group of layered rocks.

The sedimentary sequence in Nairn and Lorne townships is identical in lithologic and primary structural nature to the younger group of layered rocks in Porter township. It is true that a number of large faults interrupt the succession through southern Porter and northern Nairn townships, but because of the improbability of two stratigraphic sequences so similar and of so close a geographic relationship being of different ages, the author has little concern about correlating sections across the area. Figure 2 shows the correlation of five sections in the area north and east of Espanola. These sections were measured along the surface, and are presented in columns extending down from the highest stratigraphic unit. Strike faulting in the argillaceous rocks in southern Baldwin and Nairn townships has made accurate estimates of thicknesses of these units impossible. Thus the greatest thickness of a unit within any fault block is presented, representing a minimum possible thickness of the unit in the area.

Thomson has issued an excellent review of the nature of the rocks of the Huronian system and of the unconformity separating Huronian rocks from Archean rocks. He refers to such an unconformity in concession V, Baldwin township (Thomson 1960a, p. 9). Using map No. 1952-1 of the Ontario Department of Mines as a guide, the author visited several localities in 1958 in an attempt to explain the apparent conformability of the rocks in Baldwin township. In Porter township to the north there is evidence of unconformity between the sedimentary group and the older group of volcanic and metasedimentary rocks. An unconformity was located in the south half of lot 5, concession IV, Baldwin. township. The uranium-bearing quartz-pebble conglomerate at this location was investigated by Plum Uranium and Metal Mining Company Limited in 1954, and is described by Thomson (1960a, pp. 35, 36) and by Ginn (1960, pp. 44–46).

On the basis of this surface of unconformity, located at several points in Porter and Baldwin townships, and on the basis of the stratigraphic sequence so similar to that in the type-area of Huronian rocks to the west, the author supports the interpretation that the sedimentary rocks in Nairn and Lorne may be correlated with the Bruce group of Huronian age. The stratigraphic succession of rock units is indicated on accompanying map No. 2062 and in the map-legend.

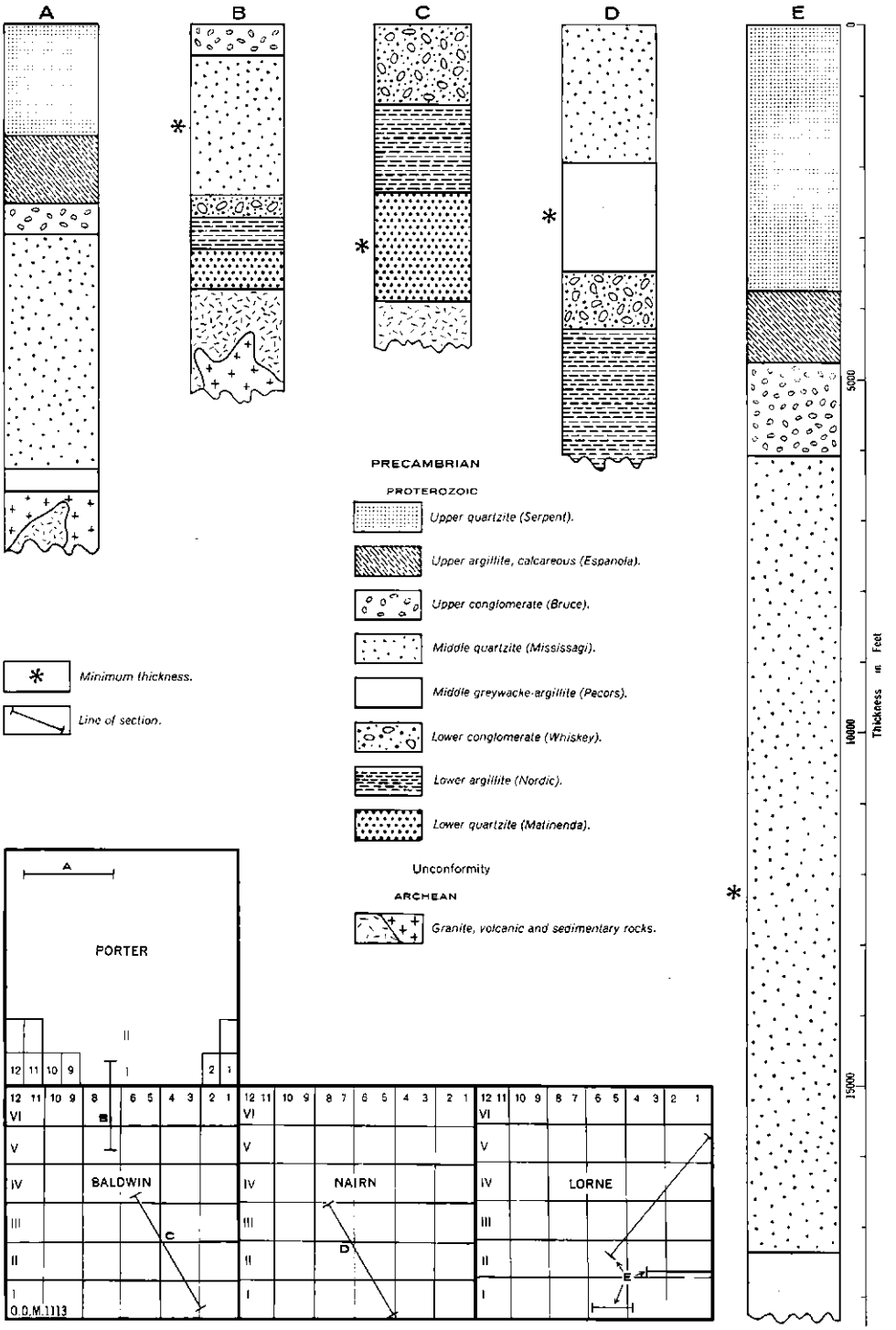


Figure 2 — Stratigraphic correlations of five sections in the area north and east of Espanola.

STRUCTURAL GEOLOGY

Primary Structural Features and Paleogeography

The primary structural features found in the sedimentary rocks have been mentioned briefly in the earlier part of the report considering the sedimentary rock units. They are reviewed here to disclose the paleogeography and sedimentary history of these Precambrian rocks.

Because the Precambrian strata are almost all dipping as a result of folding, the linear elements, which could be used to indicate paleogeography, are not horizontal. Such elements had to be returned to their original horizontal position by rotation about the strike of the beds by the magnitude of the dip. This was accomplished using a stereonet. The mechanics and justification of this correction are discussed by McDowell (1957, pp. 20, 23). These elements are plotted on the insert map on map No. 2062.

Asymmetric ripples are the product of current action. The gentle slope of the ripple is on its up-current side. The length of the ripple is almost perpendicular to the flow of current. The size of the ripple is generally proportional to the velocity of the current. Asymmetric ripples with a wavelength of about 1–2 inches were observed in the argillaceous siltstone in the Rock Lake area (*see* Photo 1) and just below Nairn Falls on the Spanish River. The sediment in these rocks is believed to have been transported from the east. The large megaripples (*see* Photo 5) were observed in the lower conglomerate in lot 3, concession II, Nairn township, and in the middle quartzite in lot 1, concession I, Nairn township, and lot 2, concession VI, Lorne township. At the first two localities the megaripples are somewhat asymmetric, indicating transportation of material from N.20°–30°E.

Symmetric ripples are formed in a standing body of water. The lengths of such ripples commonly reflect shoreline trends. Ripple marks with a wavelength of 1½ inches were observed in lot 11, concession III, Lorne township, in the middle greywacke. Megaripples were seen in the same stratigraphic unit in lot 2, concession III, Nairn township. At both localities the ancient shoreline trends are indicated to have been along the direction N.60°E. Megaripples are noted by Pettijohn (1957, p. 185), who observed that they are most common in fluvial environments. J. Satterly (personal communication) observed similar structures at Thurlestone Sands, Devon, England, caused by tidal action.

The origin of such coarse bouldery conglomerates as the lower conglomerate has been discussed by Pettijohn (1957, pp. 261–66). McDowell (1957, p. 31) has suggested that in the Blind River area it may be a tillite. The presence of megaripples suggests strong currents in an aqueous medium. The author suggests that the lower conglomerate resulted from a sudden flow of a bouldery muddy slurry. The continuity of this rock unit, now seen in a section that is at a large angle to the indicated direction of tectonic transport, indicates that it is an off-shore deposit. The attitude of the symmetric ripples supports this suggestion.

Planar or torrential crossbedding forms in fluvial environments, and is generally believed to have formed by the down-current migration of fore-set beds. Such crossbedding is shown in Photos 7 and 8. The crossbedding planes intersect in lines that are perpendicular to the direction of current flow and transport of

sediment. Twenty-eight plots of the direction of transport of crossbedded sediment are shown in the insert map on map No. 2062. Each plot is the average of at least three determinations. The direction of this line of intersection was measured in the field wherever possible. Only one occurrence of such crossbedding was seen in the lower quartzite, in lot 10, concession VI, Nairn township. The sediment was transported from N.10°E. Planar crossbedding is common in the middle quartzite, and the direction of transport is generally from the north and northeast. This indicates that the rivers that carried the sediment flowed from a northerly direction. It is the author's contention that the Birch Lake granite to the north was the source of much of the Precambrian sediment. The great thickness of middle quartzite in Lorne township, as shown in Figure 2, is suggestive of rapid settling in the depositional basin.

Mud cracks were recognized in the lower argillite in the Rock Lake area of Nairn township. This suggests that the sediment was deposited in an environment alternately immersed and elevated above water level, such as tidal flats. As mentioned earlier, the sediment in this rock unit is indicated by ripple marks to have been transported from the east. These ripple marks could have been formed by longshore currents.

The upper argillite, of calcareous composition, is correlated with the Espanola Formation. In Nairn and Lorne townships it is composed of thinly laminated limestone, siltstone, and argillite, with massive beds of graded greywacke up to 7 feet thick. Ripple marking and crossbedding are absent from this formation in the mapped area, although small oscillatory ripple marks were observed in Foster township, south of Wabagishik Lake. These rocks were deposited in a relatively quiet body of standing water.

In the upper quartzite, crossbedding, ripple marking, and channel scours are not uncommon, and indicate a moderately rapid contemporaneous erosion and deposition of material in fluvial or shallow subaqueous environments.

An impression of the shape of the miogeosyncline, in which the sediments were deposited, is obtained by considering the stratigraphic sections presented in Figure 2. In general the section thickens to the southeast. In northwestern Porter township the middle greywacke rests directly upon the basement pluton. As far as can be determined from the few complete sections of each formation, there is not only thickening of the section as a whole, but of each formational unit to the southeast. This indicates a consistent general regional slope to the south or southeast. This is in accord with the directions of sediment transport determined from primary structural features.

In summary, the sedimentary rocks of Nairn and Lorne townships are correlated with the Bruce group. They are believed by the author to have formed in a shallow miogeosyncline. Deposition of the quartzite formations may have been above or at sea level. Sedimentation was rapid in the presence of active currents during the deposition of the quartzitic rocks. Rapid sedimentation into standing waters formed the greywackes. Deposition of the limestones was in quiet waters and was accompanied by periodic introductions of poorly sorted sediment. The polymictic conglomerates are possibly the result of rapid transportation and deposition of continental and littoral debris caused by rapid continental uplift or, more likely, a shock wave. Evidence indicates that the lower formations at least were deposited from a northerly direction.

Imposed Structural Features

Fold axes, faults, and mineral occurrences are shown in Figure 3.

FOLDING

The principal regional structure is a broad anticlinal fold, or rather a series of folds, which could well be called an anticlinorium. The main axis of this structure occurs in the Baldwin anticline, located and named by Thomson (1953a) in Baldwin township. Although the axis in Baldwin township does not pass uninterrupted into Nairn township, the present author has named the corresponding principal axis of the anticlinorium structure in Nairn township the Baldwin anticline, realizing it may be incorrect to do so. The axes of the folds of this broad structure, in general trend a few degrees north of east and plunge slightly northeast. The folds are so interrupted by basic intrusions and faulting that it is not possible to state their symmetry or exact attitudes. Axes vary in both the magnitude and direction of plunge. However, the regional effect is certain. The oldest rocks occur in western and central Baldwin township, the younger rocks in the north, south, and east.

The axis of this structure passes across the northwestern part of Nairn township, so that most of the rocks in Nairn, Lorne, and southern Baldwin townships are on the southern limb of the anticlinorium.

As shown in Figure 3, the Baldwin anticline in northwestern Nairn township is truncated on the east by a discordant mass of metagabbro representing a fault zone, named the Merriweather fault. The Baldwin anticlinal axis and the flanking syncline on the south are not traceable east of the Merriweather fault. The metamorphosed argillite and siltstone east of the fault is generally flat-lying and gently folded, with no dominant axes developed.

South of the main regional fault, the Murray or Worthington fault, the principal structure is an anticline trending east-northeast, which has been cross-folded about a northwest anticlinal axis at Rock Lake, to form the Rock Lake dome. The major axis of this structure plunges about 40 degrees east-northeast and west-southwest. Because of the concordant mass of weathering-resistant metagabbro, the topographic expression of the dome is a hill.

Several small folds occur northwest of the Rock Lake dome and south of the Murray fault.

The fold axes in Lorne township generally trend northeast.A series of gently south-plunging folds east of Bell Lake are separated from the regional structure by faults. The dominant structure in the east-central part of the township is the Louise anticline, trending and plunging southwest. The Red Pine syncline in lots 5 and 6, concession I, Lorne township, is truncated on the south and east by faults (*see* frontispiece). The west limb of an anticline, the axis of which is in Louise township, is separated from the structures to the west and north by the Pistin Lake and Ann Lake faults respectively.

Generally all the folds are open and gently plunging. No overturned bedding was found, except to a slight extent near major faults.

FAULTING

Faults are numerous in this area. Field evidence of faults includes severe shearing, scarps, brecciation, and interruption of stratigraphy or structure by

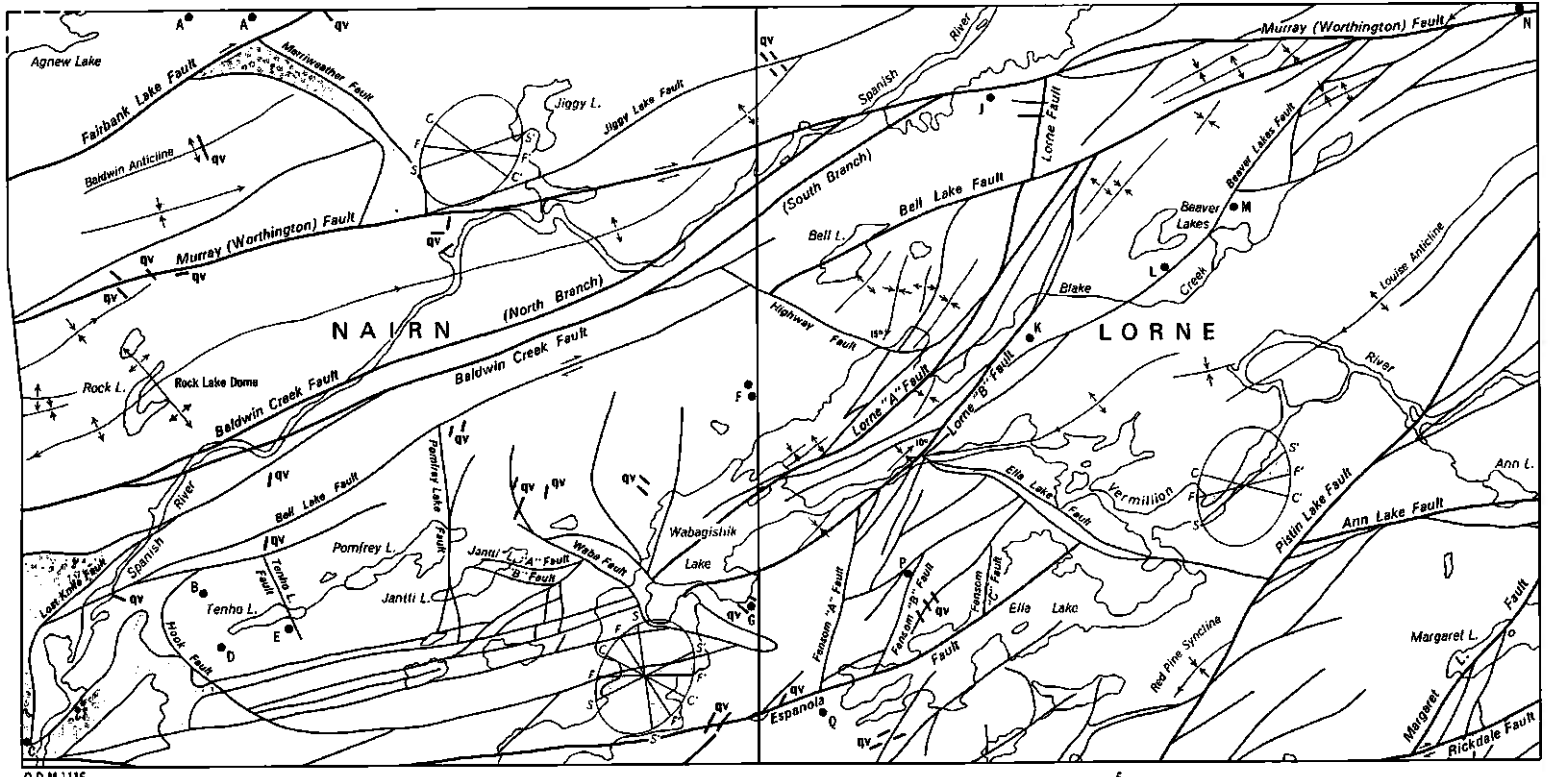


Figure 3 — Fold axes, faults, and mineral occurrences, Nairn and Lorne townships.

discordant metagabbro intrusions. Quartz stockworks with hematite stain are common in faults within such competent rocks as quartzite. Two types of breccia seen in faulted quartzite are shown (Photos 15 and 16). Faults in quartzite with argillaceous or silty intercalations are characterized by breccia consisting of rounded quartzite fragments in a matrix of relatively soft gouge. Faulting in the more homogeneous types of quartzite is marked by angular breccia fragments in a matrix of crushed quartz and sericite.

In the vicinity of faults the argillaceous rocks are schistose. Faulted basic intrusive rocks are marked by zones of unsheared gabbro fragments in a chloritic schist matrix.

The principal regional fault is the Murray fault, also called the Worthington fault, well described by Thomson (1953a, pp. 25, 26). The Murray fault is known to extend to Sowerby on highway No. 17, west of Iron Bridge (G.S.C. 1961: O.D.M. 1960, preliminary map No. P. 56).[1]

The other fault structure traced for some distance across the region has the same east-northeast trend as the Murray fault. In the map-area this structure is known as the Espanola and Ann Lake faults.

Although it would seem logical to join these two faults, on the basis of their similar alignment along a topographic linear (*see* frontispiece), there is no field evidence to support such a joining. Actually the shearing in the area between the Espanola and Ann Lake faults indicates that the northwest-trending Ella Lake fault interrupts the Espanola–Ann Lake structure.

There is a prominent system of faults trending northeast in Lorne township, including the Lorne fault system, the Pistin Lake fault, and the Margaret Lake fault. These faults appear to be a conjugate system, related to the principal east-northeast faults.

A set of north-trending faults in the southern part of Nairn township has a right-hand strike separation. The principal faults of this system are the Tenho Lake fault, the Pomfrey Lake fault, and the Lost Knife fault. The Lost Knife fault is seen as a discordant mass of metagabbro along the Nairn-Baldwin township boundary.

The final main set of faults trends northwest, and includes the Merriweather fault, the Waba fault, and the Ella Lake fault. These are seen for part or all of their lengths as discordant masses of metagabbro. The author contends that this northwest direction is the direction of regional compression and that the metagabbro intruded easily in dilated zones. The shear and tensional directions are indicated by strain ellipse diagrams (Figure 3).

Murray Fault

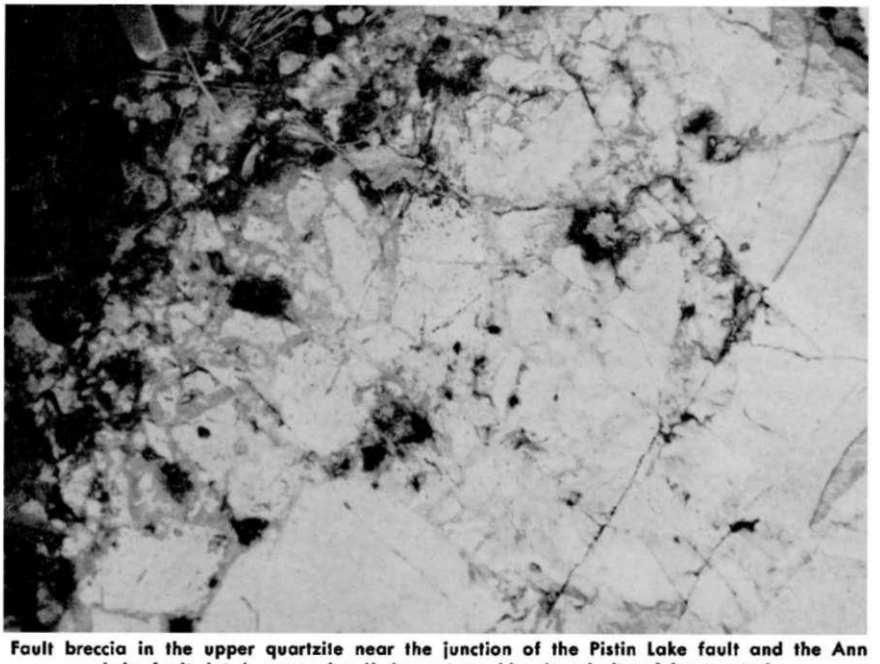
Although the Murray fault is well exposed in Baldwin township, and is described by Thomson (1953a) as the best defined fault system in that area, it is not conspicuous in outcrop in Nairn or western Lorne townships. This is probably because the underlying rocks in that area are argillaceous; where greatly sheared these rocks are readily weathered, and so are not exposed. However, in western Nairn township there is an obvious change in lithology across a broad lineament. Quartzitic beds in the neighbourhood of the fault characteristically are hosts for quartz veins and stockworks. In lot 5, concession V, Nairn township the meta-

[1]On preliminary map No. P.56, Phemister names this fault the Wanapitei fault.

Photo 15

Fault breccia in the middle quartzite, from the Lorne fault, lot 6, concession IV, Lorne township. The matrix is composed of cataclastic quartz and micaceous material derived from the argillaceous beds of the stratigraphic unit. The rounded shape of the fragments is typical of breccia in this unit.

Photo 16



Fault breccia in the upper quartzite near the junction of the Pistin Lake fault and the Ann Lake fault, lot 4, concession II, Lorne township. Angularity of fragments is typical of breccia in this stratigraphic unit.

gabbro is somewhat gneissic. Quartz veins cutting the greywacke have feldspathic margins, and stringers of albitite and epidote are common in both the sedimentary rocks and the metagabbro. Similarly in lots 7 and 8, concession VI, Lorne township the fault zone contains many irregular veins of epidote. Here the fault is marked by a prominent north-facing scarp and a huge breccia zone containing rounded fragments of quartzite, conglomerate, greywacke, and metagabbro. In lots 5 and 6, concession VI, Lorne township the fault is seen to have had post-metagabbro movement. Fragments of sedimentary rocks and metagabbro occur in fine-grained metagabbro, which is also locally sheared and brecciated. In the area of quartzite in eastern Lorne township the Murray fault is expressed as an obvious lineament, in which angular to subangular fragments of quartzite are enclosed in a matrix of cemented rock flour and white quartz veins and stockworks. No sulphides were observed in the fault zone.

In all areas along the fault the shearing is vertical. Dragfolding in lot 8, concession VI, Lorne township plunges 40°W., indicating that the north side of the fault moved east and down relative to the south side. This agrees with the sense of movement observed on several prominent faults in Porter township (Ginn 1961). The separation of the quartzite-greywacke contact zone in concession VI, Lorne township, is about 1½ miles. Thomson (1952) noted that, in Baldwin township and also in the Sudbury area, the north side has moved east about 5,000 feet.

Jiggy Lake Fault

The Jiggy Lake fault branches east-northeast from the Murray fault in lot 6, concession V, Nairn township. The junction of the two faults is in the large, northwest-trending mass of metagabbro of the Merriweather fault, and much of the Jiggy Lake fault is occupied by a relatively narrow metagabbro dike. The argillaceous sedimentary rocks and the staurolite schists of the lower argillite unit are well sheared and brecciated in the fault zone. In some areas, such as south of Jiggy Lake and in lots 1 and 2, concession VI, Nairn township, the bedding is truncated by the fault. In northwestern Lorne township a number of quartz veins in sets strike N.15°E. and N.30°W., adjacent to the fault. The shearing dips 40°–80°S. No determination of the direction or amount of movement was made.

Fairbank Lake Fault

Thomson (1953a) traced the Fairbank Lake fault northeast from its junction with the Murray (Worthington) fault in lot 8, concession III, Baldwin township, into concession V, Nairn township. In Nairn township the fault is marked by a prominent zone of schistosity dipping vertically to 65°S. Fragments of quartzite are enclosed in a sericite schist matrix. Irregular dikes of massive chloritic metagabbro cut across the shearing and breccia zones. There is local minor brecciation of the metagabbro. Although Thomson (1953a) observed a right-hand separation of contacts of only 700 feet, the lower quartzite in lots 9 and 10, Nairn township, has a right-hand separation of 4,500 feet. The explanation of this difference is that the sedimentary-volcanic contact displaced in Baldwin township is dipping 75°E., but in Nairn township the dips are about 40°E. Assuming that the movement on the fault was the same in Baldwin and Nairn townships, using apparent dips of strata at the fault, and using an average dip

of 65°S. for the fault plane, the author calculates that the movement on the fault has been vertical, the south block downfaulted relative to the north block, and that the net slip is about 2,400 feet.

Baldwin Creek Fault

The strongly sheared zone traced by Thomson (1953a) across the southern part of Baldwin township can be seen in a number of outcrops in concessions III and IV, Nairn township. In the vicinity of Nairn Centre there are two distinct nearly parallel zones of breccia and schist or slate separated by 700–1,200 feet of slightly sheared argillite and greywacke. These have been called the north and south branches of the Baldwin Creek fault, and they join the Murray fault in lots 10 and 11, concession VI, Lorne township. As seen in an outcrop on the south shore of the Spanish River, in lots 1 and 7, Nairn township, the north branch of the Baldwin Creek fault dips 60°–70°S. The south branch dips 80°–85°S. As Thomson noted, there has been some post-metagabbro movement; this is particularly evident in the sheared and brecciated character of the metagabbro in the south branch at Nairn Centre.

There is no indication of the direction or amount of movement on the fault. As noted by Thomson, there has been a minimum movement of 100 feet, the amount of offset of a vertical-dipping olivine diabase dike in Baldwin township.

Bell Lake Fault

The Bell Lake fault was traced from the Lost Knife fault in lot 12, concession II, Nairn township, east-northeast to its junction with the Murray fault in lot 3, concession VI, Lorne township.

Across Nairn township this fault is seen as a number of closely spaced shear zones, with bedding commonly dragged against the shears indicating right-hand displacement. In the Bell Lake area the fault zone is represented by a breccia zone with fragments of greywacke so well-rounded that the rock resembles a conglomerate. The matrix is composed of small pebbly fragments and rock flour. To the east of Bell Lake the breccia zone includes fragments of greywacke, argillite, subgreywacke, and metagabbro. Several metagabbro outcrops near the fault are well sheared. In lot 6, concession VI, Lorne township, the fault is seen on a prominent hill of breccia. Most of the fragments are of quartzite that has been feldspathized and silicified. The matrix of the breccia is rock flour and intrusive metagabbro, itself slightly brecciated and sheared. The breccia zone has been epidotized and hematitized.

The shearing along the Bell Lake fault is usually vertical, although locally it was observed dipping 60°S.

The Bell Lake fault has been displaced to the right by about 900 feet along the Highway fault at the Nairn-Lorne township boundary.

Lorne Fault System

A system of north-northeast-trending faults in the western part of Lorne township constitutes a major interruption of structure and stratigraphy in the area. Between the Bell Lake and Murray faults in lot 8 the Lorne fault is seen as a prominent breccia zone in outcrops of quartzite and metagabbro. It is dislocated by two east-west faults, probably related to the Murray fault.

South of the Bell Lake fault, the Lorne fault consists of a number of breccia zones and discordant masses of metagabbro. The two principal faults of this system are designated as the Lorne "A" and Lorne "B" faults on Figure 3 and on accompanying map No. 2062. The outcrop of these two faults is along north-northeast-trending scarps on hills of greywacke, quartzite, and metagabbro. As indicated by the nature of the fragments in the breccia zones, there has been considerable post-metagabbro intrusion movement.

The shearing along the Lorne fault zones is vertical. There is no evidence of the direction or amount of movement.

The Lorne "A" and Lorne "B" faults appear to end as major structures in the unsheared mass of olivine gabbro (5b) in the Waba fault zone in Nairn township. A number of strike faults west of the Waba fault might be the continuation of the Lorne fault system, but these are occupied by unsheared 5a metagabbro. Thus there has been no post-metagabbro movement along the faults, whereas the main Lorne fault system has experienced considerable post-metagabbro movement.

Beaver Lakes Fault

The Beaver Lakes fault is a prominent breccia zone trending northeast across Lorne township from the Lorne "B" fault at the Vermilion River to the Murray fault in lot 3, concession VI. It contains a number of quartz veins 2–20 inches wide, some of which are mineralized with sulphides. To the northeast of the Beaver Lakes, the fault separates opposite-facing beds of quartzite.

The shearing along the Beaver Lakes fault was observed to dip vertically to 70°NW.

At its southwest end, the fault has two branches. The breccia in the southern branch resembles conglomerate, with rounded fragments of metagabbro, quartzite, and greywacke in a matrix of gouge.

Espanola Fault

The Espanola fault, as already mentioned in this report, is a major regional structure, which crosses Nairn and Foster townships along their common boundary. Because it passes under Ella Lake in Lorne township, its trace to the east is uncertain. Vertical shearing and brecciated quartzite on the north side of a peninsula in lot 8, concession II, Lorne township, is the evidence indicating that the Espanola fault is cut off by the Ella Lake fault. This is the most likely location of the fault on the basis of field evidence. The fault does not appear to pass through the narrows at the southeast end of Ella Lake. There is some minor breccia and shearing, but the fault would have to bend considerably to miss undeformed outcrops and pass through the sheared quartzite.

In Nairn and Foster townships, and to the west, the Espanola fault is an obvious lineament. The fault zone west of Wabagishik Lake is 175–300 feet wide, consisting of angular fragments of quartzite from ½–24 inches long in a matrix of gouge and large white quartz veins. No sulphides were seen in these veins. As seen, east of Wabagishik Lake there has been post-metagabbro movement along the Espanola fault. The metagabbro is sheared, brecciated, and hematitized in the fault zone. Because it is a strike fault, there is no indication of the amount of displacement on the Espanola fault. In lot 1, concession I, Nairn township, tension fractures suggest a left-hand movement.

Ann Lake Fault

The Ann Lake fault in southeastern Lorne township seems to be as much a major regional structure east of the area as the Espanola fault is to the west. It is a prominent lineament, which separates the southwest-trending Louise anticline on the north from the west limb of a north-trending anticline on the south. The fault zone is occupied by a mass of metagabbro, but no evidence was observed indicating appreciable post-intrusion adjustment along the fault. No determination of the amount of movement between fault blocks could be made. The south side of the fault is downfaulted relative to the north side.

Rickdale Fault

The lineament of the Rickdale fault is evident on air photographs of southeastern Lorne township, south of Margaret Lake. It continues west-southwest through Truman township and east through Louise township. The fault is marked by a long narrow valley, across which contacts are separated, mostly to the right. The fault is also marked by almost vertical shearing and some breccia.

Pistin Lake Fault

The Pistin Lake fault, trending northeast across southeastern Lorne township, is a zone of major stratigraphic dislocation, and is similar in these respects to the Lorne fault system. The zone is an obvious lineament (*see* frontispiece), marked on the ground by angular breccia and numerous quartz veins and stockworks. This fault appears to be terminated by the Murray fault on the north and the Rickdale fault on the south. A number of branch faults were mapped east of this fault. Dragging on these branch faults indicates right-hand movement.

Margaret Lake Fault

The Margaret Lake fault is a cross-over between the Ann Lake and Rickdale faults through Margaret Lake in southeastern Lorne township. It is a lineament across which there is a displacement of contacts, and it is marked by breccia, silicification, and feldspathization.

North-Trending Faults

There are a number of relatively short faults trending within 20 degrees of north in the southern parts of Nairn and Lorne townships. These include the Lost Knife, Tenho Lake, and Pomfrey Lake faults in Nairn township, and the Fensom fault system in Lorne township. These are minor features, several of which will be discussed in the following section regarding economic geology. In the field the faults are characterized by breccia and shear zones. In general there is a right-hand separation of contacts, but no evidence was observed indicating fault movement. The Lost Knife fault has the greatest separation, and is unique in that it is represented by a discordant metagabbro mass.

Northwest-Trending Faults

There are three principal faults trending northwest in the area. These are the Merriweather, Waba, and Ella Lake faults, which all resemble the Lost Knife fault in that they are all seen as discordant intrusions of metagabbro, across which there is appreciable displacement of stratigraphic units and structure. These faults differ from the other faults of Nairn and Lorne townships, in that they lack extensive zones of breccia and shearing.

Because these faults have the same trend as many quartz-filled tension fractures observed in the area, and because of a virtual absence of shearing associated with the faults, the author regards them as dilational features parallel to the direction of regional compression. The dilation seems to have taken place over a period of time. The Merriweather, Waba, and Ella Lake faults are occupied by metagabbro, mostly undeformed. However, some parts of the Waba fault do contain sheared and brecciated metagabbro and adjacent sedimentary rocks. The Highway fault and the Hook fault, also having a northwest trend, offset the metagabbro sill separating the lower argillite and the lower conglomerate formations. The rocks must have been under northwest compression at the time of the intrusion of the olivine gabbro (5b) and olivine diabase dikes. The Waba fault contains unsheared olivine gabbro.

The Ella Lake fault is the one fault of this trend in which there is evidence of pre-metagabbro shear deformation. Southeast of the metagabbro-filled part of the fault the middle quartzite unit is greatly brecciated and sheared. The Ella Lake fault is terminated by the Lorne "B" and Pistin Lake faults, the three together separating the Louise anticlinal structure on the east from the Baldwin anticlinorium on the west.

Other Faults

There are a number of faults in the area that are not sufficiently exposed or extensive to warrant individual description. These minor faults are either branching or subsidiary shears related to one or more of the faults described earlier in this report.

Summary of Fault Features

The rocks of Nairn and Lorne townships are greatly faulted. The principal set trends north of east, with northeast cross-over faults, northwest tension faults and minor north faults. There is little evidence of the type of hydrothermal alteration that commonly exists in areas of epigenetic mineralization. Silicification, feldspathization, epidotization, and hematitization were observed in several of the more prominent fault zones. Sulphide mineralization was restricted to a very few secondary faults.

ECONOMIC GEOLOGY

Because of the proximity of Nairn and Lorne townships to the nickel irruptive, and because the Worthington offset dike has been traced to within 1,000 feet of the north boundary of Lorne, this area has received prospecting attention over the years. The author and his senior assistant, D. P. Rogers, examined a number of prospects, the descriptions of which follow. All prospects described have base-metal or barren sulphide mineralization.

Nairn Township

Prospect 1—Concession II, Lot 1

This prospect is in a patented lot near the south shore of a bay in Wabagishik Lake. Pyrite was found but no assays made.

An old pit was found measuring 12 by 3 feet.

The mineralized zone consists of pyrite in narrow quartz stringers across a a width of 12 inches, exposed for 6 feet, striking N.65°E., dipping steeply north, in greywacke and subgreywacke.

Prospect 2—Concession II, Lot 9

This prospect is on the north flank of a metagabbro ridge.

Massive and disseminated pyrrhotite and chalcopyrite were found in chloritic and amphibolitic gabbro in talus down the slope, and in a narrow valley just above the talus line. The prospect is a north-south sulphide vein, lacking quartz or carbonate gangue, 3 feet at the widest part, pinching out completely within 12 feet, so that no such mineralization was seen at the top of the hill.

A grab sample taken by author and assayed by the Laboratory Branch, Ontario Department of Mines, was: copper—0.94 percent; nickel—0.74 percent.

Prospect 3—Concession III, Lot 1

This prospect is in a patented lot on the boundary with Lorne township.

Three prominent excavations and a number of small pits were found. They are very old, judging by the oxidized condition of the broken rock. The north workings contain the remains of a timbered shaft at least 40 feet deep and a pit. A large pit is about 300 feet south of the shaft.

These showings are in "Nipissing" metagabbro, the mineralized rock being inclusions of partly assimilated sedimentary rocks, sheared along a N.75°W. direction. Narrow stringers of massive pyrrhotite and chalcopyrite follow the shearing, with minor disseminated sulphides throughout the inclusions. Some of the rock appears to be a granophyric phase of the metagabbro, but thin-section studies indicate a metamorphic rock resulting from alteration of sedimentary material.

A composite chip sample taken by the author from the shaft dump contained 2.92 percent copper and 0.41 percent nickel. The southern pit is in altered metagabbro immediately north of the contact with the lower conglomerate formation. A composite sample taken from the dump of the southern pit contained 0.12 percent copper and 0.58 percent nickel. (Assays by Laboratory Branch.)

Prospect 4—Fundy Bay Copper Mines Limited

This property is in lot 12, concession I, on the boundary with Baldwin townships.

The metagabbro of the Lost Knife fault zone was investigated by a magnetometer survey in 1956. Several small local anomalies were located in the area, with a reported magnetic relief of 2,500 gammas. One magnetic anomaly was checked by an electromagnetic survey, but no conductor was indicated.

Prospect 5—Keba Property

Keba property was held by Spanish Basin Mines Syndicate in 1928. It was staked and optioned to Falconbridge Nickel Mines Limited in 1953 and 1954. Geological and geophysical surveys were conducted in 1953.

The property is in lots 9 and 10, concession VI, on the boundary of Hyman township. Two small sulphide zones trending east-west, dipping steeply south are found in a mass of metagabbro (5a), which is exposed as two hills separated by 1,800 feet of drift-filled valley. The larger gossan zone on the west, ranges in width from 1 to 12 feet, and is exposed over a length of 530 feet. Disseminated pyrrhotite and chalcopyrite are present in inclusions of sedimentary rocks that have been largely assimilated by the metagabbro. Neither magnetometer nor electromagnetic surveys indicated zones of mineralization deserving exploration. Moore (1929) reported a sample of the sulphide-bearing rock to contain 0.68 percent nickel and no gold.

Prospect 6—Pays-Bas Prospecting Syndicate

This property was staked by the Pays-Bas Prospecting Syndicate in 1956. It is in lot 8, concession II, near the Tenho Lake fault. Magnetic, electromagnetic, and geological surveys were carried out.

Metals found are nickel and copper, but traces of gold, silver, platinum, and cobalt were detected. In a report by Hopkins Exploration Consultants, referring to trenches (II), 225 feet long and (III), 300 feet long, south of Tenho Lake, the assays are as follows:

Sample	Trench	Width	Nickel	Copper
		feet	percent	percent
1	II	8	0.46	0.14
2	II	8	0.37	0.92
3	II	8	0.11	0.25
4	III	12	1.28	trace
5	III	12	0.63	trace

A long north-south slab of amphibolite, a metasediment, was faulted south into metagabbro by the Tenho Lake fault. The adjoining "Nipissing" metagabbro is chilled against the amphibolite, indicating that the faulting occurred during gabbro intrusion. The amphibolite contains disseminated pyrite, chalcopyrite, and pyrrhotite. Traced by the author along a length of 400 feet, the amphibolite is almost 10 feet wide. It does not continue into the olivine gabbro sill to the south.

Prospect 7—Peterson Property

The Peterson property consists of the patented claim, the northwest quarter of the north half of lot 9, concession I. In 1955, Mogul Mining Corporation optioned the property, and carried out geophysical surveys, and drilled 13 holes, totalling 4,146 feet. The Mogul property included 44 claims in one block.

A mass of late olivine gabbro intrudes a sill of "Nipissing diabase" (metagabbro) between the lower conglomerate and middle argillite units. Several gossan zones are associated with inclusions of argillaceous sedimentary rocks or in

metagabbro that has assimilated sedimentary material. Of the numerous small pits in the area, the three on this claim are the most prominent—the northern pit measuring 150 feet long. The olivine gabbro to the south of the claim is expressed magnetically by an 800-gamma anomaly because of the high magnetite content of the rock.

The sulphide showings consist of pyrrhotite with minor chalcopyrite in altered gabbro. Except for two holes drilled immediately under the surface showings, no assays for copper or nickel were obtained from drill core. The maximum nickel assay noted in drill logs obtained from Mogul Mining Corporation was 0.05 percent. The maximum copper assay was 0.57 percent.

The electromagnetic anomaly disclosed by a survey for Mogul Mining Corporation does not reflect any surface showings, but rather was traced across the property along the south side of the gabbro ridge, at the north edge of a swampy valley. It is probably the result of swamp conductivity.

Lorne Township

Prospect 8—Bell Lake Nickel

This prospect is in lot 11, concession V. The following description written by A. Slaght, a former Inspector of Mines, is taken from the first report of the Ontario Bureau of Mines (Slaght 1891, p. 233).

> On lot number 11 in the fifth concession of Lorne township development work has been done in opening shaft No. 1 to a depth of 35 feet; shaft No. 2, 22 feet; shaft No. 3, 15 feet; shaft No. 4, 12 feet, and several smaller openings. About 500 tons of 2 percent ore is now lying on the dump ...The property will be worked later in the season by the Algoma Nickel Company which has made an option purchase of it.

Neither the author nor his party saw this prospect. A geologist of International Nickel Company of Canada Limited reported to the author that the shafts and pits are badly overgrown by underbrush and are debris-filled.

Prospect 9—Concession I, Lot 12

Three old trenches were found on this prospect.

The mineralized zone exists as a rusty shear in metagabbro about 1,500 feet south of the Espanola fault. It was traced for a length of about 200 feet, pinching out at each end, with an average width of 12 feet. Dipping 85°S., the shear contains disseminated pyrrhotite, chalcopyrite, and pyrite, with a very few narrow stringers of sulphide minerals. The zone was not sampled for assay purposes.

Prospect 10—Concession IV, Lot 8

Three old pits were found in deeply oxidized rock. A vertical sheared zone about 20 feet wide, was traced for 150 feet northeast. This zone is immediately north of the northeast-trending Beaver Lakes fault, and is probably related to it. Intermittent gossans along the zone are the result of oxidized sulphide deposits, in which grains of pyrite, pyrrhotite, and chalcopyrite were recognized. However, because of the extreme oxidation, no fresh samples were collected for assay purposes.

Prospect 11—Concession IV, Lot 6

This prospect is in patented lot 6, concession IV. The showing occurs in the Beaver Lakes fault and consists of brecciated quartzite in a matrix of gouge and quartz veinlets. The mineralized zone ranges in width from 2 to 12 inches and consists of small grains of chalcopyrite disseminated in quartz veins. The zone was observed along a length of about 25 feet. It is similar to Prospect 12.

One small shallow pit was observed.

Prospect 12—Concession V, Lot 5

This prospect is a quartz vein located in lot 5, concession V. It is in a patented lot. The quartz vein is 12–20 inches wide in the Beaver Lakes fault, encloses breccia fragments of quartzite, and dips 70°NW. Chalcopyrite is disseminated through the quartz. The vein was followed across the outcrop along a length of about 1,500 feet.

Typical material assayed by the Laboratory Branch gave: copper—3.48 percent; gold—0.02 ounces per ton. There has been no development.

Prospect 13—Fensom Property

Teck Exploration Company optioned this prospect, and in 1952–54 conducted a geochemical survey, and put down twenty-nine diamond-drillholes, totalling 18,977 feet.

The prospect is in patented lot 10, concession II.

On surface, the original showing is exposed in a low outcrop of subgreywacke, measuring about 190 feet long in a northeast direction by about 50 feet wide. A number of rock trenches have been cut across this outcrop in the centre of a cleared field, exposing a zone of sphalerite, pyrrhotite, chalcopyrite, and pyrite mineralization across a maximum exposed width of 18 feet. The drilling by Teck Exploration Company Limited revealed the deposit to be about 550 feet long, and to contain several zones across a total width of 200 feet (*see* Figure 4). The central zone has a maximum width of 3 feet.

The mineralized zone is in the footwall of the Fensom "B" fault, striking N.30°E. and dipping 75°SE. Massive sphalerite is the predominant sulphide, with minor chalcopyrite, pyrite, and pyrrhotite. Below the mineralized zone the subgreywacke is carbonatized, but no significant sulphide mineralization occurs within the carbonate. The sulphides enclose and appear to replace the subgreywacke fragments.

Teck-Hughes Gold Mines Limited, in their annual report of 31 December 1952, reported indicated ore reserves as follows: 156,000 tons grading 5.17 percent zinc and 0.30 percent copper over an average width of 8.86 feet; and 49,000 tons grading 4.8 percent zinc in narrower bodies.

The author observed that the mineralized zone is restricted to the contact zone of quartzite and subgreywacke along the Fensom "B" fault. Drilling south-southwest along the fault did not reveal any significant mineralization. Future exploration of this prospect might well be directed to the quartzite-subgreywacke contact zone along the other north-northeast faults of the Fensom fault system.

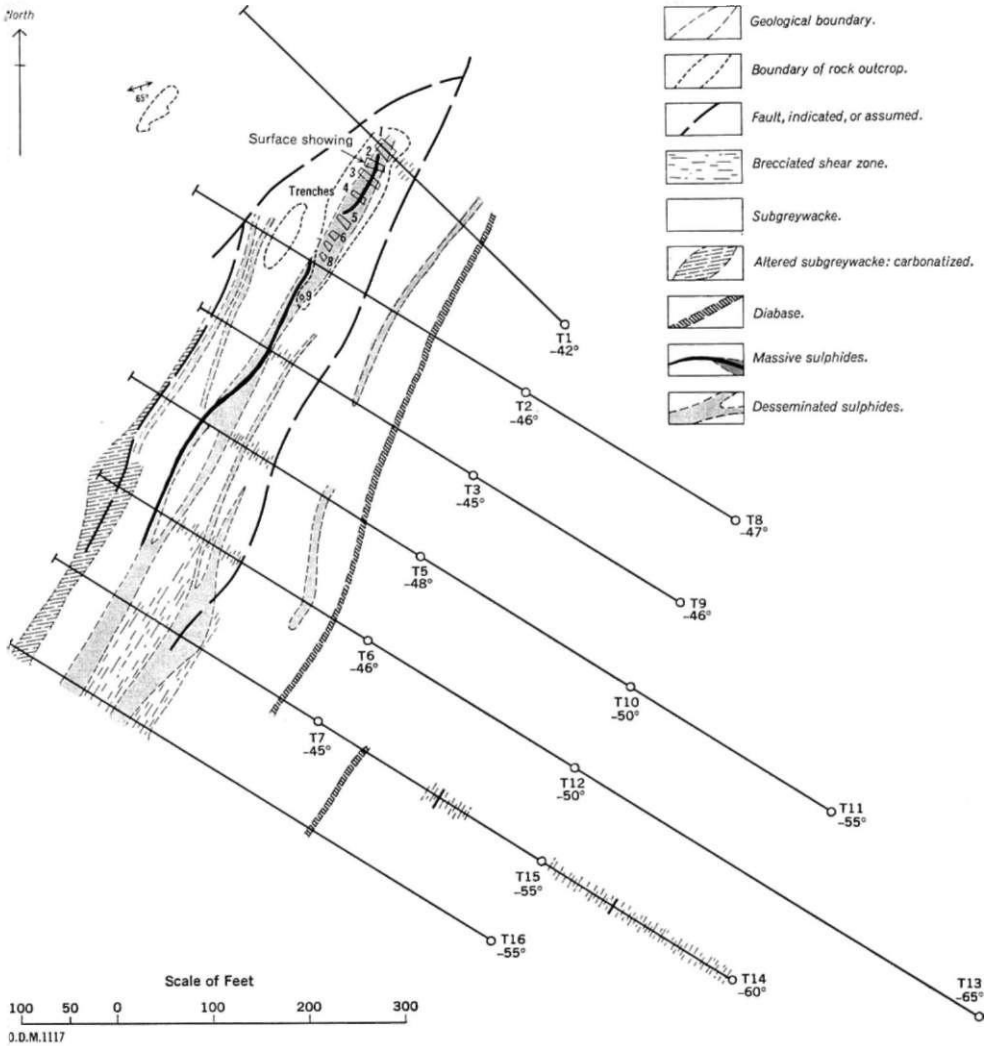


Figure 4 — Detailed plan, Fensom property.

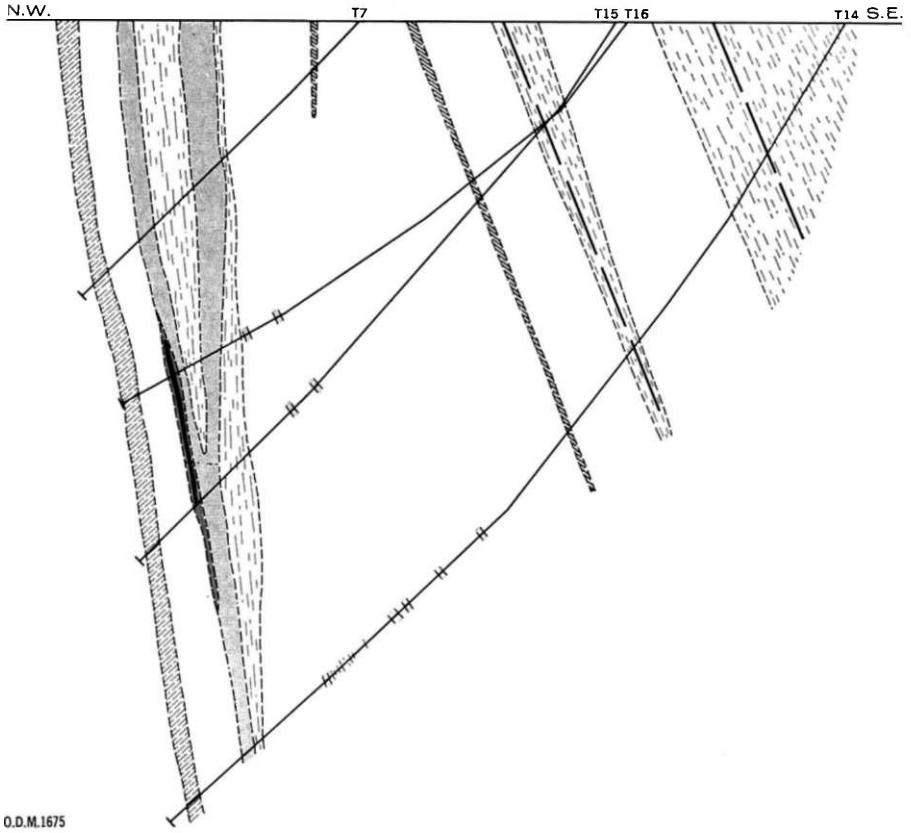


Figure 5 — Sectional drawing, Fensom property, showing drillholes T7, T15, T16, T14.

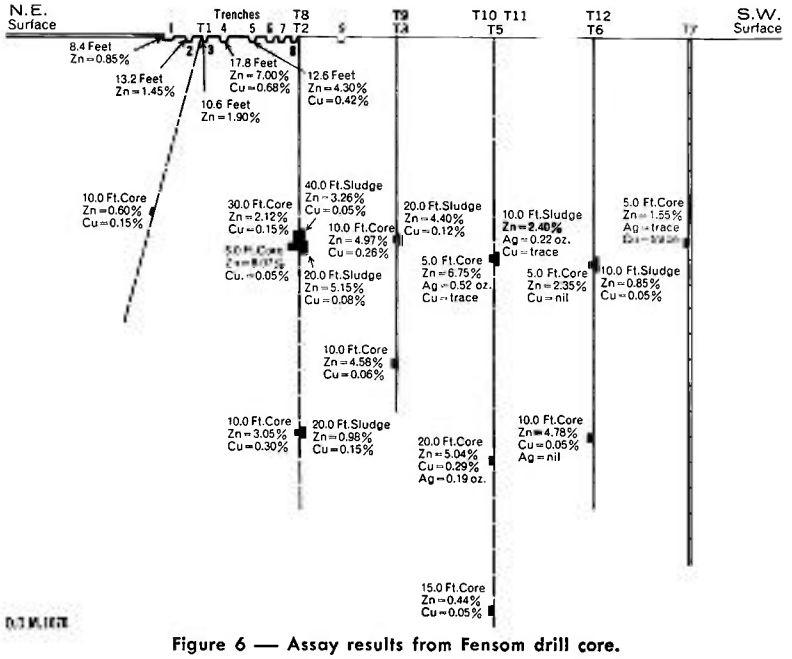


Figure 6 — Assay results from Fensom drill core.

Prospect 14—Proulx Showing

In 1955, Noranda Mines Limited optioned this prospect, in lot 9, concession VI, from A. Proulx of Timmins and investigated it by means of a loop-frame electromagnetic survey.

A grab sample of the best mineralization, taken by the author and assayed by the Laboratory Branch, showed metals present: copper—0.77 percent; nickel —0.45 percent.

There are a number of old pits and drillholes put down along a short east-west gossan zone. The gossan zone is caused by the oxidation of sulphide minerals in a pink granophyre in gabbro. As elsewhere in Nairn and Lorne townships, this "granophyre" is probably the alteration of argillaceous sedimentary rocks. The sulphides, chalcopyrite, and pyrrhotite, are not abundant. Only two anomalies were outlined by the Noranda electromagnetic survey, and neither was close to the showings. One was beneath the swamp north of the Murray fault; the other was a weak, short anomaly about 1,000 feet southwest of the showings.

Prospect 15—Tamminen

Rio Canadian Exploration Limited optioned this property in 1956. Geological, electromagnetic, and self-potential surveys were conducted by them. The prospect is in the north half of lot 1, concession VI.

The showing is in "Nipissing" metagabbro just north of the Murray fault. The gabbro outcrop is only a few feet wide, and is too small to be shown on the geological map of Lorne township (No. 2062). Minor disseminated pyrrhotite and chalcopyrite occur in the metagabbro.

No electromagnetic anomalies were discovered. Magnetic anomalies reflect Keweenawan diabase and, to a lesser intensity, "Nipissing" metagabbro. Only minor negative self-potential anomalies, 50 millivolts at the most, were observed; these coincided with areas of metagabbro and were not considered significant by Rio Canadian Exploration Limited.

Assays, copper 0.19 percent and nickel 0.01 percent, are taken from an assessment work report by the company.

Summary of Prospects

These are the principal showings of sulphide mineralization observed during the mapping of Nairn and Lorne townships. A number of them were judged to be of minor significance, but are described here, and in some cases were sampled, in an attempt to familiarize the prospector with types of mineralization in the area. Other mineralized rocks were seen, but because they were similar to those described herein and were of minor extent or intensity of mineralization they are not described individually. Parts of the Pistin Lake fault north of the Vermilion River contain small amounts of pyrite in vein breccia. Moore (1929) described several veins in lots 8 and 9, concession V, Nairn township, in metagabbro, quartzite, and greywacke north of the Murray fault. A number of pits on minor sulphide deposits were observed in metagabbro and greywacke in lot 3, concession II, Nairn township. None of these appeared to the author to be worthy of detailed examination.

Summary of Types of Mineralization

The most abundant type of mineralization in this area is pyrrhotite and chalcopyrite appearing as disseminated grains and narrow massive sulphide stringers within partially assimilated inclusions of argillaceous sedimentary rocks, commonly impure quartzite or subgreywacke, in "Nipissing" metagabbro sills. Selected samples characteristically contain promising amounts of nickel and copper, but to date this type of deposit has been found to be of limited extent and low-bulk grade.

The second most common sulphide mineralization is within quartz veins in fault or prominent shear zones. The quartz-vein type of deposit is, in some examples, of considerable length, contains 2–4 percent copper, but is characteristically narrow. The mineralization in shear zones is discontinuous and not of high grade.

The least common type of mineralization observed is that at the Fensom property—zinc and copper mineralization without quartz or carbonate gangue, replacing subgreywacke along an east-northeast fault.

Recommendations to Prospectors

In the opinion of the author, on the basis of his field observations, the east-northeast and northeast-trending faults deserve the closest prospecting attention to discover zinc and copper mineralization. In particular the Beaver Lakes fault and the Fensom faults should be explored for possible dilatant zones, perhaps at changes in strike of the faults or at the contacts of rocks of different competency interrupted by these faults.

The extension of the Worthington offset, with possible attendant nickel mineralization, was not recognized by the author (*see* pp.20, 21).

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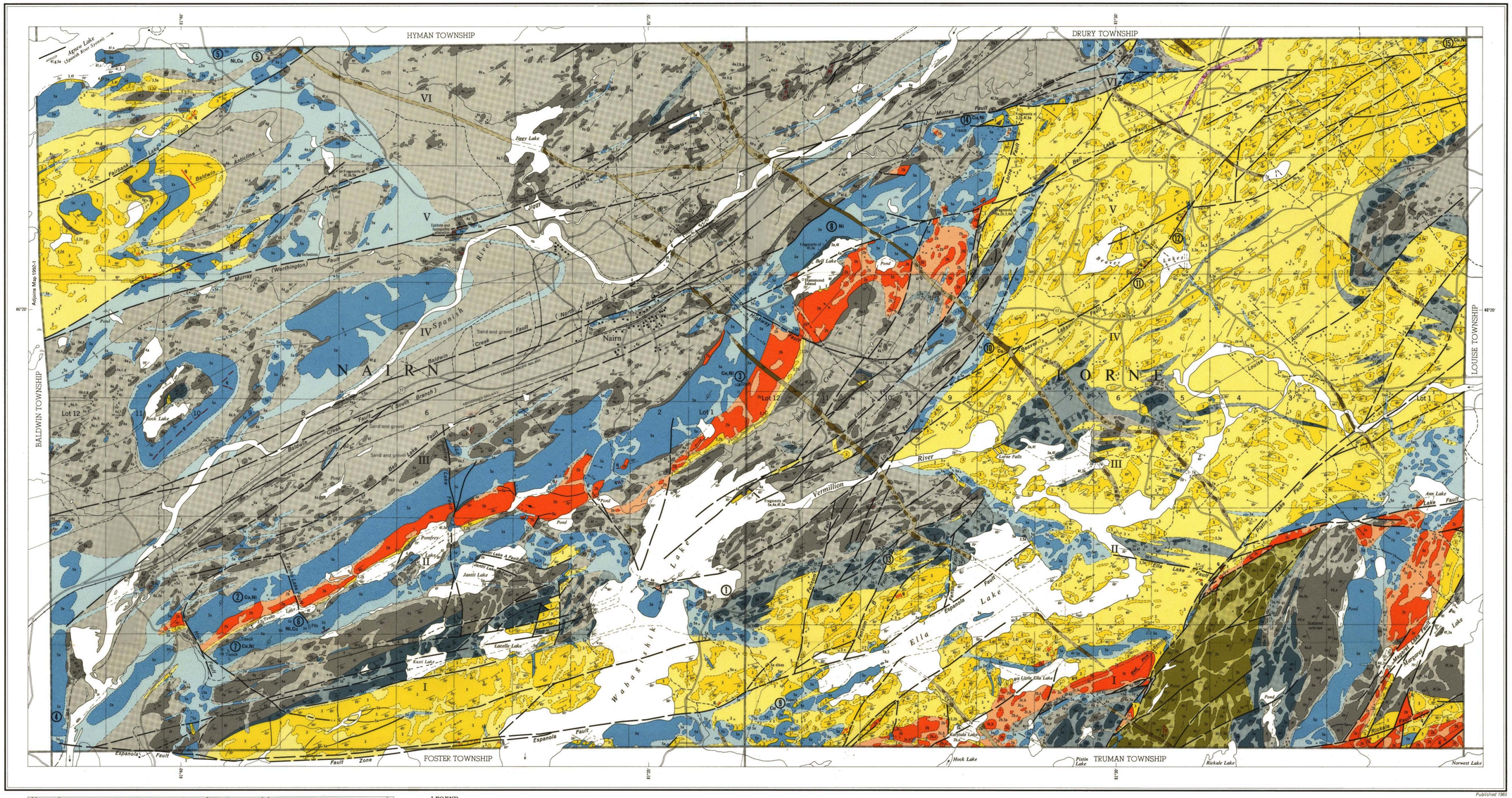
ONTARIO
DEPARTMENT OF MINES

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

Map 2062
Nairn and Lorne Townships

SYMBOLS

- Glacial striae.
- Small rock outcrop.
- Boundary of rock outcrop.
- Geological boundary, defined.
- Geological boundary, approximate.
- Geological boundary, assumed.
- Geological boundary as indicated by geophysical data.
- Horizontal bedding.
- Strike and dip; direction of top unknown.
- Strike and vertical dip; direction of top unknown.
- Direction (arrow) in which inclined beds face as indicated by gradation 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.
- Synclinal axis.
- Anticlinal axis.
- Direction of plunge of fold axis, crest line or trough line.
- Strike and dip of schistosity.
- Strike of vertical schistosity.
- Strike of schistosity, dip unknown.
- Jointing, vertical.
- Drag fold. (Arrow indicates direction of plunge).
- Fault, defined; arrows indicate horizontal movement.
- Fault, indicated or assumed.
- Vein, vein network (width in feet).
- Triangulation station.
- Muskeg or swamp.
- River, creek, stream.
- Electric power transmission line.
- Motor road. Provincial highway number encircled where applicable.
- Other road.
- Trail, portage, winter road.
- Building.
- Shaft.
- Test pit.
- Open cut, quarry, gravel pit.
- Trench.
- Township boundary, approximate position only.
- Survey line, approximate position only.
- Location of prospect.



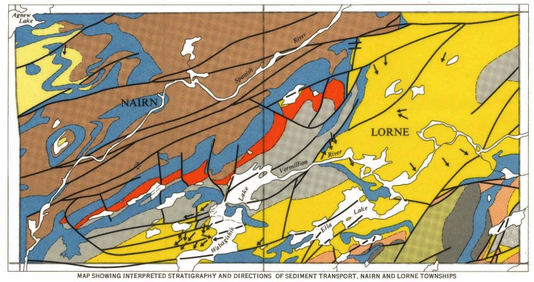
LIST OF PROSPECTS

NAIRN TOWNSHIP

1. Concession II, lot 1
2. Concession II, lot 9.....Cu, Ni
3. Concession III, lot 1.....Cu, Ni
4. Fundy Bay Copper Mines Ltd., concession I, lot 12
5. Keba property, concession VI, lots 9, 10...Ni, Cu
6. Pays-Bas Prospecting Syndicate, concession II, lot 8.....Ni, Cu
7. Peterson property, concession I, NW¼, N½, lot 9.....Cu, Ni

LORNE TOWNSHIP

8. Bell Lake nickel prospect, concession V, lot 11.....Ni
9. Concession I, lot 12.....Cu
10. Concession IV, lot 8.....Cu
11. Concession IV, lot 6.....Cu
12. Concession V, lot 5.....Cu
13. Fensom property, concession II, lot 10....Zn, Cu
14. Proulx showing, concession VI, lot 9.....Cu, Ni
15. Tamminen prospect, concession VI, N½, lot 1.....Cu, Ni



MAP SHOWING INTERPRETED STRATIGRAPHY AND DIRECTIONS OF SEDIMENT TRANSPORT, NAIRN AND LORNE TOWNSHIPS

LEGEND

- Basic intrusive rocks
- Upper quartzite unit
- Upper argillite unit
- Upper conglomerate unit
- Middle quartzite unit
- Middle greywacke unit
- Lower conglomerate unit
- Lower argillite unit
- Lower quartzite unit
- Formational contact
- Fault
- Direction of sediment transport by cross beds

Scale, 1 inch to 2 miles

Map 2062
NAIRN AND LORNE 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 R. M. Ginn and assistants, 1958. Geology is not tied to the surveyed lines.

Office revision of legend and generalization of outcrop areas by J. Satterly and J. E. Thomson, 1964.

Preliminary map, P. 48, Nairn and Lorne Townships, scale 1 inch to ¼ mile, issued 1960.

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

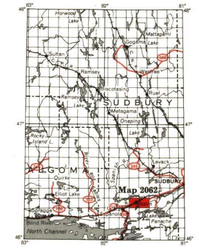
Base map derived from Ontario Forest Resources Inventory maps and air photographs, with additional information by R. M. Ginn, 1958.

Magnetic declination approximately 7° West, 1964.

COLOUR PRESENTATION

STRATIGRAPHY AND LITHOLOGY
With the exceptions noted, the legend is arranged in stratigraphic succession, but similar sedimentary rock types have been assigned similar numbers and are printed in the same colour regardless of stratigraphy. On the smaller map, lower left, stratigraphic formations have been assigned individual colours.

OUTCROP AND OVERBURDEN
Outcrops are shown in deep tones. The inferred extension of bedrock units are represented by light tones and where a unit is too narrow for colour and must appear in black a short black bar appears in the appropriate legend block. Cenozoic deposits therefore are represented by lighter or uncoloured areas.



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

LEGEND

CENOZOIC

RECENT
Muck; lake and stream deposits.

PLEISTOCENE
Sand, gravel, clay.

UNCONFORMITY

PRECAMBRIAN

KEWEENAWAN ?

7a Olivine diabase.
7b Porphyritic olivine diabase.

INTRUSIVE CONTACT
FAULTING

POST-SEDIMENTARY INTRUSIVE ROCKS

NICKEL IRRUPTIVE

6 Gabbro-diorite breccia (Worthington offset).

INTRUSIVE CONTACT

BASIC INTRUSIVE ROCKS

5 Undifferentiated.
5b Olivine diabase (possibly Keweenawan).
5a Metagabbro.

INTRUSIVE CONTACT
FOLDING AND FAULTING

SEDIMENTARY ROCKS

UPPER QUARTZITE UNIT

3b Feldspathic quartzite, fine-grained, white-weathering.
3a Subgreywacke, calcareous.

UPPER ARGILLITE UNIT

4 Undifferentiated.
4f Arenaceous greywacke.
4a Calcareous argillite, calcareous siltstone, argillaceous greywacke.
4d Argillaceous limestone.
4e Cordierite-anthophyllite hornfels, feldspar-quartz-amphibole-epidote hornfels.†
4c Sericite schist.†

UPPER CONGLOMERATE UNIT

2 Undifferentiated.
2c Polymictic boulder conglomerate, greywacke matrix.
2b Polymictic boulder conglomerate, subgreywacke matrix.

MIDDLE QUARTZITE UNIT

3 Feldspathic quartzite, medium-grained.
3a Subgreywacke.

MIDDLE GREYWACKE UNIT

4 Undifferentiated.
4a Argillite, argillaceous greywacke.
4f Arenaceous greywacke.
4c Sericite schist.†

LOWER CONGLOMERATE UNIT

2 Undifferentiated.
2b Polymictic boulder conglomerate, subgreywacke matrix.

LOWER ARGILLITE UNIT

4 Undifferentiated.
4a Argillite, argillaceous greywacke, siltstone.††
4f Arenaceous greywacke.††
4b Biotite schist, chloritoid schist.†
4c Sericite-chlorite schist.†
4g Garnet schist.†
4s Staurolite schist.†

LOWER QUARTZITE UNIT

3a Subgreywacke.
3 Feldspathic quartzite, medium-grained to coarse-grained.

vein breccia, wallrock fragments in quartz.
Breccia, commonly in faults.

Cu Copper.
Ni Nickel.
Q Quartz.
S Sulphide mineralization.
Zn Zinc.

†Metamorphic rocks not occurring as a stratigraphic sequence.

††These rocks are commonly interbedded within the Lower Argillite Unit.