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Geology of Foleyet and Ivanhoe Townships

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ONTARIO GEOLOGICAL SURVEY

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Geology of Foleyet and Ivanhoe Townships

By

J.A. Ayer

1993

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Ontario Geological Survey

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FOREWORD

Detailed geological mapping of Foleyet and Ivanhoe townships was undertaken by the Ontario Geological Survey, as part of the Canada - Ontario 1991 Northern Ontario Development Agreement (NODA), a subsidiary agreement to the Economic and Regional Development Agreement (ERDA) signed by the governments of Canada and Ontario.

These two townships were mapped in detail to update the geological data base in a high mineral potential area In the light of new geological concepts several new areas of high base metal mineral potential and a new stratigraphic succession were outlined in the map area.

B.O. Dressier

AVDirector

Geoscience Branch

Ontario Geological Survey

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ABSTRACT

Foleyet and Ivanhoe townships are underlain by two major subdivisions of the Superior Province consisting of the Kasuskasing Structural Zone in fault contact with the Abitibi Subprovince. The Kapuskasing Structuaral Zone rocks consist of paragneiss and amphibolite intruded by anorthosite, gabbro and ultramafic rocks of the Shawmere anorthosite complex in turn intruded by tonalite and granodiorite gneiss All thes rocks have been metamorphosed to granulite fades rank and represent rocks metamorphosed to lower crustal conditions thrust easterly over the Abitibi Subprovince along the northeast-trending Ivanhoe Lake cataclastic zone. Tonalite gneiss associated with the Shawmere anorthosite complex has been age dated at 2765 Ma.

East of the Ivanhoe Lake cataclastioc zone the Swayze greenstone belt of the Abitibi Subprovince consists of easterly-trending deformed supracrustal rocks metamorphosed to greenschist and amphibolite rank that have been intruded by granitoid rocks. The supracrustal rocks have been subdivided into two assemblages separated by the easterly-trending Muskego River fault North of the fault, the Muskego-Reeves assemblage consists of diverse volcanic rocks of mafic, ultramafic, felsic and intermediate compositions and sedimentary rocks consisting of conglomerate, wacke, siltstone,mudstone and ironstone. Minor synvolcanic intrusions range from pyroxenite to leucogabbro. South of the fault, the Horwood assemblage consists of mafic flows and extensive gabbroic sills. The presence of amphibolite facies rank throughout the Horwood assemblage in contrast to predominantly greenschist facies rank in the Muskego-Reeves assemblage suggests a net north side-up displacement on the Muskego River fault

Early foliated tonalite and granodiorite intrusions surround the supracrustal rocks to the north and west. Minor alkalic rocks consisting of foliated monzonite, syenite, diorite and clinopyroxenite occur in the western part of the Swayze greenstone belt. A diorite from this area has an age of 2680 +3/-2 Ma. Massive-textured stocks of predominatly granite and granodiorite intrude the supracrustal rocks and the surrounding foliated granitoids. In the north, these later granites and pegmatites are aluminous S-type granites which intrude tonalitic gneiss and minor paragneiss.

Diamond drill indicated volcanogenic stratabound massive to dissiminated sulphide zones, extensive zones of hydrothermal silicification and localizations of chloritoid-bearing mafic and felsic volcanic rocks all indicate a

potential for volcanogenic base metal deposits in southeastern Foleyet and northeastern Ivanhoe townships. Shear zone hosted gold mineralization may exist in easterly-trending deformation zones such as the Muskego River fault

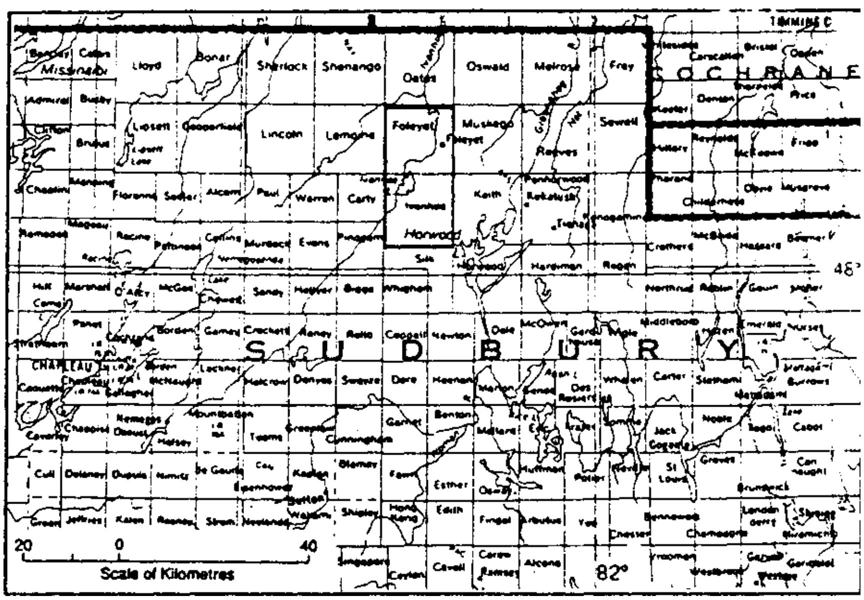

Figure 1. Location of Foleyet and Ivanhoe townships, scale 1:1584000.

Precambrian Geology

Foleyet and Ivanhoe Townships

District of Sudbury

J. A. Ayer[1]

1992

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Critical Reader G.W. Johns

INTRODUCTION

Location and Access

Foleyet and Ivanhoe Townships are bounded by latitudes 48° 03'N and 48° 19'N and longitudes 24' W and 83° 36'W. The map area is located about 100 km southwest of Timmins in the district of Sudbury. The town of Foleyet has a population of about 600 people. It is situated in the eastern part of Foleyet Township and can be reached by road from Highway 101. Access to Foleyet Township is provided by a series of forest access roads branching off Highway 101. The northwestern part of Foleyet Township is most readily accessed by float equipped aircraft from Ivanhoe Lake. The Ivanhoe River drains northward from Ivanhoe Lake and is navigable by canoe. Northwestern Ivanhoe Township can be reached from Highway 101 and the remainder of the township via forest access roads which branch off the Ivanhoe Provincial Park road. The area surrounding the southern part of Ivanhoe Lake is most readily accessed by boat

Mineral Exploration

The following information has been derived from the assessment files of the Resident Geologist's Office, Ministry of Northern Development and Mines, Timmins. Recorded past exploration activity has been mainly focused on diamond drill indicated base metal sulphide occurrences in southeastern Foleyet and northeastern Ivanhoe townships. This work began in 1964 and continues to the present time. In 1964 and 1965, Keevil Mining Group Limited conducted ground electromagnetic and magnetic surveys, geological mapping and diamond drilled 13 holes totalling 6051 feet (1845 m). Subeconomic massive to disseminated sulphide mineralization comprising pyrite, pyrrhotite and minor sphalerite and chalcopyrite were intersected in several holes. The best assay value was 0.35% Zn and 0.07% Cu over 11.5 feet (3.5 m). In 1964 and 1966, International Nickel Company of Canada Limited diamond drilled 7 holes totalling 1052 feet (321 m) in southeastern Foleyet Township. Minor sulphides were noted but no assay results were filed for assessment From 1970 to 1972, Noranda Exploration Company

Limited conducted ground electromagnetic and magnetic surveys and diamond drilled 2 holes totalling 735 feet (224 m) in southern Foleyet Township. Reported assays indicate only trace base metal and precious metal values. From 1980 to 1983, Hudbay Mining Limited conducted airborne and ground electromagnetic and magnetic surveys and diamond drilled 6 holes totalling 629.8 m in southeastern Foleyet and northeastern Ivanhoe townships. Disseminated to massive sulphides including pyrite, pyrrhotite and minor sphalerite and chalcopyrite occur in several holes with the best reported assay being 0.6% Zn over 0.9 m. C. Bruneau and R. Dubeau conducted trenching without any reported results in northern Foleyet Township in 1977 and 1980 respectively.

Present Geological Survey

Geological mapping was conducted at a scale of 1:15 840 during the summer of 1991. Pace and compass traverses provided the main component of field mapping. The general lack of outcrop in many parts of the area required careful pre-examination of the aerial photographs to determine the location of possible outcrop areas which were then targets for traverses which were as spaced at about 400 meters apart perpendicular to the regional strike of lithological units. Shoreline traverses were conducted by canoe along Ivanhoe Lake and the Ivanhoe River. The northwestern part of Foleyet Township underlain by the Shawmere anorthosite complex was not traversed and the geology from this area was compiled from the 1:15 840 mapping of Riccio (1981a, 1981b).

Geological data was recorded in the field on acetate overlays on 1:15 840 scale aerial photographs. The data was subsequently transferred to cronaflex base maps prepared by the cartography section of the Ontario Ministry of Natural resources.

Previous Geological Work

The earliest geological reference to the map area is by W.A. Parks (1900) who produced the first map of the area surrounding Ivanhoe and Horwood Lakes. T.L. Tanton (1916) outlined the distribution of the "greenstones" in the map area in a reconnaissance survey of the area along the Canadian National Railway line between Gogama and Oba.

A 1:63 360 scale geological map by Harding (1937) included all of Ivanhoe Township and the southern 1/3 of Foleyet Township. A regional scale mapping project published at a scale of 1:250 000 by Thurston et al. (1977) included all of the map area. Riccio (1981a, 1981b) mapped the northwestern part of Foleyet Township at a scale of 1:15 840. The map area is also included in a 1:100 000 scale map by Percival (1981).

The area received an airborne magnetic survey which was published in 1963 at a scale of 1:63 360 (Ontario Department of Mines - Geological Survey of Canada 1963a-d). An airborne magnetic and electromagnetic survey covering the parts of the map area underlain by "greenstones" was published at a scale of 1:20 000 (Ontario Geological Survey 1990a-f)

Physiography

Drainage throughout the map area is either into Ivanhoe Lake or the Ivanhoe River and its tributary system, all of which flow northward into the Arctic watershed. The original natural drainage of Ivanhoe Lake was via the "Old Channel" of the Ivanhoe River from the northwestern part of the lake. Damming of this outlet to facilitate early logging operations in the area resulted in breaching of the esker at the northeast end of the lake and ultimately the formation of the "New Channel" of the Ivanhoe River. A dam at the head of the new channel now provides a method for regulation of the lake water levels. Rivers and streams have generally low gradients and are typically meandering locally with short stretches of rapids.

Relief in the area is slight with low, mainly northeast-trending ridges interspersed with well-drained sand and till plains or low, poorly drained muskeg areas. Higher relief is locally provided by sinuous eskers rising to over 30 m above the surrounding glacial till or outwash sand-covered areas. Chains of numerous small kettle lakes and ponds parallel the main esker which trends northerly across the central part of the map area. Outcrop density is the map area is generally low because of extensive glacial till and outwash sand cover. Relatively good outcrop exposure does occur in the northwestern part of Foleyet Township where it is underlain by the Shawmere anorthosite complex.

Acknowledgments

M.A. Puumala, as senior assistant, carried out independent mapping over about 50% of the map area. His contributions to development of many of the geological concepts of the area are gratefully acknowledged. S. Beauchamp, C. Lang and T. Searcy served as competent junior assistants. S. Beauchamp independently mapped part of the granitoid terrain in northeastern Foleyet Township in the latter part of field season.

Logistical assistance by the staff of the Resident Geologist's Office and the Drill Core Library, Ministry of Northern Development and Mines, Timmins, was much appreciated.

GENERAL GEOLOGY

Due to extensive glacial till and outwash sand cover, geological interpretation is, in addition to the generally sparse outcrop data, heavily dependent on data from airborne magnetic and electromagnetic surveys (Ontario Department of Mines-Geological Survey of Canada 1963a-d, Ontario Geological Survey 1990a-f). information derived from assessment files (Resident Geologist's Office, Ministry of Northern Development and Mines, Timmins) and diamond drill core stored at the Timmins Drill Core Library. The geology of the Shawmere anorthosite complex located in northwestern Foleyet Township was compiled from Riccio (1981a, 1981b).

With the exception of Proterozoic diabase dikes all outcrop is of Archean age. The oldest rocks appear to be the paragneiss and amphibolite metamorphosed to granulite fades rank of the Kapuskasing Structural Zone west of the Ivanhoe Lake cataclastic zone (Figure 2). They are part of a sedimentary-volcanic succession intruded by the Shawmere anorthosite complex which predates 2765 Ma (Percival and Krogh 1983), both of which are intruded by granitoid gneiss. East of the Kapuskasing Structural Zone, the rocks of the Swayze greenstone belt and associated intrusions have the presumably younger ages of 2720-2700 Ma typical of the "Keewatin-type" supracrustal rocks of the southern Abitibi Subprovince (Jackson and Fyon 1991). These younger supracrustal rocks are metamorphosed to greenschist and amphibolite facies rank. Two lithologically distinct supracrustal assemblages are recognized in the map area. They are separated by the Muskego River fault and are called the Muskego-Reeves assemblage (MRA) and the Horwood assemblage (HA) after the subdivisions established for the Abitibi Subprovince by Jackson and Fyon (1991). The Muskego-Reeves assemblage (MRA) located north of the fault is a very diverse lithological succession comprising both volcanic and sedimentary units. The units trend easterly and all exposed facings indicate younging to the south. Extrusive rocks are mainly mafic flows with subordinate units of ultramafic flows and felsic to intermediate flows and pyroclastic rocks. The Horwood assemblage (HA) located south of the fault comprises monotonous mafic volcanic flows which differ from those of the MRA principally in their lack of intercalations of ultramafic volcanic rocks, felsic volcanic rocks or sedimentary rocks and the presence of extensive gabbroic bodies. The lithological units are in shown in Table 1 and discussed in more detail below.

ARCHEAN

Ultramafic Metavolcanic Rocks

Ultramafic volcanic rocks are only recognized within the MRA and comprise less than about 10%. As with most units in the MRA, the ultramafic units are composite units with localized intercalation of metasedimentary and mafic volcanic rocks on too fine a scale to be represented as individual units. Several units are present and the most extensive occurs in the northern part of the MRA. The unit extends west noitb-west for 6.5 km from the eastern boundary of Foleyet Township to where it is truncated by granitoid rocks north of the Ivanhoe Lake stock. Based on the sparse outcrop and diamond drill hole data and the aeromagnetic patterns the unit is interpreted to be up to about 1.4 km thick along the township boundary. Three less extensive ultramafic volcanic units outcrop in the southern part of the MRA between the Muskego River fault and the Ivanhoe Lake stock.

Ultramafic volcanic rocks arc dark-gray to green, fine grained, soft and talcose. They typically consist of massive flows, locally with polyhedral jointing patterns and rarely with preserved spinifex textures. The ultramafic volcanic rocks tend to have higher magnetite content and thus higher magnetic susceptibilities than the other supracrustal units. This feature aids in the interpretation of their distribution by correlation of outcrops with the aeromagnetic survey data (Ontario Geological Survey 1990a-f).

The spinifex consists of coarse grained plates of tremolitized olivine (Photo 1). Coarse spinifex textures are only rarely observed in outcrop, but micro-spinifex is commonly visible in thin sections of the ultramafic flows. In the micro-spinifex textures, coarse- to fine grained laths to triangular sections of olivine are now totally replaced by tremolite, locally with seams of very fme grained opaque minerals assumed to be largely magnetite. Interstitial to these large tremolitized olivine crystals are plumose aggregates of finer grained chlorite replacing clinopyroxene. The interpretations of the original mineralogy of the ultramafic volcanics are based on similar textural features described in unaltered spinifex-textured ultramafic flows (Donaldson 1982) thus suggesting that the metamorphic transitions from olivine and pyroxene to amphibole were not texture destructive. Minor carbonate and talc were also observed in some of the thin sections.

Mafic Metavolcanic Rocks

Mafic volcanic rocks are the most abundant supracrustal unit of the map area, representing about 70% of the supracrustal rocks of the MRA and essentially all of the supracrustal rocks of the HA. In addition, amphibolitic remnants within the Kapuskasing Structural Zone are probably mafic volcanic units and/or synvolcanic mafic intrusions metamorphosed to granulite facies rank (Riccio 1981c, Percival 1990).

Amphibolites in the Kapuskasing Structural Zone occur as isolated rafts intruded by variety of granitic gneiss. These rafts occur both as large mappable units and as outcrop scale inclusions. The mappable units are commonly surrounded by granitic gneiss with abundant unassimilated amphibolite inclusions. The amphibolites are fine- to medium grained, dark gray to black with strongly foliated to gneissic textures. They are mainly composed of hornblende and plagioclase (A^g.^). Accessory minerals include clinopyroxene, garnet, quartz, and opaque minerals.

Mafic volcanic rocks in the Swayze greenstone belt vary in colour from medium-green, to dark-green to black. They range from soft and chloritic to relatively hard and amphibolitic. Massive flows are the most common mafic volcanic rock type ranging from fine- to medium- grained. Pillowed flows occur in gradational contact with the massive flows. Pillows average about 30-50 cm in length with thick selvages (up to 2-3 cm) which are a darker green colour and more rusty than the pillow interiors. Vesicles infilled with quartz, carbonate and/or epidote are widespread in the pillowed flows. They typically range up to 2-3 mm in size and are concentrated in the outer parts of the pillows. Variolitic flows consist of abundant light gray coloured spherulites 1-5 cm in diameter which tend to coalesce in the interior parts of pillows. Rounded 5-20 cm light-green epidotized pods of unknown origin occur in both pillowed and massive flows in the southern central part of the HA.

Mafic volcanic rocks in the Swayze greenstone belt predominantly consist of amphibole and plagioclase. The presence of garnet, biotite, hornblenditic amphibole and plagioclase of oligoclase to andesine composition all indicate the mafic volcanics of the HA were recrystallized to the amphibolite fades rank under regional metamorphic conditions. Within the MRA metamorphic conditions range from greenschist fades rank in the north to lower amphibolite fades rank south of the Ivanhoe Lake stock. Typically the mafic volcanics of the MRA contain actinolitic amphibole and albitic plagioclase grains with abundant epidote, sericite or carbonate. Accessory minerals in the mafic volcanics of both the MRA and HA include quartz, chlorite, leucoxene and opaque minerals.

Fine grained pillowed to massive flows may have preserved plagioclase microlites defining a pilotaxitic texture visible in thin section. Relict subophitic textures are preserved in some medium grained massive flows. Pyroxene-spinifex textures occur sporadically in the coarser grained massive mafic flows. They consists of actinolitized pyroxenes in large, acicular, dendritic grains in a groundmass of finer grained plagioclase and amphibole. Rarely the massive flows contain fine to medium grained quartz eyes. These quartz grains have irregular straight-sided boundaries with earlier formed plagioclase and amphibolitized mafic minerals suggesting that they are late crystallization products rather than vesicle fillings. Varioles consist of radiating to concentric intergrowths of fine grained acicular amphibolitized pyroxene with intergranular very fine grained anhedral plagioclase. The acicular crystal growth has resulted in slight protuberances on their outer surfaces visible in thin section. These features indicate their formation as early disequilibrium crystal growths from the melt. In the higher metamorphic grade terrain of the southern part of the HA, the varioles have a relatively high content of very fine grained biotite concentrated in their outer rims. This suggests that the outer margins of the varioles are more potassic than the cores.

Pillow breccia, autoclastic flow breccia and highly vesicular flows are restricted to the area southeast of the Ivanhoe Lake stock. This area is also the locus of extensive hydrothermal silicification, probably as a consequence of the original porosity of these rocks. Pillow breccias are more abundant than pillowed flows in this area and consist of light-gray, irregular-shaped, amygdaloidal pillow fragments in a medium-gray sericitic hyaloclastite matrix (Photo **2).** In moderate silicified pillow breccias the fragments contain **10%** to **30%** vesicles up to **1** cm in diameter. The fragments are siliceous and consist of very fine grained recrystallized quartz and feldspar **(J70%),** biotite **L25%)** and amphibole ***(J5%).*** The matrix appears less silicified and consists of very fine grained plagioclase **L50%)** intensely altered to sericite and epidote, amphibole ***(J55%),*** biotite (_iO%) and quartz (Ji%). The mechanism for the relatively greater silification of the fragments than the matrix is not well understood at this time. This feature may reflect another later alteration event which affected the matrix more than the silicified clasts.

Mafic pyroclastic rocks consisting of tuff, lapilli-tuff and tuff-breccia are very rare. Mostly these are reported in diamond drill core logs which could also possibly have been miss-identified flow breccia. One unit of mafic tuff was observed in outcrop on the south margin of a gabbroic intrusion in northeastern Ivanhoe Township. The mafic tuff consists of amphibolitized pyroxene crystals **(_30%)** and siliceous fragments **C10%)** in a matrix of felted masses of very fine grained amphibole, chlorite and epidote. The massive tuff is intefbedded with thinly bedded siltstone and intermediate plagioclase-phyric tuff.

Intermediate Metavolcanic Rocks

Intermediate metavolcanic rocks constitute less than 5% of the supracrustal rocks of the map area. The most extensive unit is about 3.5 km in length and 0.5 km thick located south of Heart Lake in Foleyet Township. They also occur in two isolated lenses within the mafic flows of the HA and as a minor component of other rock units within the MRA.

Pyroclastic rocks appear to be the only representative rock type of the intermediate metavolcanic rocks. Clast size and sorting indicate that the fragmental units are tuff, lapilli-tuff and tuff-breccia. Massive, ungraded beds of tuff-breccia and lapilli-tuff 1-3 m thick interbedded with tuff and wacke beds less than 1 m thick occur along highway 101 west of the town of Foleyet. The fragmental rocks are light to medium gray-green and relatively hard. The fragments are commonly heterolithic ranging from mafic to felsic in composition and occur in a fme grained recrystallized matrix. Fme to medium grained plagioclase crystals (5-30%) are common and minor quartz crystals may also be present Essential minerals comprise plagioclase, amphibole, biotite and quartz. Accessory minerals may include chlorite, sericite, carbonate, epidote and opaque minerals. Thin section inspection reveals that some of the mafic fragments have relict pilotaxtic textures preserved suggesting the pyroclastic units may be largely derived from debris flows rather than pyroclastic eruptions. This is also suggested by the common presence of interbedded clastic sedimentary rocks within the intermediate pyroclastic units.

Felsic Metavolcanic Rocks

Felsic volcanic rocks are confined to the northern part of the MRAin a band about 5 km by 1 km extending from the Foleyet Township boundary on the east to where it is truncated by the Ivanhoe Lake stock in the west Felsic volcanics comprise flows and fragmental rocks which are typically feldspar and quartz-phyric. They are light-gray to white in colour and very hard. Felsic flows are exposed in a small outcrop on the southeast side of Highway 101. They are massive and generally nondescript but locally with zones of angular flow breccia and isolated mirolitic cavities infilled by very fine grained quartz. In the outcrops southeast of Highway 101 the felsic volcanics contain angular fragments alternating with massive felsic flow or tuff. The fragments are monolithic and are similar in composition, but generally less sericitized than their matrix. It is uncertain if these fragmental zones represent coarser pyroclastic zones in tuff or zones of brecciated flow. Altered carbonatized feldspar and quartz-phyric felsic tuffs with fine to medium grained chloritoid porphyroblasts occur in several small outcrops along the Ivanhoe River.

The felsic volcanic rocks typically contain fine grained phenocrysts of up to 30% plagioclase and 5% quartz in a very fine grained groundmass of recrystallized quartz, feldspar, sericite, carbonate and epidote. The plagioclase phenocrysts are altered to epidote, sericite and carbonate. Quartz phenocrysts are square in outline but may be recrystallized to finer quartz aggregates.

Clastic and Chemical Metasedimentary Rocks

Clastic metasedimentary rocks consists of wacke, siltstone, mudstone and conglomerate. Conglomerate contains angular to rounded, matrix supported fragments and are very thickly bedded, with normal grading evident in some well exposed localities. The fragments are heterolithic and consist of all supracrustal rock types. The felsic porphyry fragments are typically more rounded than mafic and ultramafic fragments. Gabbroic-textured fragments are relatively common but no granitoid fragments were observed. Rare massive to disseminated sulphide-bearing fragments occur in the conglomerates interbedded with ultramafic flows along the New Channel of the Ivanhoe River in Foleyet Township. Wackes are fine grained, gray to green, thin to thickly bedded and may exhibit normal grading from wacke at the base to siltstone or mudstone at the top of a bed. Sand grains are subangular to subrounded plagioclase, quartz and lithic fragments in schistose micaceous to chloride or amphibolitic recrystallized matrix. Tuffaceous wacke is thickly bedded and ungraded with medium grained quartz or feldspar crystals in a fine grained matrix. It is uncertain whether these rocks are of primary tuffaceous origin or represent resedimented volcanic rocks. Silts tones are thinly bedded, very fine grained grained, light to dark gray and may contain up to 10% sulphides. Siliceous siltstones are light gray, hard and less micaceous than normal siltstone. Mudstones are dark gray, very fine grained and schistose. Graphitic mudstones are black, very fine grained with finely disseminated graphite and up locally up to 10% sulphides. Amphibolite fades rank metamorphic conditions have resulted in growth of fine grained to medium grained garnet and andalusite (retrograded to pinite) porphyroblasts in graphitic biotite-muscovite schist along the eastern shore of Ivanhoe Lake.

Chemical sedimentary rocks consist of magnetite ironstone, amphibolitic ironstone and chert Magnetite ironstone interbanded with chert occurs south of the CNR tracks in southeastern Foleyet Township. A coincident linear positive aeromagnetic anomaly in this area is probably caused by this magnetite ironstone (Ontario Geological Survey 1991c). The ironstone is not exposed in outcrop but has been intersected in a number of diamond drill holes drilled in this area. As observed in core stored at the Ministry of Northern Development and Mines Core library in Timmins, the chemical metasedimentary rocks from this area are intercalated with ultramafic and mafic volcanic rocks and consist of thinly bedded fine grained alternations of dark gray magnetite ironstone, white fine grained, recrystallized chert and dark green, schistose, amphibolitic and garnetiferous ironstone. Very minor magnetite ironstone and chert also occur as 1-5 cm interbeds with massive mafic volcanic flows north of a lenticular mafic intrusion in the northeastern part of Ivanhoe Township.

Metamorphosed Ultramafic to Mafic Intrusions

The most extensive mafic intrusion in the map area is the Shawmere anorthosite intruded into the Kapuskasing Structural Zone in the northwest. Smaller lenticular ultramafic to mafic intrusions occur within both the MRA and HA supracrustal sequences and as unassimilated rafts within the granitoid intrusions surrounding the Swayze greenstone belt

The Shawmere anorthosite complex is a deformed and metamorphosed Archean basement-type anorthosite (Ricdo 1981c) within the Kapuskasing Structural Zone. It underlies the western part of Foleyet Township in a regionally extensive northeast-trending complex about 50 km by 10 km (Thurston et al. 1977). Riccio (1981a, 1981b) subdivided the intrusion into two zones, the main zone and the marginal zone. In the map area the main zone consists largely of leucogabbro and anorthosite, with lessor amounts gabbro, melagabbro and ultramafic rocks. The marginal zone consists of foliated garnetiferous amphibolite cut by anorthosite and gabbro dikes. The gabbroic rocks typically consist of large plagioclase megacrysts in a fine to medium grained recrystallized matrix of plagioclase, amphibole and pyroxene with or without minor opaque minerals, quartz and garnet Anorthositic rocks consist of a medium grained granulated mosaic of plagioclase and only rarely contain plagioclase megacrysts. Mafic minerals are primarily hornblende but may also include garnet, titanite, epidote, chlorite and biotite. Gneissic textures predominate in the margins and clotty and coronitic textures of primary mafic mineral overprinted by pyroxene, amphibole and garnet in the central parts (Riccio 1981c).

The compositional and textural similarity of the mafic intrusions in the Swayze greenstone belt with the volcanic rocks strongly suggest they are synvolcanic and some may be slowly cooled thick massive flows. However, locally cross-cutting contacts indicate that at least some of these are intrusions. Mafic intrusions include dark green, medium to coarse grained gabbro and minor melagabbro. Light gray-green, medium to coarse grained leucogabbro may form isolated bodies such as the lenticular intrusion west of Muskego Lake or more commonly as minor differentiates closely associated with gabbroic intrusions, mequigranular textures composed of randomly-oriented acicular amphibolitized pyroxenes in a finer plagioclase-rich groundmass are common. Relict subophitic textures were also observed in thin section. The mafic intrusions are more extensive in the HA than in the MRA. These bodies are sill-like in their relationship with the associated mafic volcanic rocks. The map pattern of the large irregular-shaped gabbro body in the central part of Ivanhoe Township at first glance suggests a plug-like intrusion. However, the distribution of relatively flat tectonic foliations within the intrusion and the surrounding supracrustal rocks suggest it is more likely a shallow easterly-dipping laccolith or sill folded in the nose of a shallow southeast-plunging synform.

Ultramafic intrusions consist of peridotite, pyroxenite and hornblendite. In the MRA and HA the ultramafic plutonic rocks are relatively minor and are typically associated with more abundant gabbroic rocks. This relationship suggests they are probable of cumulate origin but no cumulate textures were observed in thin sections to confirm this. Peridotite and pyroxenite consists of serpentinized and tremolitized olivine and pyroxene, chlorite, talc and opaque minerals. These rocks are medium grained, equigranular and light gray to dark green in colour. Hornblendite occurs as rare inclusions in the northeastern granite complex. The rock is fine to medium grained, equigranular and black with up to 90% hornblende and 10-30% biotite.

Gabbro and clinopyroxenite occur as inclusions or large rafts in the monzonite and syenite intrusions west of Ivanhoe Lake (discussed below). These mafic intrusions manifest a tectonic foliation but their mineralogy indicates a relatively unmetamorphosed nature in contrast with the above discussed mafic and ultramafic intrusive rocks. This suggests they were intruded after peak metamorphic condition were achieved in the area. Gabbros are dark gray to black and contain 50% normally zoned plagioclase (oligoclase), 25% augite, 12% hornblende and 12% biotite and trace amounts of titanite, epidote, carbonate and zircon. Clinopyroxenite is dark gray and medium grained with coarse grained hornblende phenocyrsts. A typical clinopyroxene consists of 70% augite, 55% plagioclase and 20% hornblende with trace amounts of titanite and apatite.

Foliated Felsic to Intermediate Intrusive Rocks

Much of Foleyet Township and the west part of Ivanhoe Township are underlain by gneissic-textured to strongly foliated granitic intrusions. West of the Ivanhoe Lake cataclastic zone the gneisses of the Kapuskasing Structural Zone are compositionally variable consisting mainly of tonalite and granodiorite. A tonalite gneiss body within the Shawmere anorthosite complex on the western margin of Foleyet Township, may be coeval with, or intrude, the Shawmere anorthosite (Percival and Krogh 1983). The tonalite gneiss has a minimum lead-lead age of 2765 Ma thus providing a lower limit for the age of the complex and the associated paragneisses and amphibolites of the Kapuskasing Structural Zone (Percival and Krogh 1983).

In general tonalite and diorite gneiss occurs adjacent to, and within, the Shawmere anorthosite complex while granodiorite intermixed with tonalite gneiss is concentrated further east in the Kapuskasing Structural Zone. The tonalite gneiss commonly contains abundant amphibolite xenoliths and in the northern part of Foleyet Township amphibolite gneiss is more abundant than tonalite gneiss. Minor quartz undersaturated phases comprising diorite and monzonite gneiss occur adjacent to the Shawmere anorthosite complex in southwestern Foleyet Township. Tonalite gneiss is light grey and contains plagioclase (andesine), quartz, biotite, with or without hornblende and accessory alkali feldspar, apatite, epidote and opaque minerals. Granodiorite gneiss is a light pinkish gray with 5-15% alkali feldspar and biotite as the main mafic mineral. Diorite gneiss is dark gray with plagioclase (andesine), quartz, hornblende, with or without biotite, and accessory alkali feldspar, apatite, epidote and opaque minerals.

East of the Ivanhoe Lake cataclastic zone, foliated to gneissic intrusions surround the Swayze greenstone belt to the north and west In the northeastern part of Foleyet Township the gneisses are predominantly tonalites with inclusions of paragneiss and amphibolite. Tonalite gneiss is light gray and consists of plagioclase (oligoclase), quartz and biotite with accessory epidote and titanite.

East of the Ivanhoe Lake cataclastic zone in Ivanhoe Township, the pretectonic granitic intrusions are less deformed ranging from moderately to weakly foliated. Compositions are highly variable and mainly include tonalite, granodiorite, granite and quartz-saturated, alkalic intrusions. Foliated tonalite is light gray and consists of plagioclase (oligoclase), quartz, and biotite with minor alkali feldspar, titanite, apatite and epidote. Foliated granodiorite typically has up to 10% coarse grained alkali feldspar phenocrysts in a finer grained groundmass of plagioclase (oligoclase), microcline, quartz, and biotite with minor myrmekite, titanite and opaque minerals.

Monzonite, syenite and diorite with gabbro and clinopyroxenite xenoliths occur along the Ivanhoe Lake cataclastic zone in southwestern Foleyet Township and along Ivanhoe Lake in west-central Ivanhoe Township. The intrusive phases along the Ivanhoe Lake cataclastic zone have a strongly developed cataclastic fabric defmed by elongate alkali feldspar augen. Intrusive phases along Ivanhoe Lake contain medium grained alkali feldspar phenocrysts and are only moderately to weakly foliated. Percival (1980) interpreted the alkalic intrusions in these two areas as onecontinuous body. Aeromagnetic data from these areas indicate isolated magnetic highs separated by magnetic lows. Thus a more likely interpretation is that of 2 isolated alkalic intrusions seperated by a large unexposed area which is probably underlain by subalkalic granitic intrusions (Ontario Geological Survey 1990a, c).

Geochronology on diorite from this area along the Ivanhoe Lake indicates a U-Pb age of 2680 +3/-2 Ma (Pecival and Krogh 1983).

Foliated syenite and monzonite is pinkish-gray typically with up to 10% coarse grained alkali feldspar phenocrysts which are augen-shaped where the rock is strongly deformed. The phenocrysts consist of perthitic alkali feldspar surrounded by anhedral recrystallized alkali feldspar and plagioclase in the matrix with clinopyroxene, biotite and accessory apatite and opaque minerals. Foliated diorite is dark gray with medium grained plagioclase (oligoclase) crystals in a finer groundmass of hornblende, quartz and biotite with accessory titanite, opaque minerals, apatite, and epidote.

Minor foliated granitic and quartz-feldspar porphyry dikes were observed cutting mafic metavolcanic rocks and gabbro in southeastern Ivanhoe Township. An easterly-trending unit of strongly foliated quartz porphyry is exposed in outcrop for about 1.5 km in central Ivanhoe Township. The unit may be a dike or possibly deformed felsic volcanic rocks. It is light-gray with medium grained quartz phenocrysts in a schistose quartzo-feldspathic groundmass with lepidioblastic sericite and biotite. The rock is unusual in that it also contains rare porphyroblasts of fine grained garnet and andalusite.

Felsic to Intermediate Intrusive Rocks

Massive, post tectonic, granitic intrusions are restricted to east of the Ivanhoe Lake fault. The intrusions exposed in the northeastern and southern margin of the area are parts of much larger plutons extending beyond the boundaries of the map area (Thurston et al. 1977). Smaller granitic intrusions include the Ivanhoe Lake stock and a pluton on the eastern margin of Foleyet Township whose position is based on aeromagnetic interpretation (Ontario Geological Survey 1990d) and is correlated with the Hoodoo Lake pluton in southwestern Keith Township (Breaks 1978).

Compositions of the post tectonic granitic intrusions are generally more potassic than the foliated to gneissic granitoids. They are predominantly granite and granodiorite with or without coarse grained tabular alkali feldspar phenocrysts. The intrusions in the northeast and southwest corners of the map area are granites extensively invaded by pegmatites with graphic-textured intergrowths of perthite and quartz. The pluton in the south is a homogeneous biotite granite consisting of microcline, plagioclase (oligoclase), quartz and biotite with trace amounts of apatite, epidote and opaque minerals. The northern pluton is more complex with tonalitic gneiss, paragneiss and amphibolite extensively intruded by biotite-muscovite granite and pegmatite. The granite consists of plagioclase (oligoclase), microcline, quartz, biotite and muscovite and trace amounts of epidote, titanite, opaque minerals and rarely garnets. Pegmatite dikes in the northern pluton may also contain minor fine grained garnets. The aluminous nature of these granites and pegmatites is indicated by the presence of both muscovite and biotite and rare garnets. These intrusions are therefore S-type and were most likely derived by partial melting of sedimentary rocks in the source area

In the area around Ivanhoe Lake, the Ivanhoe Lake stock in northern Ivanhoe Township is homogeneous pinkish-gray, alkali feldspar porphyritic, biotite granodiorite. It consists of plagioclase (andesine), quartz, microcline and biotite with trace amounts of opaque minerals, titanite, epidote, sericite and carbonate. In the east the stock consists of light gray, alkali feldspar porphyritic biotite quartz monzodiorite and equigranular tonalite dikes into the surrounding country rock. Biotite quartz monzodiorite is composed of strongly saussuritized plagioclase, microcline, quartz and biotite with trace amounts of titanite and opaque minerals.

Alkalic Mafic Intrusive Rocks

Rare lampyrophyre dikes were observed in scattered localities within the Swayze greenstone belt but not within the Kapuskasing Structural Zone. Massive biotite lampyrophyre dikes up to 20 cm thick occur in foliated monzonite along the west side of Ivanhoe Lake and in the massive granite pluton in southwestern Ivanhoe Township. The dikes are carbonate-rich and are a recessively weathering rusty brown colour. They consist of fine grained pyroxene and biotite phenocrysts extensively replaced by carbonate in a very fine grained groundmass whose original mineralogy is obscured by extensive carbonate. Late ultramafic dikes up to 1 m wide in the mafic metavolcanic rocks of southeastern Ivanhoe Township are also interpreted as part of the lampyrophyre clan. They are dark green with up to 10% fme grained biotite phenocrysts (strongly chloritized) in a fme grained groundmass of abundant amphibole and chlorite replacing earlier ferromagnesian minerals, minor plagioclase and traces of opaque minerals largely altered to leucoxene.

PROTEROZOIC

Mafic Intrusive Rocks

Diabase dikes were observed scattered throughout the map area. In the Swayze greenstone belt the dikes are up to 50 m wide and have the typical northwesterly-trend of the Matchewan and Hearst dike swarms which have a Paleoproterozoic U-Pb age of 2454 +/- 2 Ma (Osmani 1991). Within the Kapuskasing Structural Zone the diabase dikes are up to 10 m wide and trend east to northeasterly and they are interpreted to be Kapuskasing dikes with an argon-argon age of 2043 Ma (Percival 1990). Both sets of dikes are tholeiitic quartz diabase. They are fine to medium grained, brown weathering with a subophitic texture. They consist of plagioclase (normally zoned from andesine to oligoclase) and clinopyroxene with minor opaque minerals and quartz.

PHANEROZOIC

Pleistocene and Recent

Much of the map area is covered with an extensive mantle of Pleistocene and Recent unconsolidated deposits. Diamond drilling in southeastern Foleyet and northeastern Ivanhoe townships indicate maximum overburden thickness of up to about 50 m. Thurston et al. (1977) indicate that glacial till forms the surface deposits in eastern Foleyet and Ivanhoe townships and northwestern Foleyet Township. Flat to gently rolling sand, gravel and boulder deposits in the central portions of Ivanhoe Township suggest the moraine deposits are continuous between northern Ivanhoe and Silk townships rather than the isolated interlobate deposits indicated in Thurston et al. (Fig. 17; 1977). This observation is also supported by the presence of several easterly-trending sharp angled moraine ridges up to about 15 m high in the south central part of Ivanhoe Township. Extensive deposits of outwash sand reworked into rolling hills by aeolian processes are evident in the central parts of Ivanhoe Township closely associated with the main esker meandering in a southerly trend across central Foleyet and Ivanhoe townships. This esker represent one of the more extensive esker systems with a regional extent of over 75 km (Thurston et al. 1977). The esker is up to 100 m wide and rises up to 30 m above the surrounding country side. It is predominantly composed of sand and gravel which provides good road building material. Glacial striae, gouging and rocb.es moutonnee trend south to southwest reflecting the direction of glacial ice transport during late Wisconsin between about 10 700 and 11 500 years B.P. (Prest 1970).

Central Foleyet and western Ivanhoe townships are underlain by surface laustrine sedimentary deposits from Lake Barlow-Ojibway deposited between 8 700-9 500 years B.P. (Thurston et al. 1977). Varved clay and sand deposits visible in the banks of the New Channel of the Ivanhoe River north of Ivanhoe Lake represent deposits from Lake Barlow-Ojibway. Recent swamp and muskeg deposits occur throughout the map area and are extensive in low areas west of Muskego Lake, and along the Muskego River south of Muskego Lake.

Metamorphism

Mineral assemblages in paragneiss and amphibolite gneiss indicate granulite facies metamorphic conditions prevailed in the Kapuskasing Structural Zone. Minerals assemblages indicative of these conditions include garnet + clinopyroxene + plagioclase + quartz +/- orthopyroxene in mafic gneiss and garnet + biotite + plagioclase + quartz + orthopyroxene in paragneiss (Riccio 1981c; Percival 1990). Geothermometry and geobarometry by Percival (1990) indicates increasing metamorphic conditions representing progressively deeper exposure of lower crustal rocks eastward across the Kapuskasing Structural Zone. He estimates maximum temperatures in the range of 700-800° C and pressures in the 8-9 kbar range in the easternmost part, adjacent to the Ivanhoe Lake cataclastic zone.

Mineral assemblages indicate metamorphic conditions ranging from upper greenschist to amphibolite facies rank in the Swayze greenstone belt supracrustal rocks of the map area. Mineral assemblages in mafic volcanic rocks in much of the MRA include saussuritized albitic plagioclase, actinolitic amphibole and/or chlorite indicating greenschist facies rank prevailed throughout this area. Garnetiferous amphibolites were intersected in a diamond drill holes about 2 km southeast of the town of Foleyet suggesting the northern margin of the MRA was metamorphically upgraded to amphibolite facies rank due to its proximity to the surrounding granitoids. Garnetiferous amphibolites are also abundant in mafic metavolcanic rocks of the HA. Typical mafic metavolcanic mineral assemblages in the HA include recrystallized plagioclase of oligoclase to andesine composition and hornblende, with or without garnet and biotite. This assemblage indicates that all of the HA has undergone regional metamorphism well into the amphibolite facies. In the pelitic sedimentary rocks south of the Ivanhoe Lake stock mineral assemblages consisting of biotite + muscovite + garnet + andalusite are also indicative of lower amphibolite facies rank. These metasedimentary rocks occur close to the contact of the Ivanhoe Lake stock and thus may be metamorphically upgraded by contact metamorphism. The thermal effect of the stock on the country rock is also evident by the presence of biotite in mafic volcanic rocks up to 500 m from the southeastern margin of the stock.

Alteration

Alteration consisting of silicification, carbonatization and epidotization are evident in many parts of the Swayze greenstone belt in the map area Silicification was observed in a number of places within the MRA. It is most extensive as a northeast-trending zone exposed over 5 by 1 km in northeastern Ivanhoe Township within mafic flows cut by the southeastern margin of the Ivanhoe Lake stock. In much of the exposed parts of the zone silicification has occurred to a moderate degree. Moderate silicification is most evident in pillow breccia where the fragments are light gray in a darker gray schistose matrix. Silicification in these zones appears to have been controlled by early porosity as the most intense bleaching is concentrated around amygdales (Photo 2) and the lack of silicification evident in the minor non-amygdaloidal or unbrecciated flows occurring within the silicified zone. Intense silicification is only exposed in the western part of the zone. In these areas the silicification is manifest by light gray to white rock in which the original volcanic textures have been largely destroyed by multiple generations of fracturing, pervasive silicification and quartz veining (Photo 3). Thin section examination of both types of silicification indicate a considerably higher proportion of very fine grained quartz, feldspar, sericite and biotite than is evident in the unsilicified mafic flows. Numerous dikes of tonalite cut the silicified zone and foliated silicified inclusions in massive quartz monzodiorite locally occur in intrusive breccias near the southeastern margin of the Ivanhoe Lake stock. These features provide evidence that the silicification occurred prior to deformation and was cut by the post tectonic Ivanhoe Lake stock. This and the early porosity control of the moderate silicification strongly suggests the silicification was synvolcanic in its timing. Silicified amygdaloidal flows intercalated with unsilicified, non-amygdaloidal flows were also observed in diamond drill hole F-82-1 in the southeastern part of Foleyet Township.

Patchy zones of silicification occur in an outcrop of quartz and feldspar-phyric felsic pyroclastic rocks (Photo 4) in the main felsic unit in southeastern Foleyet Township about 700 m southeast of Highway 101. A felsic flow in the same unit on the southeast side of the highway also appears to be silicified and is cut by abundant quartz veins and cavities infilled with very fine grained silica.

Carbonatization occurs on a broad scale in the MRA with minor to moderate amounts of calcium and/or iron-magnesium carbonate evident in many outcrops. The most intense carbonatization appears to be associated with ductile deformation zones. This is illustrated in a well exposed deformation zone on the west side of Ivanhoe Lake. In intensely carbonatized portions of this zone small relicts of epidotized rock stand up in a matrix of recessively weathering calcium carbonate (Photo 5). Exposures of schistose and wavy, crenulated, carbonatized rock also occur within the Muskego River fault. Large angular block of similar carbonatized rocks were also observed along the New Channel of the Ivanhoe River within the ultramafic unit in southeastern Foleyet Township suggesting the presence of an unexposed ductile deformation zone in this area

Chloritoid porphyroblasts occur in diamond drill core of carbonatized mafic flows associated with a subeconomic stratabound sulphide zone in southeastern Foleyet Township (discussed further in the Economic Geology Section) and were also observed in carbonatized felsic tuffs along the New Channel of the Ivanhoe River.

Rounded epidote-rich clots of unknown origin occur within amphibolites of the HA in south central Ivanhoe Township. Epidotization is also evident in the ductile deformation zones. In the deformation zone on the west side of Ivanhoe Lake it occurred prior to carbonatization. Pervasive epidotization, possibly related to propylitic hydrothermal alteration, occurs in the foliated granitic rocks along the southwestern side of the open part of Ivanhoe Lake. Epidote also occurs as fme to coarse grained euhedral crystals with quartz and carbonate as veins in ultramafic volcanic rocks cut by granodiorite dikes on the east side of Ivanhoe Township. These epidote-rich veins are most likely related to late devolatization of the Hoodoo Lake Pluton (discussed above).

Correlation of Geology with Airborne Geophysical Data

The map area was covered by an aeromagnetic survey published in 1963 at a scale of 1:63 360 (Ontario Department of Mines - Geological Survey of Canada 1963a-d). Based on these maps regional magnetic patterns are towards the northeast in the Kapuskasing Structural Zone and to the east and southeast in the Swayze greenstone belt In an abrupt break coincident with the Ivanhoe Lake cataclastic zone higher magnetic values occur in the gneiss in the Kapuskasing Structural Zone than the adjacent granitoids associated wtih the Swayze greenstone belt The Shawmere anorthosite complex stands out as a magnetic low with gamma values generally less than 59 700 gammas in contrast with values above this for gneiss east of the complex.

A more recent airborne magnetic and electromagnetic survey covering the parts of the map area underlain by the supracrustal rocks of the Swayze greenstone belt was published at a scale of 1:20 000 (Ontario Geological Survey 1990a-f). In these maps the granitoids stand out as zones with broad widely spaced contours in contrast to more linear and closely spaced patterns in the supracrustal rocks. Intrusions with low magnetic values below 59 000 gammas include the granite underlying the southwest and northeast parts of the map area and the Hoodoo Lake pluton on the eastern margin of Ivanhoe Township. The Ivanhoe Lake stock and the quartz undersaturated intrusions on the northwest side of Ivanhoe Township have higher values generally above 59 000 gammas. Synvolcanic gabbroic intrusions typically have low magnetic character. Clastic metasediments have low magnetic values. An unexposed unit of lean magnetite ironstone intersected in diamond drilling is coincident with a linear zone of relatively high gamma values south of the CNR tracks in southeastern Foleyet Township. Areas underlain by ultramafic volcanics in Ivanhoe Township have higher gammas values than the less primitive volcanics while the ultramafic volcanics in Foleyet Township do not appear to have significantly different magnetic characteristics from other volcanics. This may be because of the higher metamorphic conditions which have affected the supracrustal rocks further to the south.

The more strike extensive electromagnetic conductors in the supracrustal rocks appear to be caused by graphitic mudstone units, many of which have been tested by diamond drilling (discussed in the Economic Geology Section). Abundant southeasterly-trending conductors associated with graphitic mudstones intimately intercalated with volcanic units occurin southeastern Foleyet Township. Less numerous northeasterly-trending conductors associated with graphitic mudstone occur in northeastern Ivanhoe Township. Past diamond drilling has also indicated that some of the less extensive conductors are associated with massive to disseminated sulphide zones in southeastern Foleyet Township. A number of these remain as yet untested by diamond drilling in Foleyet and Ivanhoe townships.

STRUCTURAL GEOLOGY

Kapuskasing Structural Zone

Eight deformation phases have been recognized in the Kapuskasing Structural Zone (Bursnall 1989). They include early D1-D4 ductile structures and late D5-D8 ductile-brittle, fault related structures. In the map area Dl gneissosity mainly strikes northeast with moderate dips to the northwest A subordinate number of easterly trending gneissosity have moderate northerly dips (Fig. 3). Small-scale D2 isoclinal folds in gneissosity and mineral lineations have shallow plunges to the southwest The map scale variations in the trend of gneissosity from northeast to east (Fig. 3) are probably caused by large scale D3 folds with shallow westerly or northwesterly plunges. Two northwest-trending late faults occur in the map area. The western fault lies along the eastern margin of the Shawmere anorthosite complex and was previously recognized by Riccio (1981a, 1981b). It is characterized by numerous "veinlets" of black, aphanitic pseudotachylite and mylonite. These cataclastic zones range up to several centimeters thick, and are extremely variable in orientation cross-cutting the earlier gneissosity. The eastern fault has been identified as the Ivanhoe Lake cataclastic zone and is considered to be the boundary between the Kapuskasing Structural Zone and the Abitibi Subprovince (Percival 1990). On a regional scale it is characterized by a zone of cataclasis up to 1 km wide marked by positive aeromagnetic anomalies, paired gravity anomalies with a low centered over the zone, and a broad zone of subsurface reflectors which dip at about 35° to the northwest detected on seismic surveys (Percival 1990). In the map area the Ivanhoe Lake cataclastic zone is characterized by augen-textured monzonite gneiss exposed along Highway 101 and the old channel of the Ivanhoe River north of the Highway 101. The monzonite gneiss has shallow west-plunging stretching lineations and gently plunging folds in the foliation with asymmetry indicating west side up displacement along the cataclastic zone.

The variation in the trend of gneissosity discussed earlier may have been influenced by uplift of the Kapuskasing Structural Zone accompanied by some dextral displacement, rotating gneissosity near the cataclastic zone into Z-shaped asymmetry. Lineations in the monzonite gneiss of the Ivanhoe Lake cataclastic zone also suggest dextral offset, as they are not oriented down the dip of cataclastic foliation, but oblique to it (i.e. plunging west rather than northwest).

North Swayze Structural Zone

Gneisses in northeastern Foleyet Township, east of the Ivanhoe Lake cataclastic zone, have gneissosity which generally trend southeast and dip steeply to the north clearly indicating that they were not influenced by the Kapuskasing Structure. However, foliated granitoids located between the Ivanhoe Lake cataclastic zone and the Ivanhoe Lake stock, have northeast-trending foliations which dip steeply to the northwest. This fabric is parallel that of the cataclastic zone and is probably an overprint of cataclastic fabric caused by movement along the contact between the Kapuskasing Structural Zone and the Swayze greenstone belt Foliated granitoids west of the Swayze greenstones in the southern half of Ivanhoe Township have variable trends from southeast to east and highly variable dips from shallow to steep and are thus unrelated to the Kapuskasing Structural Zone.

There is evidence for at least three deformation episodes in the Swayze greenstone belt supracrustal rocks. An SI foliation or cleavage is evident in many outcrops as a flattening fabric which is generally subparallel to stratigraphy. S2 is evident as variably developed steeply-dipping cleavage crenulating the SI fabric or axial planar to upright F2 folds in the S1 fabric. D3 has a relatively minor expression in the map area as shallow dipping crenulations and kink bands cross-cutting the S1 and S2 fabric. Evidence for Fl folds are scarce as a result of the general lack of outcrop and top indicators. The pattern of repetition of an ultramafic volcanic unit north of the Muskego River fault in Ivanhoe Township (partially inferred from aeromagnetic data, Ontario Geological Survey 1990c, d) may be the result of an Fl fold.

As a result of F2 folding SI foliations are quite variable in orientation in the HA (Fig. 4). In many places the SI foliation have much shallower dips in the amphibolite facies rocks of the HA, contrasting with the consistently steep dips of S1 foliations in the greenschist facies rocks of the MRA. Lineations are typically strongly developed in the amphibolites of the HA and in many places are more strongly developed than foliations (L>S tectonites). Lineations trend either NW or SE, having shallow plunges generally less than 30°. These lineations are commonly parallel to minor fold axes. Many outcrops exhibit an S2 fabric which occurs as a spaced cleavage. This fabric generally strikes SE with steep dips to the SW and their distribution thus suggests that they represents F2 fold axial surfaces to the poles of the S1 foliations (Fig. 4). An F2 anuform and synform with a SE trending axial surface trace are thus interpreted in the HA by the distribution of the above discussed fabric elements. These folds appear to be nearly upright, with shallow plunges to the NW in the northern part of the HA and to the SE in the south.

The Muskego River fault is a east-trending deformation zone which separates the MRA and HA. It consists of east-trending highly foliated carbonatized and epidotized rocks. Discriminatory kinematic indicators were not observed in the deformed rocks in the fault zone but the abrupt transition to more recrystallized amphibolites south of the fault suggests higher metamorphic conditions and hence a net south-side up displacement across the fault.

ECONOMIC GEOLOGY

Copper, zinc and minor gold mineralization occur in the map area. No mineral deposits have been found to date in the map area but potential may exist for economic concentrations of volcanogenic base metals and shear zone host gold mineralization in certain parts of the area (discussed below).

During the mapping a total of 52 grab samples were collected for assaying by members of the field party. They were geochemically analyzed for various elements including gold, silver, copper, zinc and nickel by the Geoscience Laboratories of the Ontario Geological Survey. Analytical results and comments on the type of material selected for sampling are reported in Table 2. Six of these samples contain anomalous values in zinc, copper or gold. The location of the anomalous samples are indicated on the geology map face (back pocket) by a solid triangle with the assay values in square brackets.

Description of Mineral Occurrences and Past Exploration

Descriptions of occurrences and mineral exploration are listed under the name of the last company or individual to explore the land with the date of the last phase of exploration in square brackets. The information has been derived from the files of the Resident Geologist's Office, Ministry of Northern Development and Mines, Timmins.

Bruneau, C. [1977]

Trenching work was reported in the vicinity of the Shawmere River in the northwestern corner of Foleyet Township by Cyprien Bruneau in 1977. No assay results were reported.

Dubeau, R. [1980]

Trenching was reported on a group of claims in northeastern Foleyet Township by R. Dubeau in 1980. No assay results were reported.

Hudbay Mining Limited [1983]

Hudbay Mining Limited conducted an airborne geophysical over southeastern Foleyet and northeastern Ivanhoe townships and filed the results of the magnetometer survey in 1980. Eight holes were diamond drilled to follow up on geophysical anomalies in southeastern Foleyet and northeastern Ivanhoe townships in 1982.

Six of these holes have logs filled for assessment and have their core in storage at the Ministry of Northern Development and Mines, Core library in Timmins. Re-examination of the core from hole F-82-1 located in southeastern Foleyet Township, revealed intercalations of carbonatized mafic flows in the upper part of the hole grading to silicified amygdaloidal and brecciated mafic flows in the lower part. These silicified rocks are very similar to the flows in the silicified zone along the southeast margin of the Ivanhoe Lake stock (described above). They were previously logged as felsic volcanics. Base metals are restricted to thin interbedded graphitic mudstone with minor pyrrhotite and chalcopyrite.

Hole F-82-2 was drilled in northeastern Ivanhoe Township. The hole intersected massive to amygdaloidal mafic flows which are locally carbonatized and contains only minor base metals.

Core from hole F-82-5 in southeastern Foleyet Township has been re-examined by the author and is interpreted to have intersected a zone of stratabound sulphides. The hole is located near the southern margin of the main felsic unit between Highway 101 and the New Channel of the Ivanhoe River. As facings in the area are southerly, the stratigraphic tops are interpreted to be younging down the hole. In the uppermost part of the hole are talc-chlorite schists assumed to represent deformed ultramafic flows. This unit is succeeded by a unit of locally amygdaloidal chlorite-carbonate schist which represent altered and deformed mafic flows with up to 10% fine to medium grained, randomly-oriented chloritoid porphyroblasts. This unit is abruptly overlain by 8 m of graphitic felsic pyroclastics with zones of disseminated to massive sulphides including pyrite, sphalerite and chalcopyrite. The highest reported zinc assay from this section was 0.6% Zn over 0.9 m. This mineralized section is overlain down the hole by unmineralized and unaltered felsic pyroclastics to the end of the hole.

Diamond drill hole F-82-6 intersected massive sulphides. The hole is located about 1 km west of Highway 101 in southern Foleyet Township.Re-examination of the the core by the author indicated the upper part consists of silicified, locally amygdaloidal, mafic flows. This is abruptly succeeded by 14 m of massive pyrite grading into 7 m of semi-massive pyrrhotite. Neither of the sulphide zones appear to have any significant amount of chalcopyrite or sphalerite and no assay values were reported in the logs. The sulphide zone occursat the transition from the silicified mafic flows into sericiuzed felsic volcanics and graphitic mudstones at a depth of about 50 m.

A ground electromagnetic and magnetic survey was conducted in southern Foleyet Township in 1983. Two bore holes (F-84-1 & F-84-2) were closely spaced about 1 km northwest of F-82-5 as a follow up to the geophysical surveys in 1984. The holes intersected barren mafic volcanics and graphitic mudstones with up to 5% disseminated pyrrhotite cut by massive alkali feldspar porphyritic granodiorite dikes probably derived from the Ivanhoe Lake stock.

International Nickel Company of Canada Ltd. [1966]

In 1964, International Nickel Company of Canada Limited diamond drilled 6 holes in the northern part of the MRA in eastern Foleyet Township (DDH 26640,26642,26644,26645,26645,26699). The holes intersected chemical sedimentary rocks consisting of magnetite iron formation and chert, clastic sedimentary rocks consisting of graphitic mudstone and wacke, and volcanics consisting of mafic, ultramafic and minor felsic rocks. Minor sulphides were noted but no assay results were filed for assessment. A single DDH (29152) was drilled in the southeastern corner of Foleyet Township in 1966. This hole intersected predominantly felsic volcanics and subordinate mafic volcanics with only minor sulphides and no assays were reported.

Keevil Mining Group Limited [1965]

In 1964 and 1965, Keevil Mining Group Limited conducted ground electromagnetic and magnetic surveys, geological mapping and diamond drilling on 5 separate claim groups, 4 in southeastern Foleyet Township and 1 in northeastern Ivanhoe Township. A total of 9 holes were drilled in southeastern Foleyet Township. Holes 64-13 and 64-14 were drilled west of Highway 101 and reportedly intersected mafic volcanics in the upper parts and predominantly sedimentary rock consisting of conglomerate, wacke (reported as quartzite) and graphitic and sulphidic mudstone in the lower parts. An 18 m thick zone of disseminated to massive pyrite (15-75%) was intersected in the sedimentary rocks of DDH 64-14 from which assays indicated only minor amounts of zinc and copper.

DDH 65-1 was drilled on the east side of the Old Channel of the Ivanhoe River. The hole intersected mainly mafic volcanic rocks with an interbedded unit of graphitic mudstone with disseminated pyrrhotite, pyrite, sphalerite and chalcopyrite. Assays from this zone returned up to 0.35% Zn and 0.07% Cu over 3.5 m.

Three holes (65-2,65-2a, 65-3) were drilled west of the Old Channel of the Ivanhoe River about 700 m north of 65-1. These holes intersected predominantly talc-chlorite schist, here interpreted as deformed ultramafic flows, and subordinate mafic volcanics and graphitic mudstones. No significant mineralization was noted, nor were any assays reported.

Bore holes 65-11 and 65-12 were drilled west of the New Channel of the Ivanhoe River. Both intersected sedimentary rocks consisting of wacke, conglomerate and graphitic mudstone, locally with minor disseminated sulphides which assayed only minor copper and zinc values.

Bore holes 65-13 and 65-14 were drilled in the southeastern corner of Foleyet Township. They intersected sedimentary rocks consisting of wacke and mudstone, mafic volcanic rocks and gabbro. Minor zones of disseminated sulphides assayed up to a maximum of 0.05% Cu over 3 m.

Three DDH (65-18,65-19,65-20) were also drilled in northeastern Foleyet Township about 700-1100 m east of the southeastern margin of the Ivanhoe Lake stock. The drill holes intersected mafic flows with interbedded sedimentary units consisting of wacke, siliceous siltstone and graphitic mudstone. Sulphide mineralization appears in all three holes associated with the mudstones units. In DDH 65-20 disseminated to semi-massive pyrite and pyrrhotite with minor sphalerite and chalcopyrite constitute up to 30-70% of the rock over short sections. Assays from this section returned anomalous values up to a maximum of 0.28% Zn and 0.05% Cu over 3 m.

Noranda Exploration Company Limited [1972]

Noranda Exploration conducted an exploration program on three separate claim groups in southeastern Foleyet Township in 1971-72. Work included ground magnetometer and electromagnetic surveys followed up by diamond drilling. Two holes (F-71-20, F-72-1) were drilled on the northern claim group just west of the New Channel of the Ivanhoe River. Selected portions of core from DDH F-72-1 are in storage at the Core Library in Tirnmins. Relogging of this core reveals the rock to consist of predominantly lean banded magnetite iron formation and chert (originally identified as rhyolite tuff, talcose deformed ultramafic volcanics (talcose andesite in the original log) and mafic volcanic rocks. RecrystalJization is considerable and the mafic volcanics are garnetiferous indicating amphibolite facies rank in the northern parts of the Muskego-Reeves assemblage. No significant mineralization was reported in these holes.

Guidelines For Mineral Exploration

Base Metals

The Muskego-Reeves assemblage is considered to have the greatest potential for economic concentrations of volcanic massive sulphide (VMS) base metal sulphides in the map area This is indicated by the results of past diamond drilling (discussed above), the presence of extensive zones of volcanogenic hydrothermal alteration and a diversity of volcanic compositions with alternations of felsic, mafic and ultramafic volcanic units. In the Abitibi Subprovince, VMS deposits are commonly associated this type of compositional diversity (Jackson and Fyon 1991).

Massive and disseminated sulphide clasts with sphalerite and chalcopyrite were observed in outcrops of conglomerate along the New Channel of the Ivanhoe River. Also of interest is a partially assimilated massive sulphide inclusion occurring within the Ivanhoe Lake stock. The inclusion was observed on a small island in the central part of Ivanhoe Lake (Photo 6). It consists of massive pyrite, magnetite and chalcopyrite. A grab sample of this inclusion assayed 10 700 ppm Cu (Sample 91JAA-0012; Table 2).

Hydrothermal alteration is evident in Foleyet Township by the presence of chloritoid porphyroblasts in carbonatized mafic volcanic rocks underlying a subeconomic stratabound massive sulphide horizon in a diamond drill hole in southeastern Foleyet Township (Hole F82-5, Timmins Assessment file # T-2430; Timmins Drill Core Library # TI0497) and were also observed in outcrops of carbonatized felsic volcanic rocks along the Ivanhoe River about 1.5 km east of the drill hole. This suggests the possibility of extensive chloritoid alteration in an area of little outcrop. It is worthy of note that chloritoid-bearing altered volcanic rocks are associated with a number of Archean volcanogenic massive sulphide deposits (Franklin et al. 1975).

In addition, an extensive zone of volcanogenic silicification outcropping over a 5 by 1 km zone in northeastern Foleyet Township bears resemblance to similar alteration associated with a number of Archean VMS deposits including the silicification underlying the Mine Series deposits at Noranda, Quebec (Gibson et al. 1983). Small veinlets of massive sulphide in the western, more intense part of the silicified zone, contain chalcopyrite and sphalerite. Grab samples from these veinlets contain anomalous values of up to 1080 ppm Zn (Sample 91JAA-0081; Table 2). Silicification has also been identified in felsic and mafic volcanic rocks in small outcrops and diamond drill core in southeastern Foleyet Township.

Outcropping siliceous siltstone with 5-10% disseminated sulphides intercalated with mafic and intermediate pyroclastics southwest of Muskego lake returned anomalous grab sample assays of 3950 ppm Zn and 48 ppb Au (Sample 91JAA-0107; Table 2).

Gold

Gold potential may exist associated with easterly-trending carbonatized shear zones such as the Muskego River fault The Keith-Penhorwood deformation zone, apparently along strike with the Muskego River fault, located in Keith Township east of the map area, is a zone of extensive carbonatization and deformation which hosts gold mineralization at the Joburke Mine and a number of other prospects (Siragusa 1990,1991). Anomalous gold values of up to 71 ppb were (Sample 89JAA-0148; Table 2) were determined from sulphidized shear zones at the contact between mafic volcanic rocks and a gabbro sill in the southeastern Ivanhoe Township.

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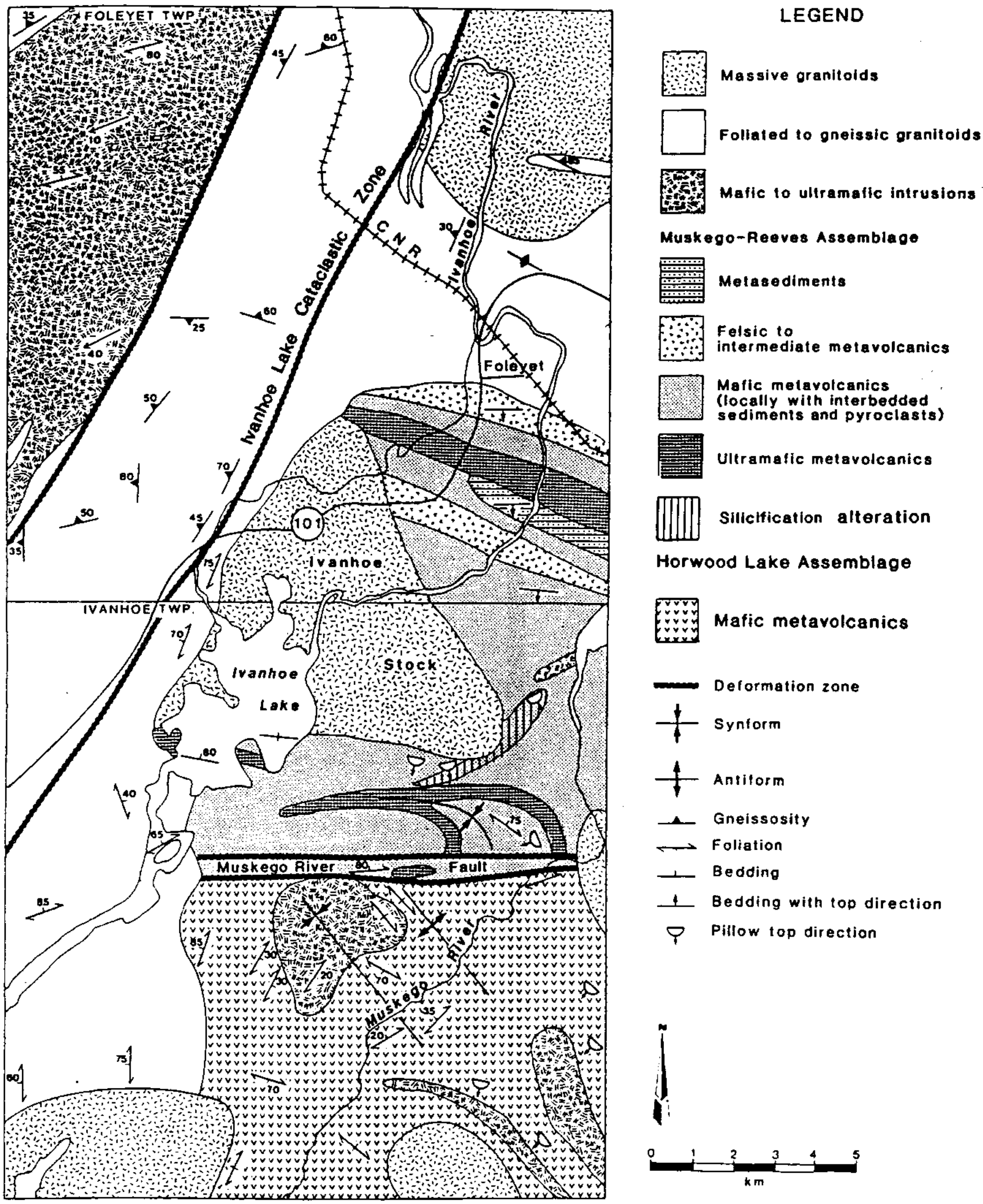

Figure 2. Generalized geology of Foleyet and Ivanhoe townships.

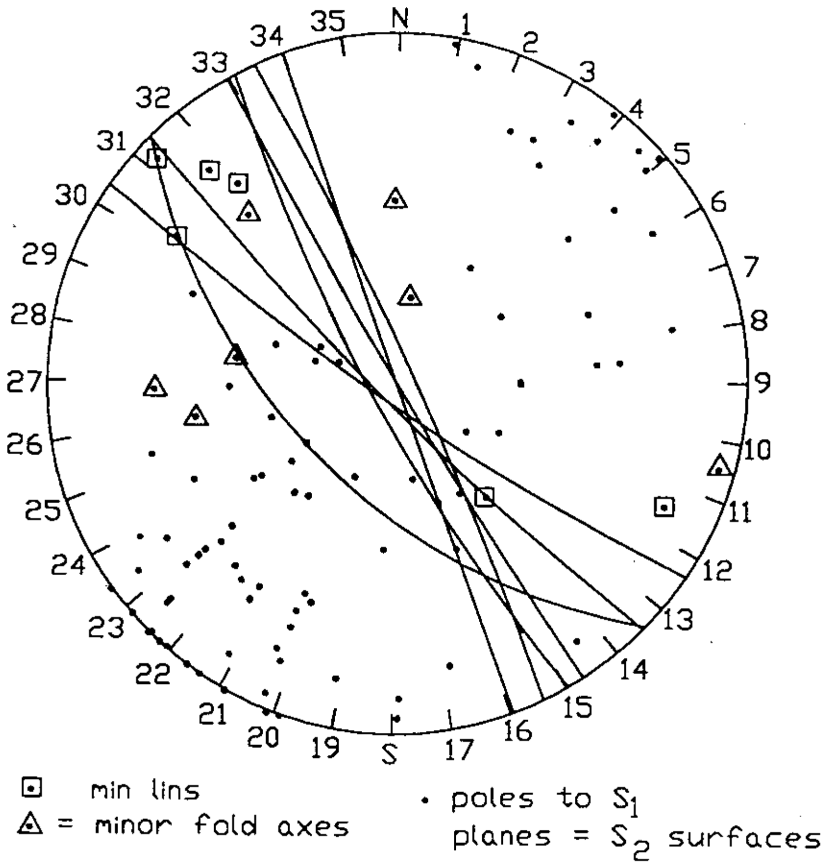

Figure 3. Steronet plot of poles to gneissosity from the Kapuskasing Structural zone.

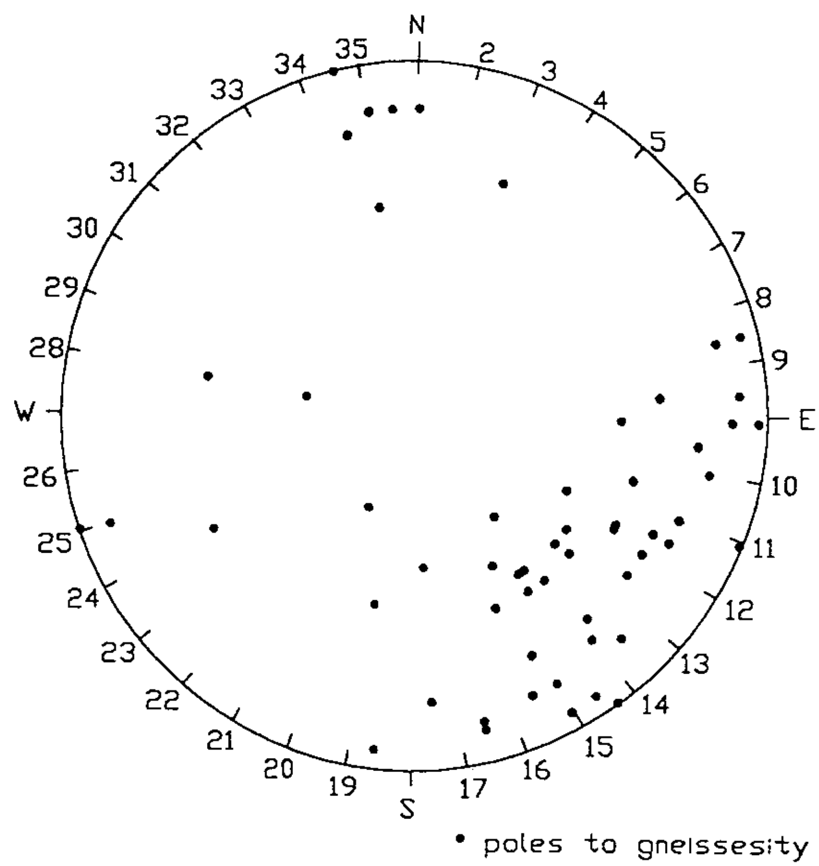

Figure 4. Steronet plot of minor fold axes, mineral lineations, poles to S1 foliations and S2 planar surfaces from th supracrustal rocks of the Horwood assemblage in southern Ivanhoe Township.

Photo 1. Close-up view of tremolitized olivine, bladed spinifex textures in ultramafic volcanic flows from central Ivanhoe Township.

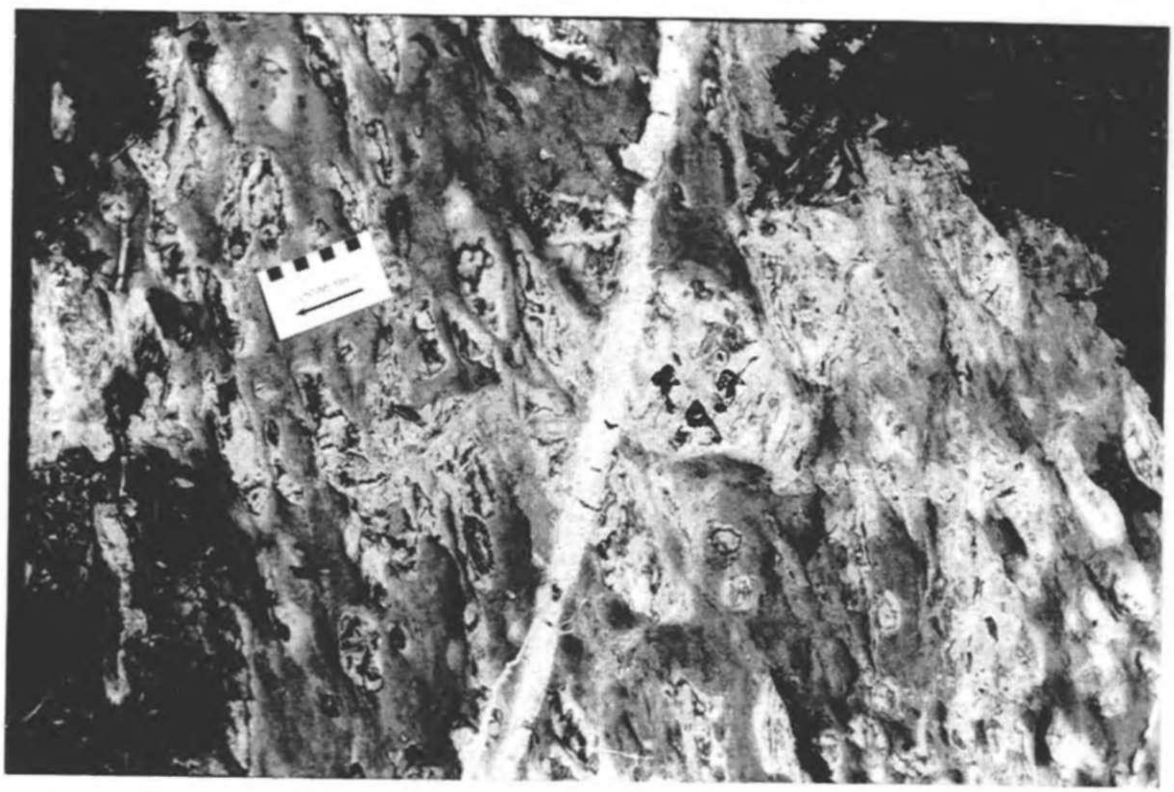

Photo 2. Moderate silicification of mafic pillow breccia cut by a thin tonalitic dike south of the Ivanhoe Lake. Early porosity-controlled hydrothermal silicification event is suggested by intense bleaching halos surrounding amygdales (e.g. area A in the photo).

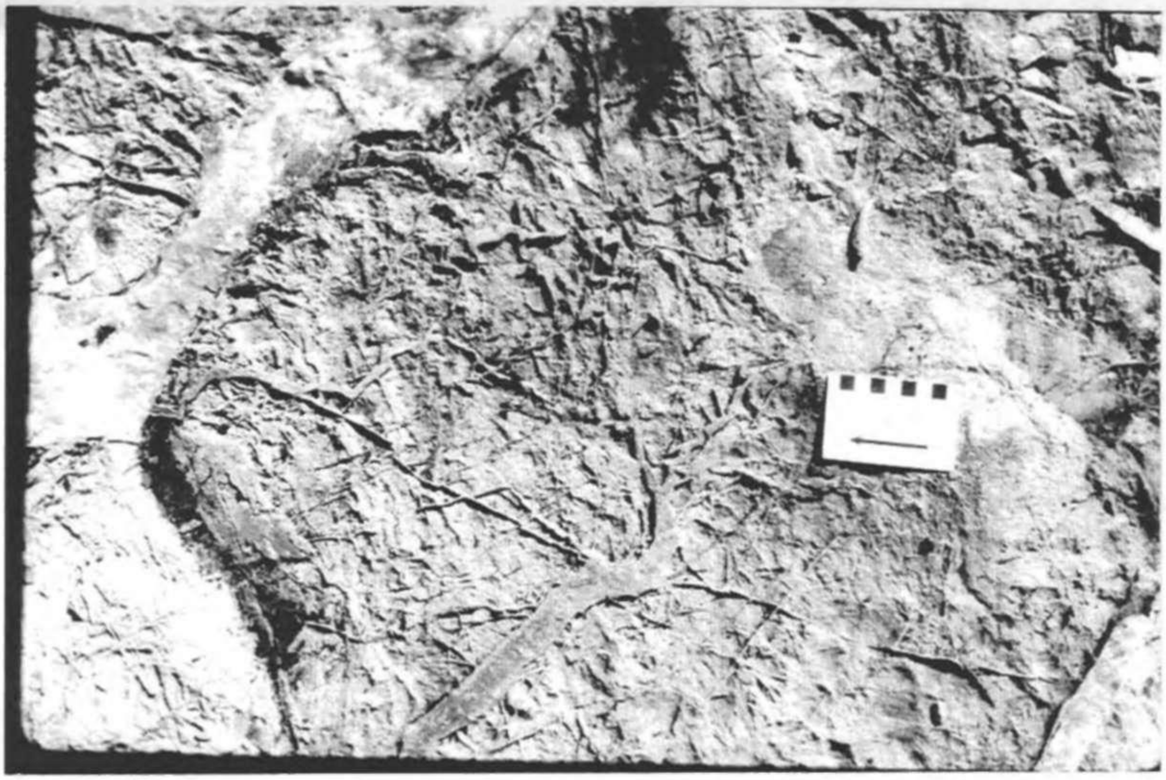

Photo 3. Intense silicification south of the Ivanhoe Lake stock. This type of silicification is texture destructive. The rock is pervasively altered and cut by multiple orientations and generations of veining.

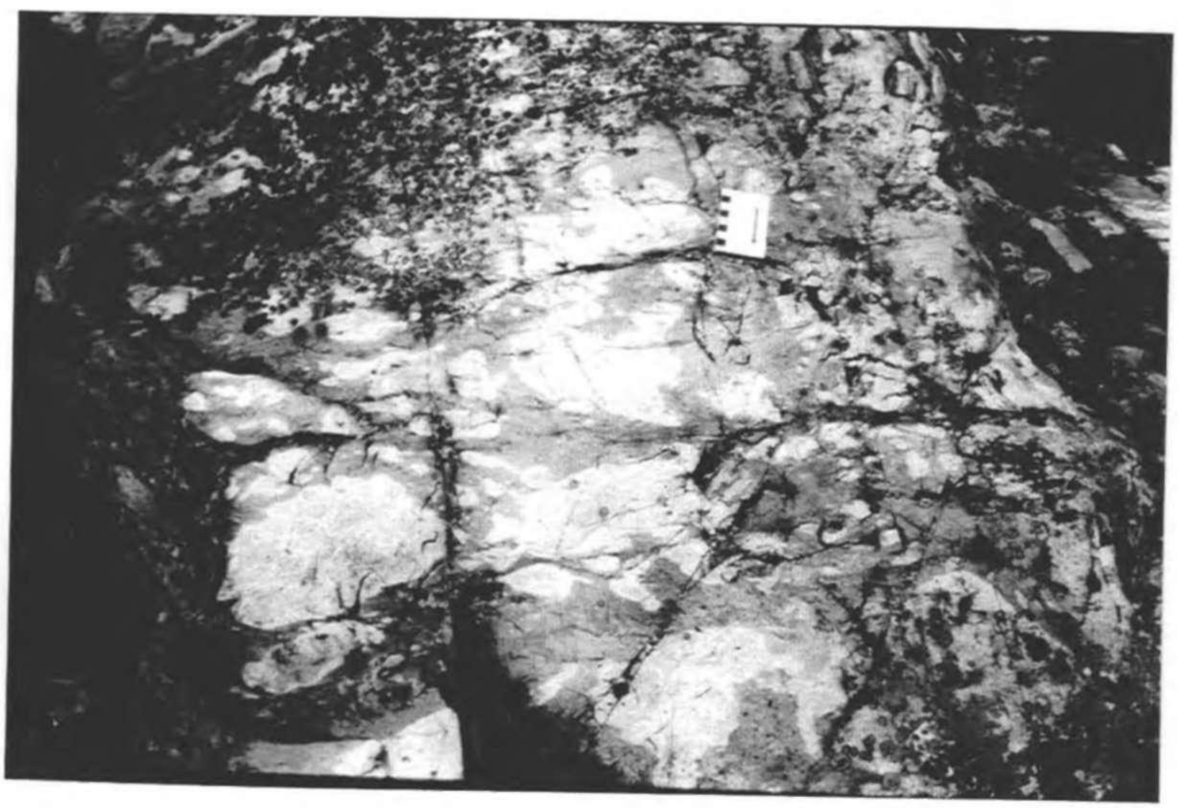

Photo 4. Patchy silicification of felsic volcanic rocks in an outcrop of quartz-phyric felsic volcanic rocks about 700 m southeast of Highway 101 in southeastern Foleyet Township.

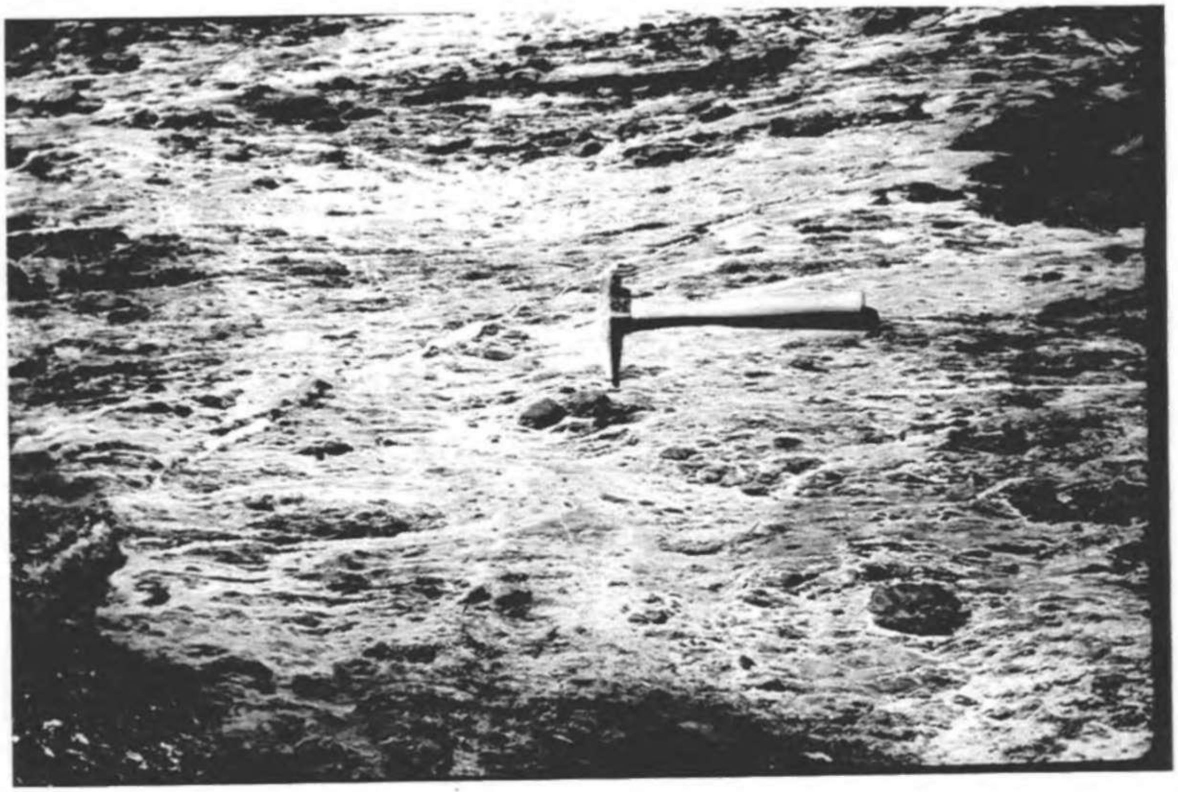

Photo 5. Ductile deformation zone from the west side of Ivanhoe Lake. Small remnants of epidotized rock surrounded by a recessively weathering, pervasively, calcium-carbonatized matrix.

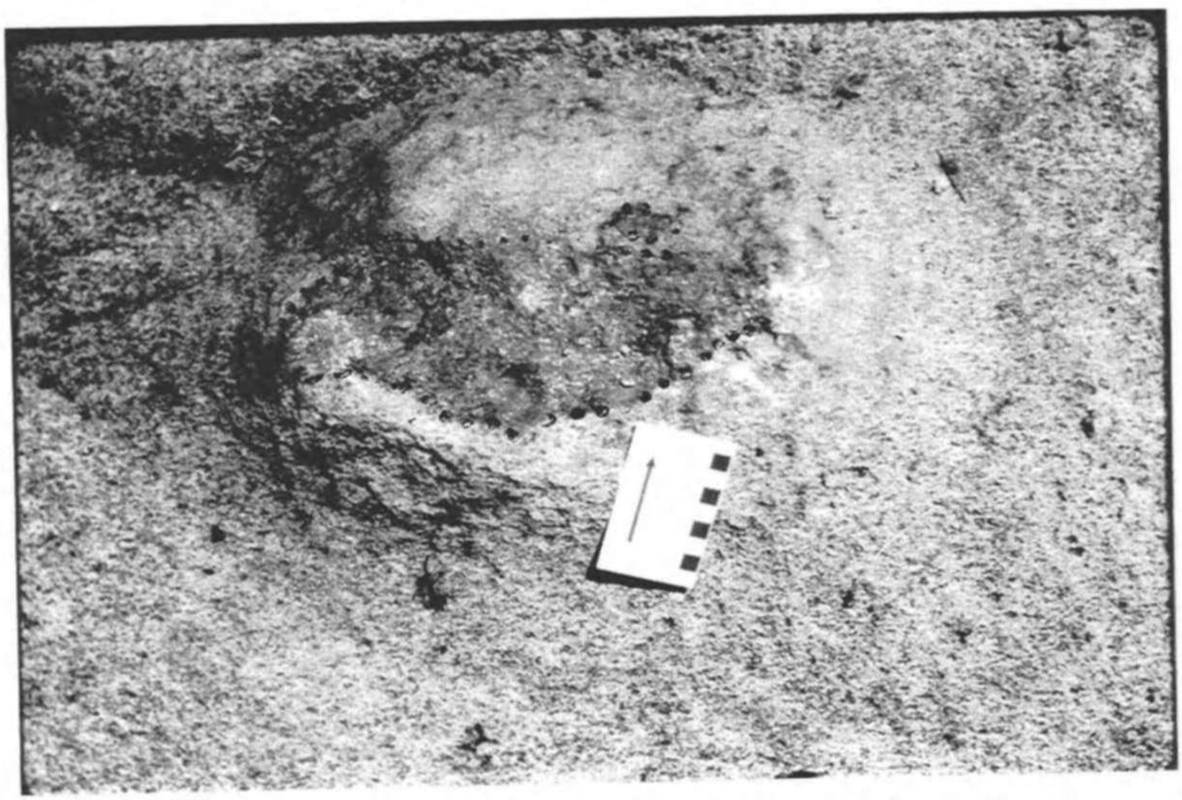

Photo 6. Unassimilated massive sulphide inclusion in the Ivanhoe Lake stock from the small unnamed island in the central part of Ivanhoe Lake.

Table 1. Lithological units for Foleyet and Ivanhoe townships.

PHANEROZOIC
CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Glacial, glaciofluvial, lacustrine and fluvial deposits

Unconformity

PRECAMBRIAN
PROTEROZOIC
Mafic Intrusive Rocks
Diabase dikes

ARCHEAN
Alkalic Mafic Intrusive Rocks
Lamprophyre dikes

Felsic to Intermediate Intrusive Rocks
Granodiorite, quartz monzodiorite, granite, tonalite, quartz diorite, pegmatite, feldspar porphyry

Foliated Felsic to Intermediate Intrusive Rocks
Tonalite, quartz diorite, granodiorite, quartz monzodiorite, granite, diorite, monzonite, syenite, pegmatite, quartz-feldspar porphyry

Metamorphosed Mafic Intrusive Rocks
Gabbro, melagabbro, leucogabbro, diorite, anorthosite, anorthositic gabbro

Metamorphosed Ultramafic Intrusive Rocks
Pyroxenite, hornblendite

Clastic and Chemical Metasedimentary Rocks
Wacke, siltstone, mudstone, conglomerate, tuffaceous wacke, magnetite ironstone, amphibole ironstone, graphitic mudstone, sulphide mudstone, chert, siliceous siltstone, paragneiss

Felsic Metavolcanic Rocks
Tuff, lapilli-tuff, tuff-breccia, massive flow

Intermediate Metavolcanic Rocks
Tuff, lapilli-tuff, tuff-breccia, massive flow

Mafic Metavolcanic Rocks
Massive flows, pillowed flows, variolitic flows, brecciated flow, tuff, lapilli-tuff, tuff-breccia

Ultramafic Metavolcanic Rocks
Massive flows, spinifex-textured flow

Table 2. Assay results for the Foleyet-Ivanhoe Townships area

Sample Number	Au (ppb)	Ag (ppm)	Cu (ppm)	Zn (ppm)	Ni (ppm)	UTM Coordinates Eastings	Northings	Comments
0002	<2	<2				391320	5329300	Quartz veins with diss. py.
0007	6	<2				389885	5329420	l-3cm rusty band in mafic volcanics.
0012	6	9	10700	57		89490	5336070	Xenolith of massive py, mag and cp in granite.
0017	6	<2				386160	5334920	Rusty zone with py, po and mag.
0038	<2	<2				384730	5335125	Cb veining in deformed ultramafic flow.
0042	<2	<2				385090	5335050	Rusty carbonatized deformed ultramafic flow.
0069	<2	<2				392880	5332465	Rusty quartz veinlets.
0075	<2	<2				393980	5332525	Rusty carbonatized and epidotized zones.
0081	5	<2	225	1080		391245	5334350	Rusty zones in silicified mafic volcanics.
0083	<2	<2	28	94		391165	5334110	Po veinlets in silicified mafic volcanics.
0084	6	<2	39	71		391060	5334050	Py veinlets in silicified mafic volcanics.
0088	6	<2	94	82		391040	5334790	Po veinlets in silicified mafic volcanics.
0099	<2	<2	43	133		393030	5335315	Rusty zones in silicified mafic volcanics.
0107	48	<2	378	3950		393825	5336090	Cherty siltstones with diss, po, py and cp.
0115	24	<2	33	92		383820	5336410	Thin magnetite ironstones beds in mafic flows
0133	<2	<2	310	205		394980	5328665	Diss, po and py in mafic volcanics.
0141	5	<2				394450	5325935	Rusty silicified zone in deformed gabbros
0143	4	<2				394450	5325800	10 cm rusty shear zone with diss. py.
0147	18	<2				393610	5324415	2 m shear zone with quartz veinlets and diss.
0148	71	8				393780	5324230	2 m shear zone with semi-massive py patches.
0152	9	<2	129	725		393795	5340540	Graphitic mudstone with diss. po.
1001	<2	<2				390930	5331700	Carbonatized mafic flows with diss. py.
1004	<2	<2				390575	5332035	Carbonatized mafic flows cut by py seams.
1016	<2	<2				390960	5331550	Gabbroic mafic flows with py seams.
1017	<2	<2				390940	5331425	Quartz veins with diss. py.
1021	<2	<2				391345	5332300	Quartz vein with cb and py.
1023			52		28	391315	5332010	Gabbroic amphibolite with diss. po.
1028	8	<2				391270	5334300	Quartz veins with diss. py.
1030	<2	<2	42	515		391650	5334305	Diss, py in rusty silicified mafic volcanics.
1033	5	<2	159	134		391650	5334305	Rusty silicified mafic volcanics.
1043	<2	<2				388020	5325145	20 cm quartz vein.
1044	<2	<2				388020	5325145	35 cm quartz vein.
1055	<2	<2				389850	5324925	Py-rich lenses in gabbroic amphibolite.
1058	<2	<2				391075	5326360	Rusty vein quartz float.

Table 2. Continued

Sample Number	Au (ppb)	Ag (ppm)	Cu (ppm)	Zn (ppm)	Ni (ppm)	UTM Coordinates Eastings	Northings	Comments
1059	10	<2				391075	5326360	Silicified gabbroic amphibolite with diss. py.
1061	<2	<2				390745	5326560	2 m quartz vein.
1068	<2	<2				390660	5326600	Silicified gabbroic amphibolite with diss. py.
1089	5	<2				390845	5327160	Gabbro with py seams.
1098	<2	<2				392390	5329240	Vein quartz float.
1099	<2	<2				392390	5329240	Sheared mafic volcanic float with diss. py.
1100	<2	<2				392390	5329240	Carbonatized mafic volcanic float with diss, py
1101	<2	<2				392390	5329240	Carbonatized mafic volcanic float with diss, py
1102	<2	<2				392260	5329240	Carbonatized mafic volcanic with diss. py.
1106	<2	<2				394050	5331825	Carbonatized mafic volcanic with diss. py.
1107	<2	<2				394050	5331825	Carbonatized mafic volcanic with diss. py.
1110	<2	<2				392180	5327400	Carbonatized mafic volcanic with diss. py.
1114	<2	<2	197		57	394100	5327575	Carbonatized gabbro with diss, po and cp.
1130	3	<2				393215	5324850	Sheared feldspar porphyry with diss py.
1143	<2	<2				392215	5325425	Deformed gabbro with diss. py.
1149	<2	<2				394645	5324695	Carbonatized mafic volcanic with diss. py.
1153	<2	<2				393070	5338970	Carbonatized mafic volcanic float with diss, py

Table **2.** Assay results for the Foleyet and Ivanhoe townships area. The samples were collected by members of the field party and the geochemical assays were preformed by the Geochemical Labratories of the Ontario Geological Survey, Toronto. Values considered to be anomalous by the authour are reported on the map face (back pocket).

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m-	3.280 84	feet	1 foot	0304 8	m
l m	0.049 709 7	chains	1 chain	20.116 8	m
1km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km
			AREA		
1 cm2	0.155 0	square inches	1 square inch	6.451 6	cm2
1 m2	10.763 9	square feet	1 square foot	0.092 903 04	m2
1 km2	0.386 10	square miles	1 square mile	2.589 988	km2
lha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm **3**	0.061 02	cubic inches	1 cubic inch	16387 064	cm **3**
1 m3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m3
lm3	1.308 0	cubic yards	1 cubic yard	0.764 555	**m3**
			CAPACITY		
1L	1.759 755	pints	1 pint	0.568 261	L
1L	0.879 877	quarts	1 quart	1.136 522	L
1L	0.219 969	gallons	1 gallon	4.546 090	L
			MASS		
l g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28349 523	g
I g	0.032 150 75	ounces (troy)	1 ounce (troy)	31.103 476 **8**	g
1kg	2.204 62	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
It	1.102 311	tons (short)	1 ton (short)	0.907 184 74	t
1kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 **8**	kg
1**1**	0.984 206 5	tons (long)	1 ton (long)	1.016 046 908 8	t
			CONCENTRATION		
lg/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
lg/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factorswhich arein bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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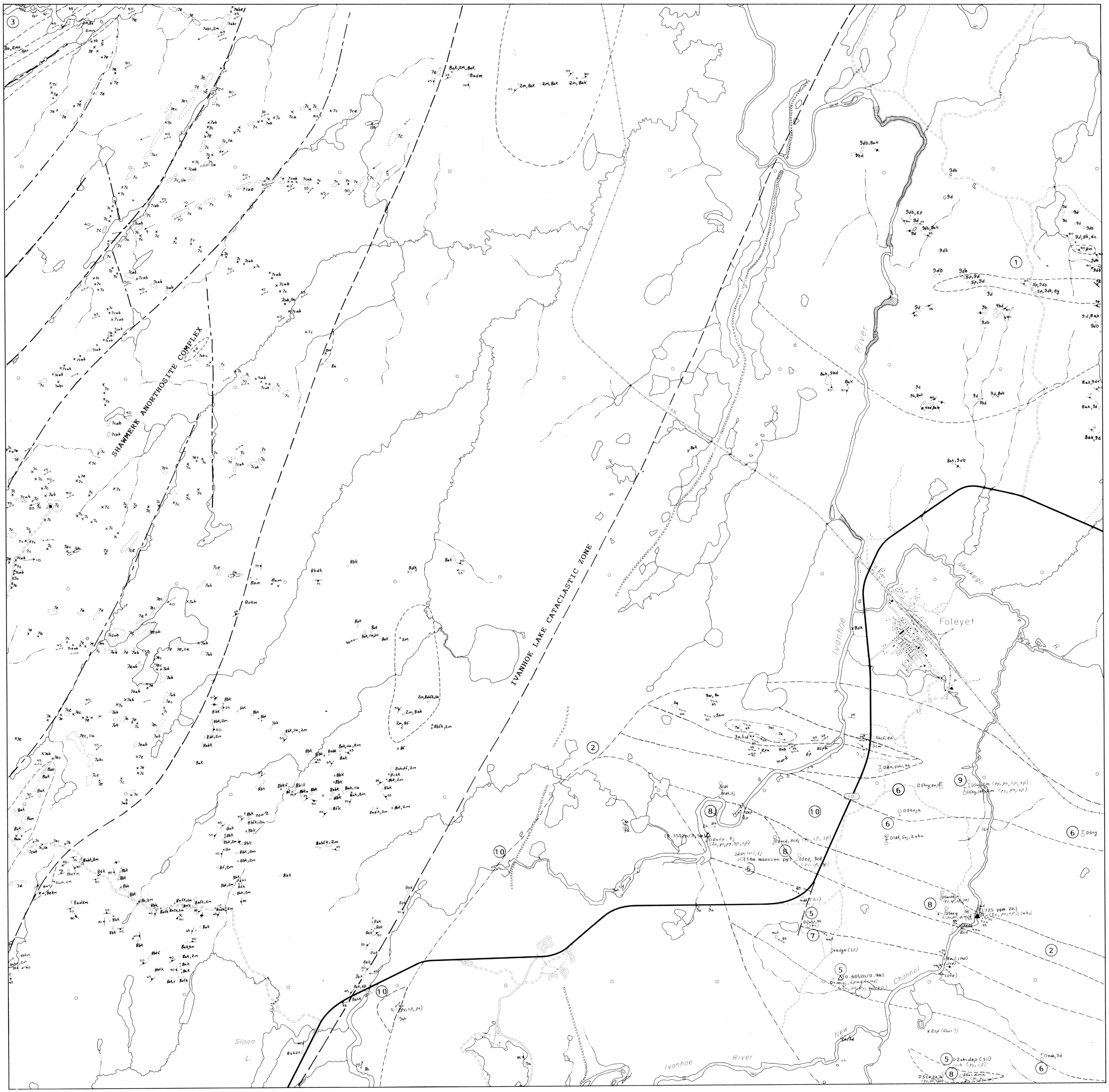

LEGEND[a]

PHANEROZOIC
CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Unconsolidated glacial, glacial-fluvial, lacustrine and fluvial deposits

UNCONFORMITY

PRECAMBRIAN
PROTEROZOIC

11 **Mafic Intrusive Rocks**
- 11a Diabase

INTRUSIVE CONTACT

ARCHEAN

10 **Alkalic Mafic Intrusive Rocks**
- 10a Biotite lampyrophyre
- 10b Ultramafic lampyrophyre

INTRUSIVE CONTACT

9 **Felsic to Intermediate Intrusive Rocks**[b]
- 9a Biotite &/or hornblende granodiorite, quartz monzodiorite
- 9b Biotite &/or hornblende granite
- 9c Biotite &/or hornblende tonalite, quartz diorite
- 9d Pegmatite
- 9f Feldspar porphyry
- 9h Alkali feldspar phenocrysts

INTRUSIVE CONTACT

8 **Foliated Felsic to Intermediate Intrusive Rocks**[b]
- 8a Hornblende &/or biotite tonalite, quartz diorite
- 8b Hornblende &/or biotite granodiorite, quartz monzodiorite
- 8c Biotite granite
- 8d Hornblende diorite
- 8e Hornblende &/or biotite monzonite, syenite
- 8f Pegmatite
- 8g Feldspar-quartz porphyry
- 8h Alkali feldspar phenocrysts
- 8j Epidotized
- 8k Intensely foliated to gneissic
- 8m Mylonite, pseudotachylyte

INTRUSIVE CONTACT

7 **Metamorphosed Mafic Intrusive Rocks**[c]
- 7a Gabbro
- 7b Melagabbro
- 7c Leucogabbro
- 7d Diorite
- 7e Anorthosite, anorthositic gabbro
- 7g Epidotized
- 7h Schistose to intensely foliated

INTRUSIVE CONTACT

6 **Metamorphosed Ultramafic Intrusive Rocks**[c]
- 6a Peridotite
- 6b Pyroxenite
- 6c Hornblendite

INTRUSIVE CONTACT

Metamorphosed Volcanic and Sedimentary Rocks[d]

5 **Sedimentary Rocks**
- 5a Wacke
- 5c Siltstone
- 5d Mudstone
- 5e Conglomerate
- 5f Tuffaceous wacke
- 5g Magnetite ironstone
- 5h Amphibole ironstone
- 5j Graphitic mudstone
- 5m Sulphide ironstone
- 5n Chert, siliceous siltstone
- 5p Paragneiss
- 5q Carbonatized
- 5r Garnetiferous

4 **Felsic Volcanic Rocks**
- 4a Tuff
- 4b Lapilli tuff
- 4c Tuff breccia
- 4d Massive flow
- 4f Brecciated flow
- 4g Monolithic fragments
- 4j Feldspar-phyric
- 4k Quartz-phyric
- 4m Carbonatized

3 **Intermediate Volcanic Rocks**
- 3a Tuff
- 3b Lapilli Tuff
- 3c Tuff breccia
- 3d Massive flow
- 3j Monolithic fragments
- 3k Heterolithic fragments
- 3m Feldspar-phyric
- 3n Quartz-phyric
- 3p Carbonatized
- 3r Schistose to intensely foliated

2 **Mafic Volcanic Rocks**
- 2a Fine-grained massive flow
- 2b Medium-grained massive flow
- 2c Pillowed flow
- 2d Amygdaloidal flow
- 2e Variolitic flow
- 2f Plagioclase-phyric
- 2g Quartz-phyric
- 2h Brecciated flow
- 2j Tuff
- 2k Lapilli tuff, tuff breccia
- 2m Amphibolitized
- 2n Garnetiferous
- 2p Calcium-carbonatized
- 2q Iron-carbonatized
- 2r Epidotized
- 2s Epidote clots
- 2u Schistose to intensely foliated

1 **Ultramafic Volcanic Rocks**
- 1a Massive to polyhedral-jointed flows
- 1b Spinifex-textured flows
- 1d Carbonatized
- 1e Epidotized
- 1f Schistose to intensely foliated

[a] *This is a field legend and may be changed as a result of subsequent laboratory investigations.*

[b] *The order of subdivision of units 8 and 9 does not necessarily indicate age relationships.*

[c] *May be in part extrusive.*

[d] *The order of subdivision of the major rock units does not indicate age relationships.*

Ministry of Northern Development and Mines
Ontario

Mines and Minerals Division
Ontario Geological Survey

Map P.3198

PRECAMBRIAN GEOLOGY

FOLEYET TOWNSHIP

DISTRICT OF SUDBURY

Scale 1:15 840

500 m 0 0.5 1 km
Mile 1/4 0 1/2 Mile

NTS Reference Numbers: 42 B/1, 42 B/2

NODA • EDNO CANADA ONTARIO
This publication was funded under the Minerals program of the Canada-Ontario Northern Ontario Development Agreement (NODA), a four year joint initiative signed November 4, 1991.

SYMBOLS

- Glacial striae
- Esker
- Small bedrock outcrop
- Area of bedrock outcrop
- Geological boundary, position interpreted
- Geological boundary geophysically inferred
- Fault
- Lineament
- Jointing (inclined, vertical)
- Shear zone
- Drag fold with plunge
- Antiform, synform
- Drill hole
- 0.2%Zn/3m Anomalous metal values for assessment file data
- 71 ppb Au Anomalous metal values from grab sample assays
- Widespread silicification alteration
- Property
- Bedding, top known; (inclined, vertical)
- Bedding top indicated by arrow
- Pillow lava
- Foliation (S_1, S_2)
- Gneissosity (inclined, vertical)
- Lineation with plunge (L_1, L_2)

ABBREVIATIONS

and	andalusite	mag	magnetite
Au	gold	po	pyrrhotite
cp	chalcopyrite	py	pyrite
cltd	chloritoid	sil	silification
Cu	copper	sp	sphalerite
gt	garnet	Zn	zinc

PROPERTIES, MINERAL OCCURRENCES, AND EXPLORATION WORK[ab]

1. Bruneau, C. [1977]
2. Cominco Ltd.
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6. International Nickel Company of Canada Ltd. [1966]
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[a] *Information current to Aug 31, 1991*

[b] *Date in square brackets indicates the last year of recorded exploration*

SOURCES OF INFORMATION

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Geology not tied to survey lines.

Magnetic declination approximately 7°09' west in 1991.

Metric conversion factor: 1 foot = 0.3048 m.

CREDITS

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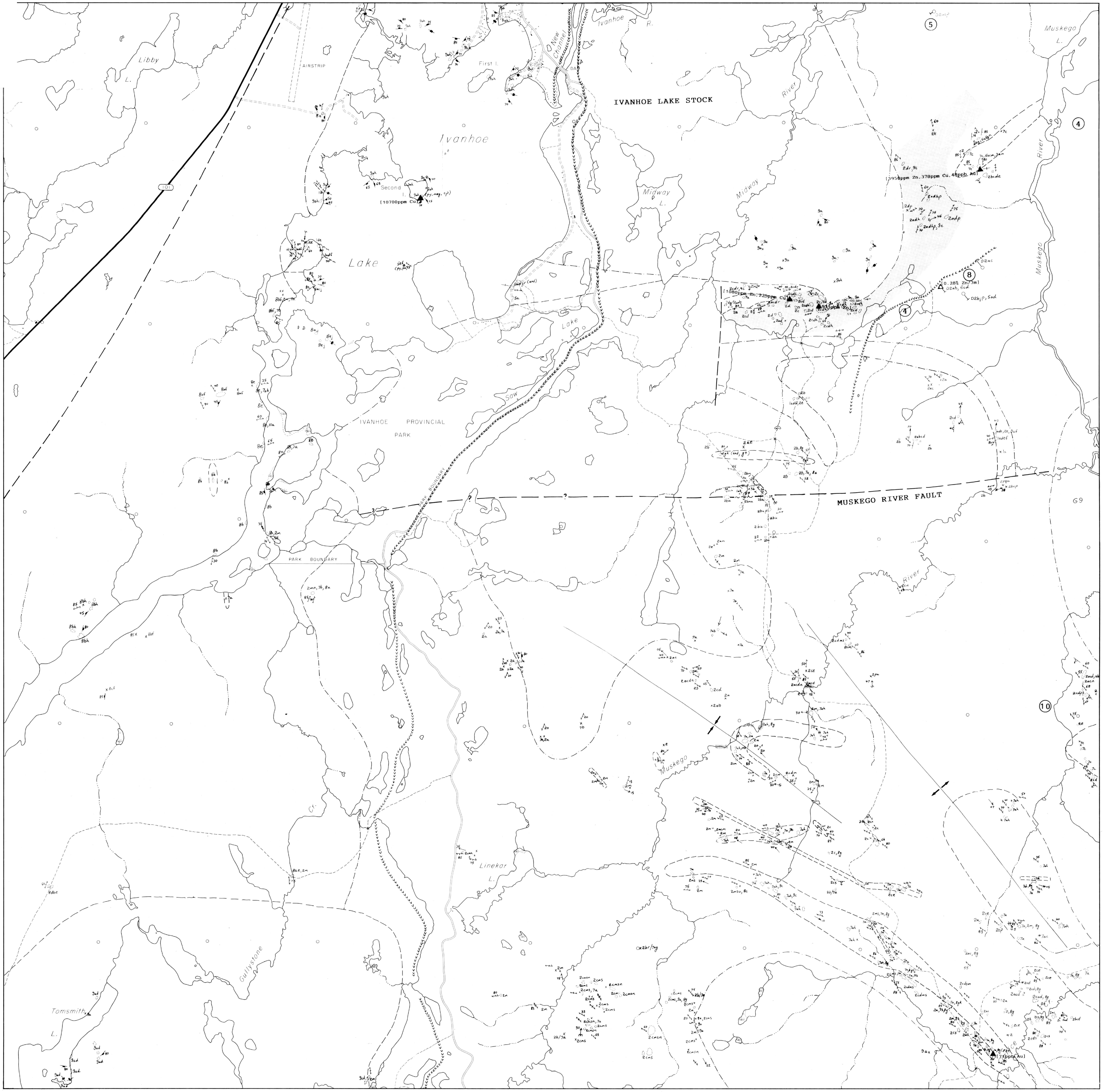

Ministry of Northern Development and Mines
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Map P.3199

PRECAMBRIAN GEOLOGY

IVANHOE TOWNSHIP

DISTRICT OF SUDBURY

Scale 1:15 840

500 m 0 0.5 1 km

Mile 1/4 0 1/2 Mile

NTS Reference Numbers: 42 B/7, 42 B/8

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