Minerals of Manitoba

Volume II: Metallic Minerals

Department of Mines, Natural
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Minerals of Manitoba

Volume II: Metallic minerals

by

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Cover plates:
Top left - Gold in limonitic veinlets cutting vein quartz (Elbow Lake)
Top right - Pyrrhotite accompanied by large black hornblende crystals and cut by small chalcopyrite veinlet (Dumbarton mine)
Bottom left - Chalcopyrite ore with graphitic gangue material (Mandy mine)
Bottom right - Sphalerite ore with minor pyrite and white plagioclase (Chisel Lake Mine)

Foreword

This publication is the third in an educational series intended to introduce the general public to the rocks and minerals of Manitoba. The first, entitled Common Rocks in Manitoba (1975), introduced the layman to the principal rocks likely to be encountered. The rock-forming, pegmatitic and non-metallic minerals were then described in the first volume of Minerals of Manitoba (1978), with details of their occurrences throughout the province. This paved the way for the present volume which, in describing Manitoba's metallic minerals, gives examples from widespread outcrops, orebodies and mineral deposits, some as far north as Lynn Lake, and others near the Trans-Canada highway at Falcon Lake. The numerous rock-dumps to be found on the surface at old mine-sites and near abandoned shafts are of great interest to rockhounds and mineral collectors. In thus describing both the operational and worked out mines of the province, as well as many exploration shafts, much information is incidentally given about the history of mining in Manitoba. The main purpose is, however, to describe Manitoba's rocks and minerals to the general public, while references to source documents are given at frequent intervals for the benefit of readers who may be interested in greater geological detail.

Colour Plates

Black and White Plates

Photography

All photographs were taken by Peter R. Beech of the Manitoba Government's Information Services. Museum specimens were kindly lent by Dr. G.E. Lammers, Chief Curator of the Manitoba Museum of Man and Nature. Others were from the collection of the Mineral Resources Division.

Colour separations by Litho Color Services Ltd.

Maps

Figures

Safety Precautions

To avoid serious eye-damage, protective goggles should be worn at all times when rocks are being hammered. Abandoned shafts and old workings should never be entered owing to the danger of rock-falls or cave-ins. For safety reasons, visits can only be made to operational mines at prearranged times, if permitted by the mine authorities. Further information on this subject could be obtained from the Mining Association of Manitoba, 405 - 155 Carlton Street, Winnipeg.

Acknowledgements

The writer acknowledges the arduous fieldwork of the pioneer prospectors who laid the foundation for Manitoba's present mining industry. The reader's attention is also invited to the list of References which gives the names of the numerous geologists whose published works have formed the basis of the present review. Personal thanks are due to W.D. McRitchie, R.F.J. Scoates, J.W. Stewart, G.H. Gale, P. Theyer, R.H. Pinsent, and S. Singh for script-reading and helpful suggestions. Other contemporary colleagues whose published works have proved of great value are J.F. Stephenson, W. Weber, A.H. Bailes and D.C.P. Schledewitz.

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Produced by Magnescan

Iron Oxide Minerals

A) Banded iron formation showing magnetite and quartz bands (Knee Lake)

Various iron oxide minerals can be readily seen in outcrops in Manitoba; iron-titanium and iron-chromium oxides can also be found. The minerals considered here are:

Magnetite .... Fe_3O_4
Hematite .... Fe_2O_3
Goethite .... FeO(OH)
Ilmenite .... FeO TiO_2
Chromite .... FeO Cr_2O_3

MAGNETITE (plate 1) is a hard black mineral, easily recognized by its strong magnetic properties; loose grains react immediately to a hand magnet, and larger concentrations will divert a compass needle. Individual crystals are often octahedral in shape (figs. 1, 2); they lack true cleavage but frequently show octahedral partings. Magnetite is an important iron-ore mineral in Ontario, Quebec and Labrador. Elsewhere, grains of magnetite are concentrated in black sand beaches that make up some shoreline deposits. In some parts of the world, large black sand deposits have been worked as iron-ore, as the magnetite can easily be extracted by electro-magnets. The source of the magnetite is typically a basic igneous rock such as gabbro, anorthosite or basalt in which primary magnetite had crystallized from the magma at high temperature. Magnetite is also a common accessory mineral in many other igneous rocks.

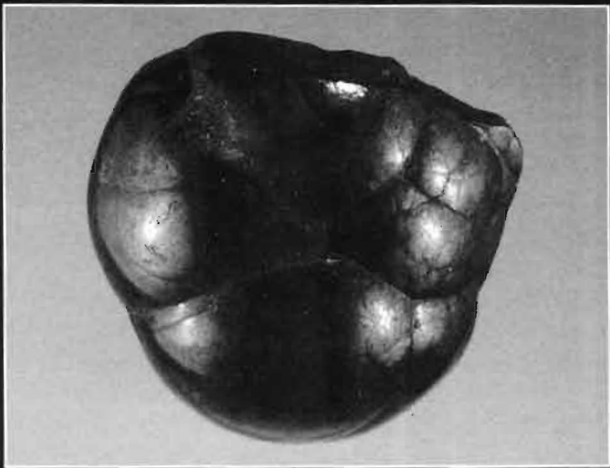
A common mode of occurrence for magnetite is in the rocks known as iron formation, many of which are strongly banded (plate A). There are various types of iron formation, not all of which contain magnetite, but most are generally considered to have originated as chemically precipitated sediments on the sea-floor. The Precambrian iron formations in Manitoba have almost invariably been altered by metamorphism however, and magnetite has in many cases been formed through the breakdown of other iron-rich minerals. Magnetic iron formation in Manitoba consists essentially of dark, magnetite-rich bands, usually from a millimetre to several centimetres in thickness, alternating with pale cherty or quartzitic bands which are commonly somewhat thicker.

In SOUTHEAST MANITOBA, magnetite of metamorphic origin is associated with garnet-rich layers in dark schistose greywacke along the south shore of **Bird Lake.** Magnetite-rich beds alternate with siliceous bands, and beds containing up to 75 per cent garnet. Cordierite-bearing rock is closely assoicated with the greywacke. The garnet-magnetite outcrops (B 1)* are on and near a small island about 3 km east of the outlet of Bird River. Nearby, the **Dumbarton** nickel-copper mine (see B 12) was noteworthy for an abundance of magnetite with the sulphide ore. Some of the magnetite is in massive form and some, accompanied by iron sulphides, is interbedded with chert; this rock has been referred to as sulphidized iron formation. Three kilometres to the west-southwest, gabbro at the **Wento** copper prospect (see B 13) contains masses of titaniferous magnetite.

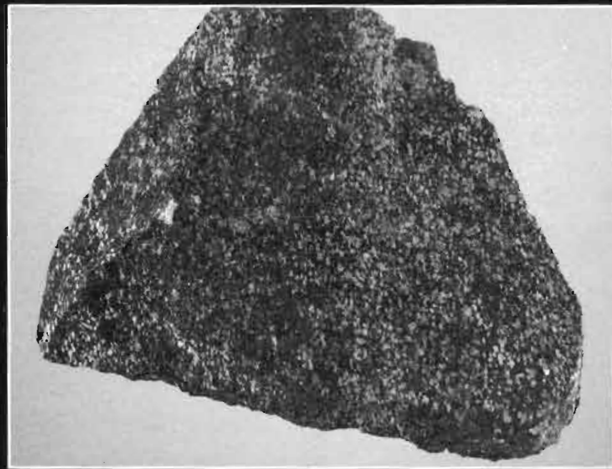
References: Davies 1955; Davies *et al* 1962, p. 43; Karup-Moller & Brummer 1971; Phillips 1978, map C; Wilson *et al* 1972, pp 40-42

More typical iron formation is fairly common in the altered sedimentary rocks of the Rice Lake

**Such references are used throughout to indicate the relevant map (A, B, C, etc) and locality (1, 2, 3, etc) within this volume.*



B) Hematite in the form known as kidney-ore (Museum)



C) White pseudomorphs of serpentine after olivine in black chromite groundmass (Bird River Sill)

Group in southeast Manitoba. One or two small outcrops occur along the north shore of **Wanipigow Lake** (C 1-2) in a greywacke-argillite sequence, and there are a few scattered outcrops 4 to 11 km to the east-southeast, north of the Wanipigow River (C 3-4). The best outcrops of magnetic iron formation are found however at **Wallace Lake**, where they are associated with arkose, grit and conglomerate of the Rice Lake Group. Outcrops (C 5-6) can be seen on the northwest and south shores of the largest island, and the shorelines to the north and east. The iron formation extends eastward along the north side of the Wanipigow River. The outcrops (C 7), about 3 km east of Wallace Lake and a few hundred metres north of the river, are underlain to the south by quartzite and gabbro. Between these rocks and the river there are some striking outcrops of gossan (see Goethite), derived from the weathering of iron sulphides that occur with garnet, magnetite and actinolite.

Argillite of the Rice Lake Group, with minor greywacke and lesser amounts of chert and iron formation, strikes northwest from **Gem Lake** to Long Lake (C 8); iron formation is exposed on the shore, southeast to the westernmost tip of Gem Lake (C 9). Iron formation also occurs with schist and paragneiss around Garner Lake and northwestward to Beresford and Moore Lake. A band of iron formation a few hundred metres east of southern **Beresford Lake** (C 10) strikes northeasterly for about 1.5 km. A firsthand description of these and other outcrops (C11) in this area was given by Russell as follows:

...iron formation with abundant ferruginous limestone was found near the north end of the Garner Lake-Beresford Lake portage. On a ridge to the east of the first rock encountered southward from Beresford Lake (along the winter road) five more beds of iron formation were found. Traverses east of Beresford Lake and Moore Lake show that this wide zone of iron formation beds is continuous northward and curves parallel to the east shores of Beresford Lake and Moore Lake...(East of the south end of Moore Lake) eight parallel bands of iron formation are exposed. Near Moore Lake the iron formation is highly siliceous and composed of uniform beds of quartzite (one half to one inch thick) separated by thin beds (one eighth to one quarter inch thick) of granular magnetite...(A little further east) five-foot bands of nearly pure magnetite were seen...between massive bodies of diorite.

References: Marr 1971; McRitchie 1971a, p 112, 1971b; Phillips 1978, map D; Russell 1952b; Weber 1971a

In the SNOW LAKE AREA, iron formation has been recorded in the **Grass River Provincial Park**, associated with a pyroclastic-greywacke sequence. The best exposure (F 1) is in a railway cutting near milepost 11, about 2 km west of the railway bridge over the Grass River. Large, dark grey outcrops show thin cherty and iron-rich bands, only a few millimetres thick, associated with volcanic schists. The iron-rich bands consist mainly of magnetite but iron sulphides are also present. Magnetite-rich iron formation again crops out on the east bank of the Grass River (F 2) about halfway between the railway bridge and **Iskwasum Lake**, which is another 5 km downstream. Trenches on the west side of the river, near its entrance to Iskwasum Lake (F 3) show disseminated magnetite as well as sulphides in altered gabbro.

There is very little magnetite in the copper-zinc mines around Flin Flon, but towards **Snow Lake** this mineral is relatively common owing to the higher grade of metamorphism. Magnetite is particularly abundant at the **Dickstone** copper mine (F 6), associated with the major sulphides; it occurs in large rounded grains with good cleavage. At the **Stall Lake** mine (G 4) of Hudson Bay Mining and Smelting Company Limited, magnetite occurs as tiny crystals in the hornblende gneiss host-rock, and a few large crystals are found in the sulphide orebodies. At the **Anderson Lake** mine also (G 3), magnetite is a minor associate of the ore minerals, appearing as grains with prominent cleavage.

References: Grice 1976; Hunt 1970; Phillips 1978, maps I & L; Sabina 1972

In the CROSS LAKE AREA, there is a good example of primary magnetite in the **Pipestone Lake** sill (N 1), about 65 km northeast of Lake Winnipeg and only a few kilometres southeast of Cross Lake. The sill, which is composed of gabbro and anorthosite, is about 1200 m wide, dips almost vertically, and strikes east-west for several kilometres. The sill has intruded the contact zone between a gneiss complex to the south and greenstones to the north. Hornblende gabbro is one of the major sill-rocks, grading to massive grey anorthosite which is composed mainly of labradorite with small amounts of hornblende and magnetite. Ovoid-shaped clusters of labradorite in the gabbro are enclosed in a hornblende-rich groundmass that may contain up to 20 percent magnetite in clots and bands. Offshoots of the sill occur in basalt along the south shore of Pipestone Lake, and a magnetite-rich zone, 30 m in width, has been traced along the shore for 1 km or more by means of a magnetometer survey. Some massive layers of magnetite in this zone are as much as 3 m thick. Microscopic studies have shown that the main ore-mineral is vanadium-bearing titaniferous magnetite; the titanium content is due to ilmenite, microscopically intergrown within the magnetite which occurs with hornblende and chlorite between crystals of plagioclase.

References: Bell 1962; Rose 1967; Rousell 1965

In the NICKEL BELT, iron formation is associated with the feldspathic quartzites and other altered sedimentary rocks of the Thompson belt, which extend in a zone over 6 km wide between Setting Lake in the southwest and Moak Lake in the northeast. The iron formation is composed of coarsely crystalline quartz and dark bands that contain garnet, amphibole, carbonate, biotite and pyrrhotite in addition to magnetite, as at the Thompson mine. On the north shore of **Mystery Lake**, thin-bedded iron formation has been traced northward along strike for about 2 km (I 1); it is a black, fine-grained rock containing 50 percent quartz, 35 percent biotite, and 15 percent magnetite in small scattered grains. There are also a few small exposures of iron formation on the west shore of Mystery Lake. Along the railroad right-of-way northeast of Mystery Lake, outcrops show iron formation in which bands rich in quartz and magnetite alternate with thicker quartz-biotite bands; this rock is surrounded by well foliated diorite. Between Mystery Lake and Moak Lake (map I), contorted iron formation is well exposed in a borrow pit by a trail just north of the main road, 7 km northeast of the Thompson Ski Club; as well as magnetite and quartz, this rock contains garnet and an iron-rich amphibole believed to be grunerite.

Elsewhere in the Nickel Belt, three small

Fig. 1: Octahedral crystal of magnetite

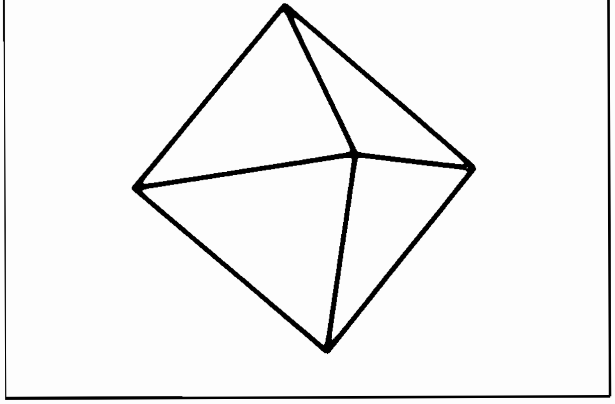
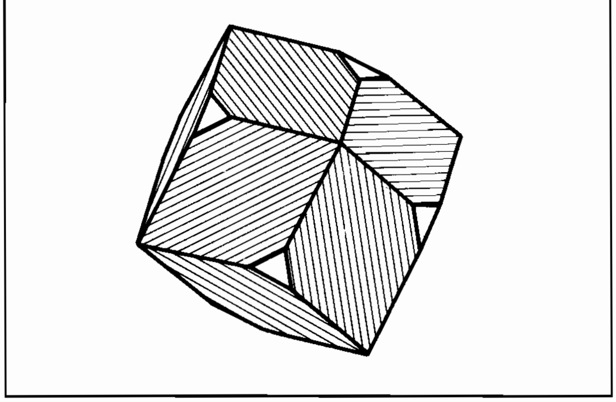


Fig. 2: Magnetite crystal with dodecahedral faces (striated) and small octhedral faces



outcrops of iron formation have been recorded just north of **Nichols Lake** (I 2), 3 km southeast of Ospwagan Lake; they consist of massive quartz-magnetite rock with variable garnet and amphibole. Twenty kilometres to the southwest, magnetic iron formation crops out near the northwest and southeast shores of **Joey Lake** (I 3). It is a medium to coarse-grained grey to brownish rock that weathers rusty red. Fresh rock is dense, massive and siliceous, but the weathered surfaces are crumbly and friable. Fresh hand specimens show magnetite and pyrrhotite with quartz, coarse red garnet and black pyroxene.

Another important mode of occurrence for magnetite in the Nickel Belt is in serpentinite, as at **Ospwagan Lake**, where magnetite makes up about ten percent of the rock as a result of the metamorphic breakdown of olivine and pyroxene. This rock is best exposed on a broad peninsula on the east side of the lake (I 4), cropping out on the east point of a small, north-facing bay. (We may note in passing that the gossan on the west point of the same bay, 230 m across the water, represents one of the best-mineralized locations around Ospwagan Lake: a heavily rusted shear zone has been trenched for over 35 m, revealing pyrrhotite in greywacke-schist. Gossans are defined subsequently under the heading of Goethite.) Serpentinized peridotite at **Mystery Lake** (I 5) is cut by irregular joints that are filled with coarse magnetite, chert, white fibrous serpentine and coarse calcite crystals. Serpentinite near **Moak Lake** shows fractures filled with magnetite, as seen on the nearby waste-dumps (I 6).

Magnetite is widespread as a common accessory mineral in the orebodies of the Nickel Belt. It forms overgrowths around cores of chromite at the **Birchtree** (I 9) and Pipe mines; these compound crystals are in octahedra several millimetres in diameter at the **Pipe Mine** (I 7). At the **Thompson Mine** (I 8), well shaped grains of magnetite occur in coarse-grained sulphide ore. At the **Manibridge** (H 5), Pipe and Birchtree mines, secondary magnetite forms an asbestiform replacement product, resulting from the serpentinization of olivine and pyroxene.

References: Coats et *al* 1972; Gill 1951; Godard 1966; Grice 1976; Patterson 1963; Phillips 1978, map Q; Quirke et *al* 1970; Stephenson 1974

In the RAT LAKE AREA, metamorphic effects include the widespread development of magnetite. Biotite-magnetite gneiss extending south from **Rat Lake** (J 1) has a spotted appearance due to quartzo-feldspathic knots with magnetite cores. Similar features are shown by some bodies of grey, schistose quartz-diorite which may contain 5 percent magnetite. Some of these quartz-diorite masses (J 2), west of the north end of Rat Lake, are several kilometres long and enclosed in microcline granite. Others, immediately north and east of Rat Lake, are in concordant contact with hornblende-biotite-magnetite gneiss, and cordierite-sillimanite-anthophyllite-biotite gneiss.

References: Phillips 1978, map S; Schledewitz 1972, map 71-2-2

In the LYNN LAKE - GRANVILLE LAKE REGION, magnetite is a common accessory mineral in the Black Trout diorite, an altered, fine to medium-grained rock which consists mainly of black biotite, grey plagioclase, quartz, and enough disseminated magnetite to cause strong magnetic effects. The magnetite would appear to have been largely derived from the breakdown of earlier ferromagnesian minerals, such as the hornblende that has been extensively replaced by biotite. At **Lasthope Lake**, 27 km south-southeast of Lynn Lake (and 11 km northwest of Black Trout Lake), outcrops of the diorite (M 1) show grains of magnetite several millimetres in diameter on their weathered surfaces. Extensive outcrops along the southeast shore of **Amy Lake** (M 2) are part of an elongated sill of the diorite. Other sills of Black Trout diorite around Metcalfe Bay (M 3-4), in the southwestern part of **Granville Lake**, form sinuous ridges up to 150 m in width; the rock contains up to 5 percent magnetite.

References: Fawley 1949, 1952; Godard 1966a; Milligan 1960, Maps 6 & 10; Pollock 1966

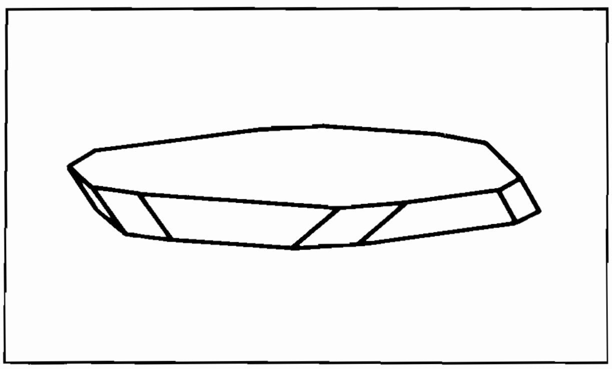


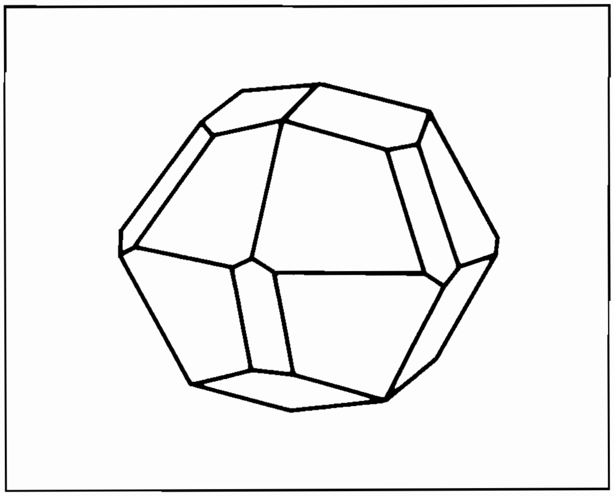
Fig. 3: Tabular crystal of hematite

HEMATITE occurs in a variety of forms (figs. 3, 4) but all are characterized by their brownish red streak. Crystals are steel-black and usually tabular, with prominent basal planes and bevelled rhombohedral edges. Some scaly micaceous varieties can be scratched with a knife but this is not generally possible with typical crystals. Platy or flaky crystals with brilliant metallic lustre are called specularite (plate 2). Thin plates may be grouped in rosettes known as iron roses. The name martite is applied to hematite that has replaced magnetite pseudomorphically, often retaining the octahedral shape. Turgite is hematite containing adsorbed water. Large deposits of hematite frequently show many botryoidal or reniform shapes, as seen in kidney ore (plate B). Still more abundant are the earthy varieties, including red ochre. Oolitic deposits of hematite are found in some sedimentary rocks (plate 3).

Worldwide, hematite is the most important of the iron-ore minerals. It forms huge deposits in sedimentary rocks of all ages; iron concentrations have often been enriched by post-depositional metamorphic or oxidation processes. The best known hematite deposits are the enormous Lake Superior iron formations in the United States; the iron-ore varies from hard specular hematite to the soft red earthy types. Orebodies have resulted from the concentration in favourable locations of the iron content of sedimentary rocks that were originally rich in iron carbonates and iron silicates; the action of circulating waters and subsequent dehydration have been important factors. Some highly metamorphosed iron formations, such as the ore deposits in northern Baffin Island, contain hard, dark grey to blue hematite, and also interbanded magnetite and specularite.

In Manitoba, hematite is found as an accessory mineral in igneous rocks, as a low-grade metamorphic mineral, and as a vein-mineral filling cracks in quartz veins. Because hematite forms at lower temperatures than magnetite, it is less common in the high-grade metamorphic rocks, but

Fig. 4: Complex rounded crystal of hematite



may occur as a lower grade alteration product of magnetite or other iron-rich minerals. The red iron oxide staining on many rock-surfaces is familiar evidence of the presence of hematite, but large concentrations are relatively few in Manitoba. The best known hematite deposit is in LAKE WINNIPEG and falls within the Hecla Provincial Park. The outcrops at Red Cliff (D 1), on the south shore of **Black Island**, attracted the attention of early explorers in the 18th century. Most of the island is overlain by glacial drift, and the underlying bedrock is mainly Ordovician, except for the Precambrian rocks at the northeast end of the island, and the localized red hematite rocks near the middle of the southerly shore. The white sandstone cliffs (up to 20 m high) that are worked for silica sand along the northwest and southeast shores belong to the Winnipeg formation at the base of the Ordovician; the sandstone was laid down on an eroded surface of the Precambrian Shield. The bedrock in the southwest part of the island (not well exposed) is mottled dolomitic limestone of the Red River formation which overlies the sandstone. The oldest Precambrian rocks are the altered volcanics that crop out at the north end of the island and on the Gray Point peninsula; they consits of andesite, basalt, chlorite schist and rhyolite. Hornblende gabbro also crops out on the north shore and on Cairine and nearby islands; pronounced schistosity causes the weathered gabbro to break readily into slabs. The host-rock for the hematite is quartz-sericite schist, derived from the alteration of arkose, as seen on the mainland at the mouth of Wanipigow River and on offshore islands. The quartz-sericite schist on the mainland (Hole River Reservation) shows streaky red hematite stains. The Black Island hematite is exposed in a low cliff overlooking a beach; the outcrops extend about 100 m along the shore. The red iron-ore is composed of concretionary hematite in a groundmass of calcite. The rounded concretions may be oolitic (diameter less than 2 mm) or pisolitic (more than 2 mm). Much of the ore consists of agglomerated or botryoidal masses of concretionary hematite or turgite (plate 4). The calcite is known to be later than the hematite because it fills cracks in shattered pisolites. Diamond drilling in 1943, at a downward angle of 45°, passed through a hematitic zone (0 to 38 m) into a hematite-pyrite zone (38 to 59 m) in which pyrite is partially ozidized to hematite; and then into a zone of graphitic schist with much pyrite, both disseminated and in solid masses. The pyritic zone was traced to 148 m down the non-vertical drill-hole. From this data it was inferred that a capping of rusty limonitic gossan (see Goethite) had once formed over the pyrite deposit, owing to surface weathering conditions before the Ordovician sandstone was deposited. After being buried beneath the Palaeozoic sediments, the ferric (limonitic) hydroxides eventually became dehydrated to form ferric oxide (hematite).

References: Baillie 1952; Brownell & Kliske 1945; Davies 1951; Phillips 1978, map D

In the GRASS RIVER PROVINCIAL PARK, some serpentinites and associated rocks contain sufficient hematite to impart a strong red colouration. Serpentinite is well exposed along the railway track 100 m west of the bridge over the Grass River. Red hematite occurs as scattered grains derived from magnetite, and is also finely dispersed along fractures in the rock. Some of the iron oxides outline the shape of ferromagnesian minerals that have been replaced. Quartz-dolomite veinlets and finely disseminated hematite both add to the mottled and streaky appearance of the serpentinite. The contact rocks, exposed west of the serpentinite over a width of about 50 m, are volcanic schists rich in talc, hematite and dolomite; the hematite-rich rocks (F 4) are easily recognized by their strong red colours. Similar rocks occur downstream on the banks and islands of the Grass River: hematite-rich schist (F 5) is recorded in a wide backwater east of the main stream, 1.5 km north of the bottleneck through which the river flows into **Iskwasum Lake.** Microscopically, the red rock is seen to consist of hematite, talc, dolomite and very fine-grained quartz; dolomite may form 30 percent of the rock, and magnetite, partly altered to martite, up to 20 percent.

References: Hunt 1970; Phillips 1978, map I

In the BARRINGTON LAKE AREA, an extensive zone of iron formation contains relatively large amounts of hematite interbanded with chert. The hematitic iron formation is associated with magnetite-bearing slates, and these rocks have together been traced for a distance of about 5 km within a width of 400 m. The outcrop-zone (K 1) trends westerly from a locality about 1.5 km west of **White Owl Lake** through **Farley and Gordon Lakes.** These three small lakes were reached by portages from Barrington Lake. The best outcrops, 2 km west of Gordon Lake, are 8 km north-northeast of Hughes Lake, which adjoins provincial road 391. The dominant rock-type in these outcrops is banded iron formation consisting mainly of hematite and chert. Some hematite bands are over 2 cm in width, and the cherty interbands generally less than 0.5 cm. In places the hematite is interbedded with fine-grained, greenish grey, siliceous argillite. The magnetite-bearing slate is a dark grey to black, well banded rock containing abundant small octahedra of magnetite in an argillaceous groundmass; a small outcrop between Gordon and Farley Lakes shows many distinct beds, up to 1 cm thick, composed almost entirely of magnetite.

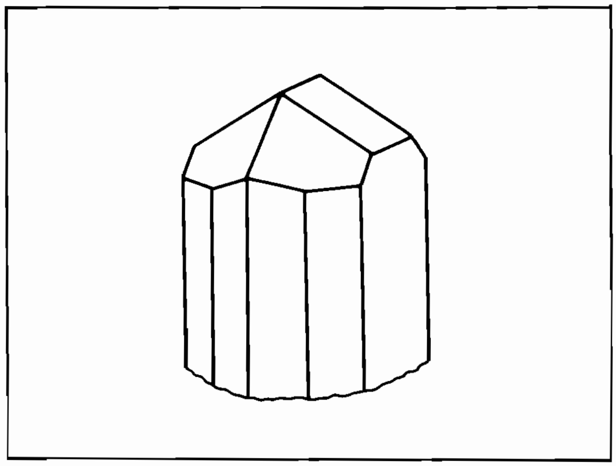


Fig. 5: Prismatic crystal of goethite

References: Milligan 1960, Appendix C, Maps 3 & 10; Phillips 1978, map S; Stanton 1948

GOETHITE is a dark brown to black mineral that forms as hydrous ferric iron oxide in the zone of weathering. It is an abundant alteration-product of iron-bearing minerals such as pyrite, pyrrhotite, magnetite, chalcopyrite and siderite. Its crystalline form is prismatic to acicular (fig. 5) but distinct crystals are rarely seen. Radiating fibrous aggregates are typical (plate 5), and massive, reniform or stalactitic varieties are common. Goethite can be scratched with a knife and has a yellowish brown streak. Yellow ochre is clay, coloured yellow by finely divided goethite. Goethite is a very important iron-ore mineral where it occurs with hematite in huge deposits of the Lake Superior type. This type of iron-ore is derived from iron formation by natural, near-surface weathering processes that bring about concentration of iron oxides and leaching out of silica and other impurities. **Limonite**, though not a mineral species, is a useful field term for amorphous mixtures of impure hydrous ferric oxides that often form on iron-rich outcrops (plate 6); such mixtures may consist mainly of goethite, together with substances such as clay, earthy hematite, manganese oxides, siderite, calcite, quartz and fragments of other rocks and minerals. Thick, extensive occurrences of this nature, known as **gossans** (plate 7), are sought by prospectors because they frequently represent a superficial cover derived from the weathering of pyrite or pyrrhotite, with which other, valuable metallic minerals may be associated. Pits or trenches are dug through the gossan to determine whether the underlying rock contains iron sulphides and, if so, whether they are accompanied by sulphides containing copper, zinc, nickel or other valuable metals. The possibility that gold may be present is tested by panning the oxidized material, as described under Gold.

In the FLIN FLON AREA, rusty, yellowish brown goethite forms a powdery coating on pyritic schist at the **Baker Patton** deposit (E 8), and on pyrite-bearing rocks at the **North Star-Don Jon** mine dumps (E 9). Similar alteration can be seen wherever iron sulphide minerals have been affected by weathering. Fresh, unoxidized sulphide specimens are in fact not easy to find except from underground sources.

In SOUTHEAST MANITOBA, the greenstone belt that trends parallel to **Falcon Lake** contains numerous gossans (Map A), some of considerable size. The underlying sulphide bodies are mainly pyrrhotite, but some also contain much pyrite. The numerous pits and trenches that have been dug into these gossans mostly date back to the first quarter of the century, when the area was intensively prospected for gold. The sulphide concentrations occur mainly in the sedimentary rocks that are interbedded with the volcanics of the greenstone belt; they have the form of pods, lenses and stringers of solid sulphides occupying shear zones that strike easterly or northeasterly. Some of the gossans contain variable amounts of quartz. In addition to the massive sulphide gossans, there are places where sulphides are widely scattered throughout the sedimentary rocks, giving rise to rusty-looking weathered surfaces. The largest of the massive gossans are several hundred metres in length, as can be readily seen in the sedimentary rocks of **West Hawk and Star Lake** (Map A). The gossan parallel to, and 140 m south of Howe Bay is about 450 m long; it is part of a gossan-zone that trends west for over 2 km, crossing highway 44 southwest of Howe Bay. Another large gossan occupies the north end of a wide peninsula in the southwest part of Star Lake. Other examples are shown on Map A.

References: Davies 1954, pp 27-28; Davies et *al* 1962, pp 30, 36 & fig. 8; Phillips 1975, pp 16-17 & fig. 3; Springer 1952, pp 14 & 20

ELSEWHERE, selected examples of **gossans**, or limonitic iron sulphide occurrences, are shown on other accompanying maps. Most of these are old prospects of no economic value, and they are shown for no other purpose than that of demonstrating to interested amateurs the kind of surface indications that prospectors look for. Few of these locations are likely to provide collectors with fresh crystalline specimens. Sources of information may be found by referring to numbered mineral occurrences shown nearby on the respective maps.

ILMENITE, a ferrous titanate, is an important ore-mineral of titanium. It is a hard black mineral with metallic lustre and a black to brown streak. Crystals of ilmenite are generally tabular in shape (figs. 6,7) with prominent basal planes, and they often show a thin, platy habit. Ilmenite is often associated with magnetite and microscopic intergrowths of the two minerals are not unusual; the presence of minor magnetite may cause ilmenite crystals to display slight magnetism. Magnetite deposits, on the other hand, may contain small proportions of ilmenite, as in the titaniferous magnetite of the Pipestone Lake sill (Map N). Titanic iron ore is ilmenite with microscopically intergrown hematite, causing a modification of the streak to reddish brown. Grains of ilmenite may, like magnetite, be concentrated in black sands, and large beach deposits have been worked in some parts of the world. The major ilmenite ore deposits in the Canadian Shield, however, are compact crystalline masses of magmatic origin, associated with gabbro-anorthosite intrusions. The large ilmenite deposits of eastern Quebec are of this type, occurring as dykes and sills of ilmenite in gabbro-anorthosite. The high-grade Lac Tio deposit near Allard Lake is one of the world's largest open-pit ilmenite mines.

Reference: Rose 1969

In NORTHERN MANITOBA, ilmenite is an accessory mineral in some basic to intermediate igneous rocks, and also occurs in certain metamorphic rocks. No concentrations of economic value are currently known however. Among the more extensive occurrences are those associated with the porphyritic, altered volcanic rocks (J 3) around "Esker Lake", 5 km southeast of **Ruttan Lake.** Most of the phenocrysts are hornblende and plagioclase, but magnetite and ilmenite phenocrysts are widespread in the porphyritic basalts and picrites; the phenocrysts are corroded and extremely variable in size. At the nearby Ruttan copper-zinc mine (J 4), needles and blebs of ilmenite are fairly common; the major host-rock is amphibolite derived from the basic volcanic rocks. Subsidiary magnetite and rutile are closely associated with the ilmenite.

References: Grice 1976; Phillips 1978, map S; Steeves & Lamb 1972, map 71-2-6

Likewise, at the **Fox Lake** copper-zinc mine, which is about 130 km to the west, ilmenite and magnetite are also present as minor metallic minerals (L 2). The principal host-rock is hornblende-biotite gneiss of the greenstone belt. It is interesting to note that samples of the Dunphy Lakes gabbro, which adjoins the greenstones, were found to contain up to 5 percent titanite (sphene) and ilmenite. These minerals were not found in related gabbros elsewhere in the Lynn Lake region.

References: Grice 1976; Milligan 1960; Phillips 1978, map T

At the Lynn Lake mine, ilmenite is occasionally found with magnetite but is not abundant. Three kilometres to the southwest however, ilmenite of clearly metamorphic origin accompanies garnet in a banded amphibole-carbonate rock that is interbedded with greywacke. The garnet-bearing rocks (L 1) crop out intermittently for about 1.5 km between **Sheila Lake** and a locality slightly south of **Margaret Lake.**

References: Emslie & Moore 1961; Phillips 1978, map T

At **Melvin Lake,** which lies 60 km northeast of Lynn Lake and immediately north of Barrington Lake, ilmenite occurs in an igneous complex, consisting of gabbro, anorthosite and diorite, that has intruded granitic gneisses. From outcrops (K 2-3) mapped on islands and the northeast shore of the lake, the basic intrusion appears to trend northeast for about 8 km, with a maximum width of 2.5 km across the southerly islands. The anorthosite is composed of labradorite with minor amounts of pale green, fibrous amphibole, and it appears to grade into hornblende gabbro. Locally however, the gabbro contains up to 25 percent hypersthene. The diorite, much of which is coarse-grained to pegmatitic, occurs mainly in the outer zones of the complex. In a few places, coarse-grained dykes of diorite cut the anorthosite and gabbro. The diorite is composed of andesine and hornblende, with increasing amounts of quartz where it has intruded the surrounding gneisses. Grains of ilmenite are scattered throughout the diorite, with local concentrations up to 3 percent in the coarse-grained phases. Field observations showed that the coarse marginal diorite had undergone considerable alteration as a result of its interaction with the contact gneisses, and the ilmenite appears microscopically to have been an alteration product. Although ilmenite was not identified in the gabbro or the anorthosite, it can nevertheless be assumed that the titanium originated within the basic

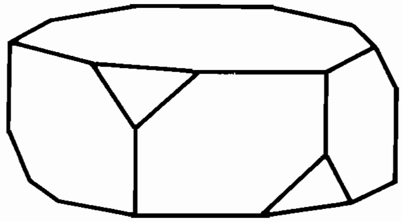


Fig. 6: Tabular crystal of ilmenite showing prismatic side-faces

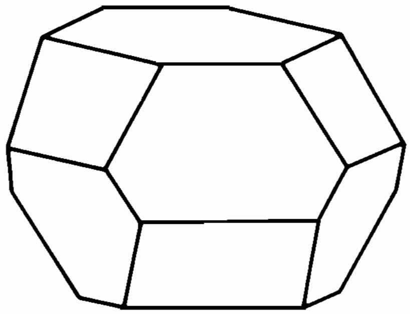


Fig. 7: Thick tabular crystal of ilmenite showing rhombohedral side-faces

igneous magma and was subsequently redistributed.

Reference: Hunter 1952

In SOUTHEAST MANITOBA, considerable amounts of granular ilmenite are associated with massive magnetite, which is widespread, at the **Dumbarton mine** (B 12) where nickel-copper ore was produced. The principal host-rock is amphibolite derived from andesite. On its south side, the andesite is in contact with the Bird River sill, a very large layered intrusion composed essentially of gabbro and peridotite. The gabbro grades locally into anorthosite, and in places contains titanomagnetite and titanite (sphene) as accessory minerals.

References: Davies 1952; Davies *et al* 1962, p 37; Karup-Møller & Brummer 1971

CHROMITE, the ore-mineral of chromium, occurs as disseminated grains and granular masses in ultrabasic rocks and serpentinites. The black octahedral crystals somewhat resemble magnetite, but are non-magnetic and have a sub-metallic to pitchy lustre; the streak may by dark brown rather than black. Weathered chromite may show yellow or green oxidation products. Ideally the chromium oxide content (Cr_2O_3) represents 68 percent by weight, and iron oxide (FeO) 32 percent of chromite, but usually the iron is partially replaced by magnesium, and the chromium by aluminum and ferric iron.

In SOUTHEAST MANITOBA, The **Bird River** gabbro-peridotite sill contains very large but low-grade deposits, discovered in 1942, of chromite associated with serpentine (plate C). The chromite contains relatively high proportions of alumina and iron. The low chrome to iron ratio (1.4:1) has inhibited mining activites under prevailing market conditions. Many outcrops of the sill, which has an average thickness of about 1 km, are strung out along a 30 km zone north of Bird River, between Lac du Bonnet and Bird Lake. These outcrops, which include many of the chromite deposits, represent the southern limb of a large fold structure; they show steep dips, generally to the south. The principal outcrops of the northern limb are 20 km to the north, near **Cat Lake.** Along the southern limb, both the sill, and the greenstones that it has intruded, have been cut into numerous segments by cross-faults, some of which have caused offsets of over a mile. A major strike-fault marks the contact of the sill with the greenstone belt west of Bird Lake. Both the greenstones and the sill have been affected by the emplacement of a younger mass of granite to tonalite, and its pegmatitic offshoots.

The sill shows strong primary layering, apparently due to sinking of the heavier crystals as the magma cooled, and before steep dips were imposed by later deformation. This would account for the position of the heavier peridotite at the stratigraphic base of the sill and the lighter anorthosite at the top. In detail, the peridotite is overlain by narrow bands of pyroxenite and olivine gabbro, and then by hornblende gabbro and, in places, anorthosite. All of these rocks have been considerably altered: the peridotite contains a great deal of serpentine, and the pyroxenite much tremolite; actinolite is abundant in the gabbros and anorthosites. In the lower half of the sill, small grains of primary chromite occupy a zone within the peridotite, parallel to the gabbro contact and about 50 m below it. In this zone, alternating bands of dense and disseminated chromite are separated by layers of peridotite containing only small amounts of chromite. The main chromite band has been traced for several kilometres, with an average width of 2 m. The average grade is reported to be about 26 percent Cr_2O_3. Dense chromite ore contains 40 to 75 percent chromite in small, irregular to rounded or octahedral grains with a diameter of about half a millimetre. Typical disseminated ore carries about 25 percent chromite.

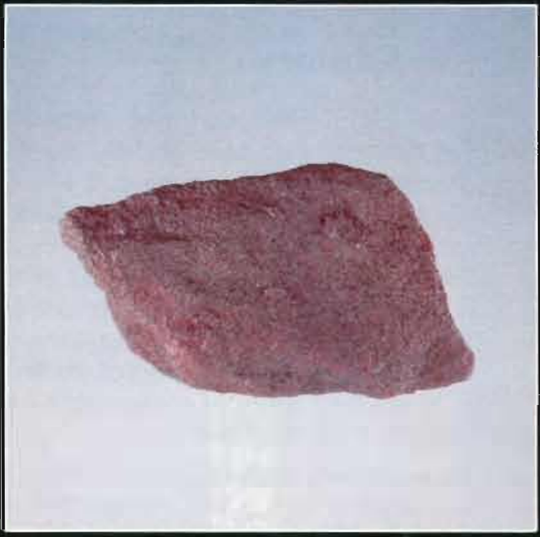
Some of the best chromite-bearing outcrops are those of the **Chrome** and **Page** properties (B 2-3), respectively 3 km southwest and 2 km north of the junction between provincial roads 314 and 315. In these deposits, which are well layered, a northern mass of serpentinized peridotite contains a chromite stringer-zone, 1 m or so in width, and, to the south, a band of dense ore of about the same width. These two chromite horizons are separated by 10 m of barren peridotite. The upper main chromite zone is another 10 m to the south; it is up to 3 m wide and consists of alternating layers of dense ore, disseminated ore and peridotite, all sharply banded (plate 8).

At least eight other chromite properties are recorded between Bird Lake and Lac du Bonnet; some of these are shown on the map (B 4-9). On the Wolf claims (B 4) at the west end of **Bird Lake,** alternating bands, about 30 cm thick, of dense ore and disseminated ore have a total width of 15 to 30 m. The Euclid claims (B 5) in the northern limb of the sill, at the south end of **Euclid Lake,** show similar features. Drilling there is reported to have indicated 10 million tonnes of ore averaging 4.6 per cent Cr_2O_3 to a depth of 300 m.

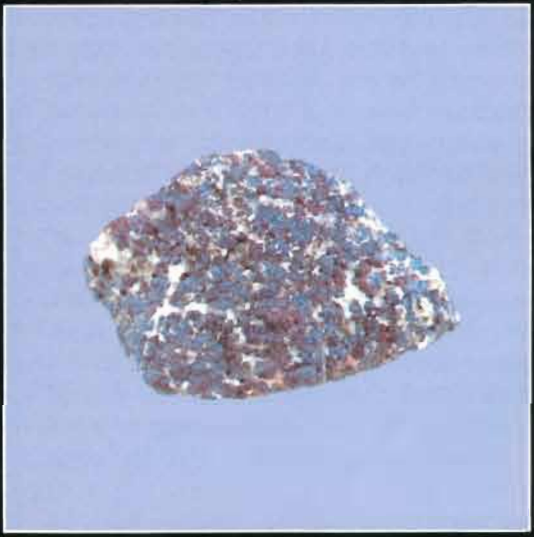
References: Davies 1952; Davies et *al* 1962, pp 37-40; Lang et *al* 1970, p 183; Phillips 1978, maps B & C; Springer 1950; Traill 1970, p 147; Trueman 1971

1) Octahedra of magnetite in chlorite schist cut by quartz veinlets (Museum)

2) Specularite crystals on magnetite-hematite groundmass (Museum)



3) Oolitic hematite (Museum)



4) Spherulitic hematite (turgite) with interstitial calcite (Black Island)

5) Botryoidal goethite, showing radiating fibrous structure (Museum)

6) Weathered limonitic surface of pyrrhotite-rich andesite (Bird River area)

7) Typical structure of limonitic gossan (Museum)

8) Polished slab of chromite ore showing banding (Bird River Sill)

9) Cubic and distorted pyritohedral crystals of pyrite (Anderson Lake Mine)

10) Botryoidal pyrite with vein quartz (Dumbarton mine)

11) Large pyrite crystals in pyrrhotite-chalcopyrite groundmass (Osborne Lake Mine)

12) Radiating prisms of marcasite (Museum)

Copper – Zinc Ore Suites

The most abundant sulphide mineral in the copper-zinc deposits is almost invariably the iron sulphide,

Pyrite (plates D,9,10,11), occurs typically in pale brass-yellow, striated cubes, but also in octahedra or pyritohedra (figs. 8-10); usually however it is found in massive form. Where exposed to the air, pyrite tarnishes quite readily to deeper yellow or golden colours; hence its nickname "fool's gold". It is too hard to scratch with a knife however, and this distinguishes it from gold, and from other yellow sulphides. The weathered surfaces of pyrite deposits are normally altered to rusty brown, limonitic, oxidized cappings known as gossan (see Goethite). Gossans are sought by prospectors because they indicate the possible presence of gold or other valuable metals that tend to accompany pyrite.

Marcasite (fig. 11) has the same composition as pyrite but is less common. Its old name was white iron pyrites, an allusion to the almost white colour it shows on fresh surfaces. It oxidizes more rapidly than pyrite however, and soon tarnishes to bronze-yellow or brownish. Marcasite often shows a radiating, fibrous structure (plate 12); cockscomb and spear-shaped crystal groups indicate twinning (fig. 12). The mineral forms at relatively low temperatures and occurs typically as replacement deposits in limestone. Silurian dolomitic limestone at Grand Rapids and elsewhere contains nodules of marcasite (Baillie 1951). This mineral is also found, usually in minor amounts, in some sulphide deposits.

Pyrrhotite (see fig. 17) contains more iron and less sulphur than pyrite. It is bronze rather than yellow, and can often be identified by its magnetic effects upon a compass needle or hand magnet. It is usually massive and rarely shows crystalline form (plates 13,14). Pyrrhotite is abundant in Manitoba.

Chalcopyrite, a copper-iron sulphide, is the most important copper ore-mineral in Manitoba. Generally it occurs in massive form, often intergrown with pyrite. Pseudotetrahedral crystals are characteristic (see fig. 18). Where fresh (plate 15), its colour is slightly more yellowish than fresh pyrite, but it tarnishes to a bronzelike hue. A hardness test is more reliable than colour, because chalcopyrite can be scratched with a knife. Its brittleness contrasts with the malleability of gold, for which it has often been mistaken. On oxidized surfaces, chalcopyrite is sometimes partly altered to malachite, a distinctive green, copper carbonate mineral.

Cubanite is a brassy to bronze-yellow, copper-iron sulphide, occurring massive or in brassy to bronze-yellow tabular crystals. It is relatively rare and can be distinguished from chalcopyrite by its strong magnetism.

Sphalerite (fig. 13), the principal source of zinc, can be easily scratched with a knife, and the streak (usually some shade of brown) is always paler than its natural colour which varies generally from brown to black. The resinous lustre and numerous cleavages (fig. 14), which seem to reflect the light from all angles, are also distinctive (plates 16,17). Sphalerite is often intergrown with chalcopyrite and is an important ore-mineral in Manitoba.

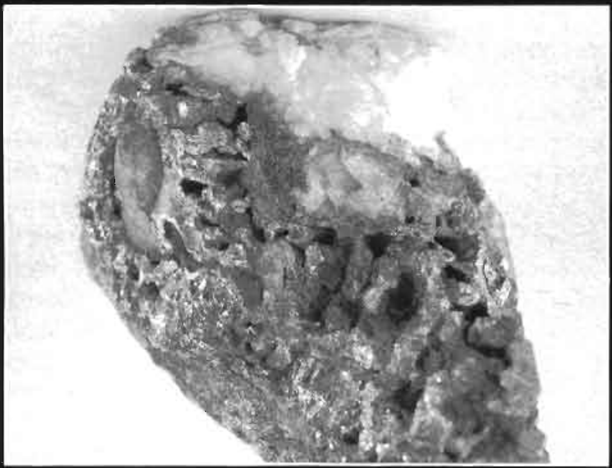
Galena, the lead sulphide, though less abundant in Manitoba, is a common associate of sphalerite. The lead-grey, cubic crystals (fig. 15), with easy cubic cleavage, can be readily recognized (plates 18, 19). Their softness, high lustre, and high specific gravity are also distinctive.

Tetrahedrite is occasionally found with copper-zinc ores, especially those that contain silver. It is essentially a sulfantimonide of copper, but iron, zinc and silver may be present in variable proportions. Also, arsenic may take the place of antimony, causing an ultimate gradation to **tennantite.** The mineral is commonly found in cubic crystals, and tetrahedral forms are characteristic (fig. 16). The colour is typically greyish black and the streak brownish black.

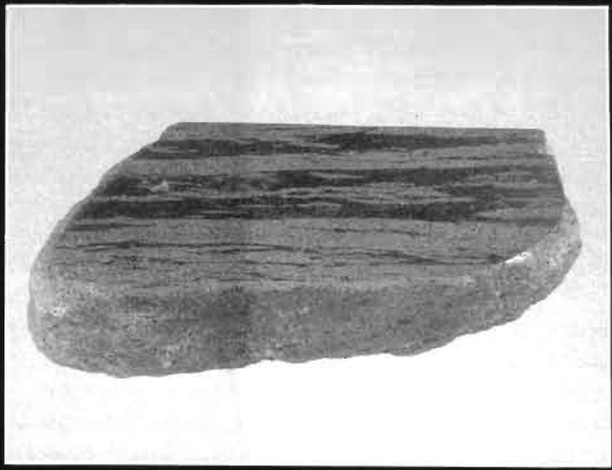
Arsenopyrite is described subsequently with the gold-ore suites, with which it is often found.

FLIN FLON AREA

Manitoba's base-metal industry may be said to have originated in the Flin Flon area in December 1914, when Thomas Creighton found a mineralized outcrop near the small border town that now bears his name. The following year his party staked 16 claims, one of which they named Flin Flon. More than a decade was to pass before development of the Flin Flon copper-zinc mine, and meanwhile the small, but high-grade **Mandy Mine** (E 1), 5.5 km to



D) Pyrite with vein quartz; network structure due to leaching (Ruttan Mine)



E) Polished slab showing banding in pyrite-chalcopyrite ore (North Star mine)

the southeast, became the first base-metal producer (1917-20) in Manitoba. This copper-zinc deposit was staked in 1915 on a peninsula in the Northwest Arm of Schist Lake. The host-rocks are greenstones that have a north-south width of over 60 km along the provincial border. The orebody occurred in chlorite schists derived from sheared volcanic breccias and tuffs. It consisted of a core of massive chalcopyrite, enclosed by a sphalerite-rich zone that was itself surrounded by a pyrite-rich zone. During the first world-war the copper-ore was mined from a 60 m shaft and transported to the smelter at Traill, British Columbia. When the railroad was built, Mandy Mines Limited deepened the shaft to 315 m (1928-29), and in 1943-44 Emergency Metals Limited installed a mill and produced lower-grade ore containing copper, zinc, silver and gold. The gold was in chalcopyrite and the silver in sphalerite. Today the mine-site is marked only by small heaps of wasterock, some drill-core and the mill foundations, but a few ore specimens (plate 15) can still be found on what is left of the mine-dump.

Numerous other sulphide deposits occur in the greenstones of the Flin Flon area. The orebodies, mostly in altered volcanic rocks, consist mainly of massive sulphides with some zones of disseminated sulphides. Pyrite is the predominant sulphide but sphalerite and chalcopyrite are the principal ore-minerals. Some of the massive sulphide orebodies show both copper-rich and zinc-rich zones. Hence some deposits are classed as copper-zinc and others as zinc-copper ore. Many of the orebodies are accompanied by narrow zones of wall-rock alteration containing chlorite, carbonate, quartz, sericite and carbonate.

The **Schist Lake Mine** (E 2) is little more than 1 km south of the Mandy Mine. It was discovered by drilling through the ice in 1947, and brought to production by Hudson Bay Mining and Smelting Company Limited in 1954. Before the orebodies were mined out in 1976, a three-compartment shaft had been sunk with 17 levels to 695 m, and an auxiliary shaft reached 1090 m. The ore-zone lay within carbonatized sericite and chlorite schists. The various orebodies were tabular to lens-shaped. The major metallic minerals were pyrite, chalcopyrite and sphalerite, occurring in three main types of ore: massive sphalerite-pyrite, massive chalcopyrite-sphalerite, and disseminated chalcopyrite-pyrite. Minor arsenopyrite and galena were also present and a little native gold was reported.

A small mineralized outcrop staked by Creighton on the south shore of a frozen wilderness lake in 1915 led to the development of the **Flin Flon Mine** (E 3). From this mine, over the years, zinc has exceeded copper production, and silver has exceeded gold as a by-product. Two prospecting shafts were sunk by the Mining Corporation of Canada in 1920. A test mill was installed in 1926, and the following year Hudson Bay Mining and Smelting Company Limited, known informally as HBMS, was incorporated to develop the property. Great progress was made in 1928 when the railway reached Flin Flon and hydro-electric construction was started 90 km to the northwest. Mining operations commenced in 1930 and the newly built copper smelter and zinc plant began turning out blister copper and zinc slabs. The top 90 metres of a near-surface orebody were mined by open-pit methods after the lake water and mud had been removed, but since 1937 all mining has been underground from two main shafts and various auxiliary shafts. The south main shaft is about 1220 m deep. The major metallic minerals at Flin Flon are pyrite, chalcopyrite and sphalerite (plate 17); the minor metallics include pyrrhotite, arsenopyrite, galena, altaite, marcasite, magnetite and ilmenite. The principal wall-rocks are chlorite and sericite schists (plate 20), derived from andesite breccias, tuffs and quartz-porphyry. The ore occurs in six lenticular-shaped orebodies. Like the other copper-zinc deposits of the Flin Flon area, the orebodies are essentially strata-bound, in layered, predominantly volcanic rocks. The massive ore consists mainly of pyrite with black sphalerite and chalcopyrite; these minerals are associated with wall-rock remmants and with quartz and carbonate gangue. There is also a disseminated type of ore composed of chalcopyrite, pyrite, pyrrhotite and brown sphalerite in chlorite and talc schists. As a matter of interest to mineral collectors, a crystal aggregate of native copper was found during the shaft-sinking.

Owing to mining operations, casual visits are not possible, but guided tours of the mine and smelter are organized by the company for visitors at certain times. Cadmium, extracted from the zinc concentrate, is cast into metal rods at Flin Flon. From the copper concentrate, silver, gold, selenium and tellurium are ultimately recovered during conversion of the anode (blister) copper to pur electrolytic copper in eastern Canada.

Copper-zinc ore is transported to Flin Flon for processing from various smaller mines in the area. Their ore is generally similar to the deposits already described, with variations in detail. At the **White Lake Mine** for example (E 4), 13 km southeast of Flin Flon, pyrrhotite and pyrite (plate 21) occur in approximately equal proportions as the major sulphides; galena, although present, is inconspicuous. The orebody, which is associated with chlorite-sericite schist, contains about twice as much zinc as copper. The mine was opened in 1972 and has a 420 m shaft. The **Centennial Mine** (E 5), 4 km to the southeast, was opened in 1977. Its orebody is beneath Lake Athapapuskow, and the mine is serviced by a 13° decline which extends 700 m from the shore to the top of an internal shaft, 80 m under the lake. The shaft was sunk downwards for 430 m to intersect the orebody. Pyrite, chalcopyrite, sphalerite and tennantite-tetrahedrite are the principal metallic minerals. Minor amounts of magnetite and arsenopyrite are also present in the orebody which is associated with chlorite-sericite schists.

Rockhounds and mineral collectors can find interesting specimens on the rock-dumps of other small sulphide deposits near Flin Flon. The **Cuprus** mine (E 6) on the northeast arm of Schist Lake, 12 km southeast of Flin Flon, was operational between 1948 and 1954; the main shaft was 320 m deep. The principal sulphides were pyrite, chalcopyrite, sphalerite and pyrrhotite, with small amounts of arsenopyrite and galena. The orebodies were associated wtih graphitic schist and chert; chloritic schist, andesite, diorite and graphitic tuff were encountered in the mine workings, and pinkish white, massive dolomite is also found on the dumps. The **Pine Bay** shaft (E 7), 16 km east of Flin Flon, is situated on a peninsula towards the north end of Sourdough Bay. The copper deposit was explored by Cerro Mining Company of Canada Limited during the past decade, but was not brought to production. Pyrite, chalcopyrite and pyrrhotite are the principal sulphides, while sphalerite is rare. The metallic minerals occur with quartz in chlorite schist and volcanic rocks. The gangue minerals provide good specimens of talc, epidote and chlorite. Old trenches on the **Baker-Patton** property (E 8), near the opposite (northeast) shore of Sourdough Bay, date back to 1922, and the 125 m shaft was sunk in 1928 by Callinan Flin Flon Mines. Pyritohedra and cubic aggregates of yellow to silvery pyrite can be found on the rock-dumps (plate 22), and massive bronze-yellow pyrite is also common. The associated rocks are cherty chloritic schist and sericitic schist. Powdery coatings of rusty brown goethite have developed on pyritic schists due to oxidation. The **North Star** mine (E 9) is located 19 km east of Flin Flon, on a small island near the west shore of Thompson Lake. Hudson Bay Mining and Smelting Company Limited sank a shaft to 495 m to produce copper ore between 1955 and 1958. The orebody consisted of massive pyrite and chalcopyrite (plate E) in silicified chlorite schist. The adjoining rocks are andesite, dacite and a sill or flow or quartz porphyry. The **Don Jon** mine (also E 9) on a small island 320 m to the southeast, was connected by a cross-cut to the North Star shaft at the 180 m level. Don Jon Mines Limited extracted copper ore through this shaft between 1955 and 1957. The two lenticular orebodies were similar to that of the North Star but occurred in chloritic dacite, bounded by quartz porphyry partly altered to siliceous sericite schist. The rock-dumps show irregular masses and some crystals of pyrite and chalcopyrite, in cherty-looking chlorite schist. Epidote, chlorite, dolomite and pink feldspar are found here with massive quartz. The bright green encrustations on ore-bearing rocks are brochantite, a hydroxyl-bearing copper sulphate that forms

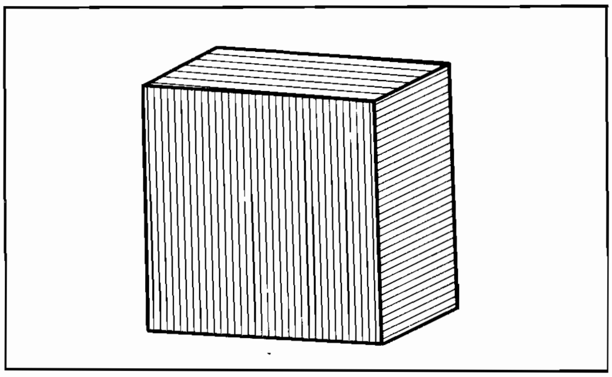


Fig. 8: Striated cube of pyrite

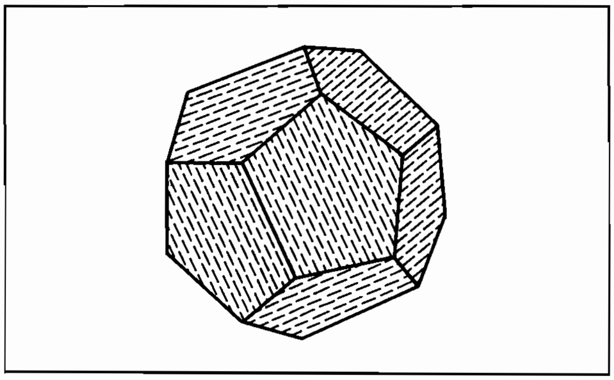


Fig. 9: Striated pyritohedron of pyrite

in the oxidation zone of copper deposits. The silky, pale blue substance is posnjakite, a hydrated copper sulphate, also of secondary origin.

References: Bailes 1971a; Davies et *al* 1962, pp 64-75; Gale & Koo 1977; Grice 1976, pp 128-135; Lang et *al* 1970, pp 190, 196-198; Phillips 1978, map H; Sabina 1972, pp 38-47; Scott 1977

SNOW LAKE AREA

After the closing of the Nor Acme gold mine (G 7) in 1958, Snow Lake might have become another ghost-town but for the exploration activities of Hudson Bay Mining and Smelting Company Limited which resulted in the opening of the Chisel Lake Mine and several others since 1960. These mines are located near the east end of the Flin Flon - Snow Lake greenstone belt, but the country rocks are generally more gneissic than those of the Flin Flon area. Some of the gneisses have been derived from volcanic rocks, others from sedimentary rocks. Their grade of metamorphism is higher than that of the Flin Flon schists, and they contain some interesting metamorphic minerals. The orebodies are essentially strata-bound. A railway line was extended east from Optic Lake to link the Snow Lake mines with Flin Flon, where all ore has been transported for processing. Currently, a mill is under construction at Snow Lake from which only the concentrates would have to be sent to Flin Flon.

References: Bailes 1971a; Davies et *al* 1962, pp 78-80; Harrison 1949; Phillips 1978, maps K, L, N; Russell 1957

The **Chisel Lake Mine** (G 1), 8 km southwest of Snow Lake, is a high zinc producer, as the ore produced to date contains about ten times more zinc than copper and lead combined. It has been in production since 1960. The mine-shaft was sunk to 440 m near the southeast shore of Chisel Lake, which has been partly drained. The nearest outcrops are volcaniclastic and sedimentary rocks that crop out a few hundred metres to the north. Geophysical surveys and diamond drilling outlined a mineralized zone striking northwest and dipping northeast. The wall-rocks include biotite schists containing staurolite and garnet. The orebody consists of a massive aggregate of coarse-grained sulphides, mainly (in order of abundance) sphalerite, pyrite, pyrrhotite, chalcopyrite, galena and arsenopyrite. The sphalerite (plate 16) is dark brown to black and occurs with other sulphides in a groundmass dotted with pyrite crystals. Galena and tetrahedrite occur as blebs in massive sphalerite. Silver is present microscopically in tetrahedrite. Veins (plate 19) and disseminations of sulphides in the wall-rocks are preferentially associated with biotite and sericite. The principal gangue minerals in order of abundance are: actinolite, dolomite, tremolite, chlorite, biotite, quartz, white mica and talc. Massive green rocks composed mainly of coarse actinolite grade, in places, into granular dolomite-tremolite rocks. Galena fills angular spaces between some of the actinolite prisms. Tremolite-talc schists and biotite-chlorite schists are also present as gangue-rocks. The **Ghost Lake Mine** (G 2) is located only 900 m east of the Chisel Lake shaft. The orebody is similar in shape, strike and dip to that just described, and the ore-suite, gangue minerals, wall-rocks and host-rocks are also similar. Hudson Bay Mining and Smelting Company Limited sank a decline to reach the Ghost Lake orebody from a location near the Chisel Lake shaft, and commenced production in 1972.

References: Davies et *al* 1962, pp 87-89; Gale & Koo 1977; Grice 1976, pp 129, 136; Sabina 1972, pp 65-66; Williams 1966

The **Anderson Lake Mine** (G 3) is about 5 km southeast of Snow Lake town. Copper ore with a little zinc has been mined there since 1970 by Hudson Bay Mining and Smelting Company Limited from an 875 m shaft near the north shore of the lake. The nearby rocks are mostly of volcanic origin, with subsidiary metasediments. A major

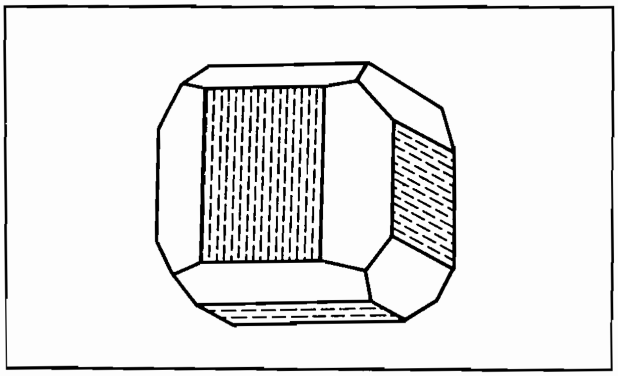


Fig. 10: Pyrite crystal with cubic faces (striated) and pyritohedral faces (blank)

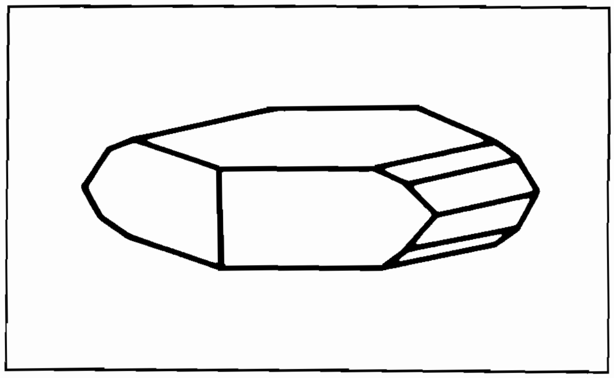


Fig. 11: Tabular crystal of marcasite

host-rock at the mine is staurolite-garnet-cordierite schist. Chlorite and sericite schists occur in the wall-rocks. The orebody is tabular-shaped and dips northwest. The ore consists of coarsely crystalline pyrite, chalcopyrite and pyrrhotite (plate 23) with minor amounts of sphalerite and magnetite. Some pyrite cubes (plate 9) are 10 cm in diameter. Pyrrhotite is interstitial and much less abundant. Chalcopyrite is also interstitial and occurs as blebs in pyrite and silicate minerals. Magnetite is found as crystals and nodules in chlorite schist. Large amounts of grey and blue kyanite are associated with the orebody. Other gangue minerals include large crystals of staurolite, almandine and cordierite. Calcite with radiating clusters of green actinolite accompanies massive quartz in the gangue, and coarse flaky aggregates of dark green chlorite are also common. Brown prismatic aggregates of anthophyllite and coarsely cleavable masses of anhydrite can also be found on the mine-dump.

References: Campbell et *al* 1970, p 27; Gale & Koo 1977; Grice 1976, pp 129, 135; Sabina 1972, pp 63-64

The **Stall Lake Mine** (G 4) of Hudson Bay Mining and Smelting Company Limited is 6.5 km southeast of Snow Lake town and has been in production since 1964. The main shaft is 897 m deep and an auxiliary shaft reaches 110 m. The ore is copper-rich with minor zinc. The sulphide concentrations are in gneisses of pyroclastic origin, near their contact with overlying amphibolites derived from basic tuffs and flows. Several tabular-shaped orebodies are located in quartz-hornblende gneiss where it is in contact with a more biotite-rich gneiss. Some of the ore is in staurolite schist, presumably from bands within the gneiss. The main sulphides, in order of abundance, are pyrrhotite, pyrite, chalcopyrite and sphalerite, occurring in coarse-grained masses (plates 13, 24); some well-formed pyrite crystals are as much as 20 cm across. Minor amounts of magnetite and ilmenite accompany the sulphides (plate 25). The magnetite forms large, irregular-shaped crystals that often contain inclusions of pyrite, pyrrhotite, or ilmenite. Non-metallic minerals on the mine-dump include dark, smoky green cordierite, found with the sulphides, cruciform twins of staurolite, red garnets, blue and grey blades of kyanite, and granular aggregates of epidote with quartz.

References: Gale & Koo 1977; Grice 1976, pp 129, 135; Sabina 1972, p 61

Eight kilometres east-southeast of Snow Lake, and about 1.5 kilometres east of the mine just described, the **Little Stall Lake Mine** (G 5) of Stall Lake Mines Limited produced 23,000 tonnes of copper-zinc ore between 1962 and 1964 from a 915 m shaft. Some further shaft-sinking took place in 1971 but the mine has remained dormant. It is located in a belt of siliceous volcanic rocks, 900 m wide, that is bordered by amphibolites, The host-rock is a siliceous "quartzeye" schist with inter-bands of chlorite schist, mica schist and amphibolite; it is underlain by rhyolite. The wall-rocks are extensively permeated by carbonate which is also prominent in the ore. Quartz gangue is also abundant. The orebody consisted of a massive lens of chalcopyrite with minor sphalerite, pyrite and arsenopyrite. Only small pockets of this copper-rich ore remain at the 600 m level. At the 900 m level, a variety of uneconomic sulphide mineralization was encountered, including massive pyrite, mixed pyrite-pyrrhotite, and coarse vein material consisting of quartz with pyrite, pyrrhotite and chalcopyrite. Metallic concentrations in drill core from a deeper and much larger mineralized zone were found to contain 40 percent chalcopyrite, 30 percent sphalerite, 12 percent pyrrhotite, 3 percent arsenopyrite, and minor galena and marcasite. Crystals of pyrite and arsenopyrite can be found on the rock-dumps. Red crystals and aggregates of garnet, and dark

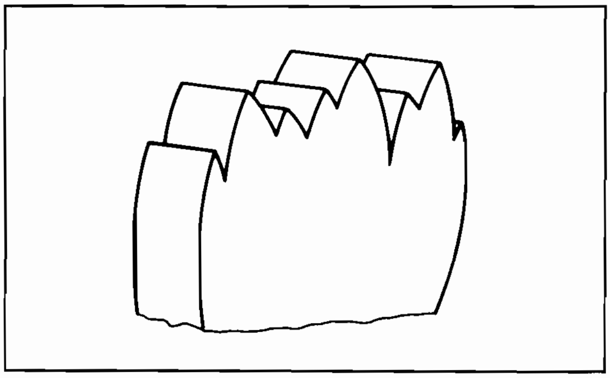


Fig. 12: Marcasite showing cockscomb twinning

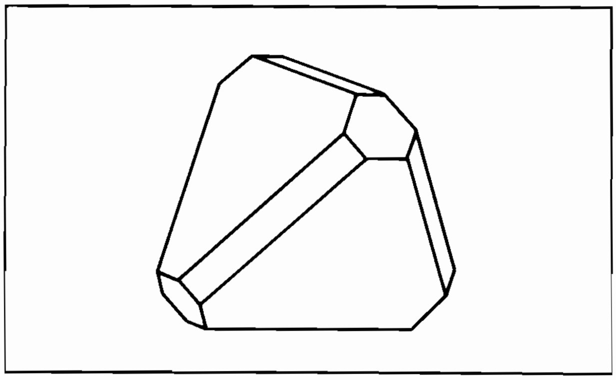


Fig. 13: Sphalerite crystal showing octahedral and cubic faces

brown staurolite are abundant. Black hornblende and pale brown anthophyllite form prismatic aggregates. Fine-grained dolomite occupies some rock-cavities, and coarse green flaky masses of chlorite are also found on the dumps.

References: Coats *et al* 1970; Sabina 1972, p 62

The **Osborne Lake Mine** (G 6) of Hudson Bay Mining and Smelting Company Limited is 21 km northeast of Snow Lake town. It is located in quartz-hornblende-biotite gneisses beyond the east edge of the greenstone belt. A three-compartment shaft was sunk to 1509 m in 1962 and production of copper-zinc ore was started in 1968. In 1973 the shaft was deepened by 168 m. Both massive and disseminated sulphides occur in the tabular-shaped orebody which lies along a zone of faulting. Both the ore-zone and wall-rocks are intruded by coarse, sheared pegmatite. The ore is coarse-grained and contains more copper than zinc. Pyrrhotite, pyrite and chalcopyrite are the principal sulphides (plates 11, 26), with subsidiary sphalerite; the minor metallic minerals are arsenopyrite, galena and marcasite. A little rutile accompanies the ore minerals. Red garnets are common in the gneiss, and brown, 1 cm crystals of sphene occur in massive white quartz. Other gangue minerals include bright green mica, smoky brown anthophyllite, greyish green pyroxene, chlorite, green serpentine and epidote. Massive greyish blue plagioclase and white to greenish feldspar are also present.

References: Grice 1976, p 129; Sabina 1972, p 63

The **Dickstone Mine** (F 6), 32 km west of Snow Lake, is not accessible by road; it is 4 km southwest of File Lake and 3 km west of Morton Lake. Copper ore was trucked 16 km southward from the mine to the railhead, and thence hauled to Flin Flon. The mine is owned by a Winnipeg Company, Dickstone Copper Mines Limited, and the mining operations were done by Hudson Bay Mining and Smelting Company Limited on a profit-sharing basis. The acidic volcanic host-rocks are intruded by diorite about 30 m west of the ore-zone, while the rocks to the east are typical greenstones. Early excavations revealed soft, fissile, dark green schist accompanied by silicified rocks. Two elongated orebodies were detected at shallow depths and shafts were sunk to 409 m and 356 m. Production was begun in 1970, and ceased in 1975 at a depth of 350 m. The No. 1 orebody contains mainly pyrrhotite and chalcopyrite, with a considerable concentration of magnetite; minor amounts of pyrite, sphalerite and tellurobismuthite are also present. The sulphides are massive and relatively coarse grained; much of the chalcopyrite is pitted and contains blebs of sphalerite. Magnetite is very common, forming large rounded grains with good cleavage.

References: Grice 1976, pp 129, 135; Harrison 1949, pp 54-55

SHERRIDON AREA

The copper-zinc mine at **Sherridon** (E 10), 65 km northeast of Flin Flon, produced 120,742 tonnes of copper, 67,570 tonnes of zinc, 3,145 kg of gold and 100,140 kg of silver between 1931 and 1951. The mineralized outcrops were first discovered and staked in 1922 by Philip Sherlett, a Cree prospector. Sherritt Gordon Mines Limited, formed in 1927 to mine the ore, sank three shafts and installed a concentrator before the mine was temporarily shut down in 1932 owing to the low price of copper. Operations were resumed in 1937 and continued until the ore was exhausted. Copper and zinc concentrates were sent by rail to Flin Flon for processing. The No. 1 (East) shaft was 113 m deep, and the No. 2 (Central) shaft 146 m. No. 3 (West) was an inclined shaft sunk to 642 m. It was located next to the concentrator on the east shore of Camp Lake. The Central and East shafts are respectively 1¼ and 2.5 km to the southeast. The mine equipment, buildings and houses were moved by Sherritt Gordon to their new mine at Lynn Lake in the early nineteen fifties, but the mine-site is still accessible

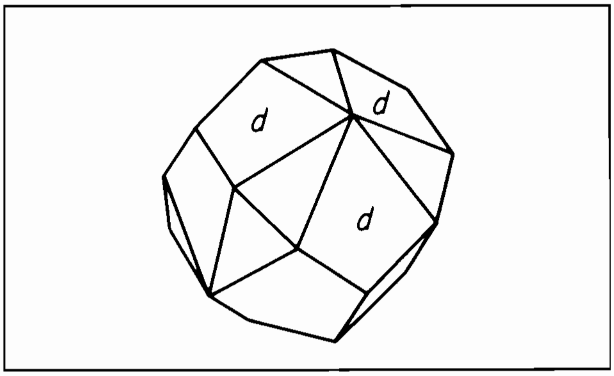


Fig. 14: Sphalerite cleavages are parallel to dodecahedral faces (d)

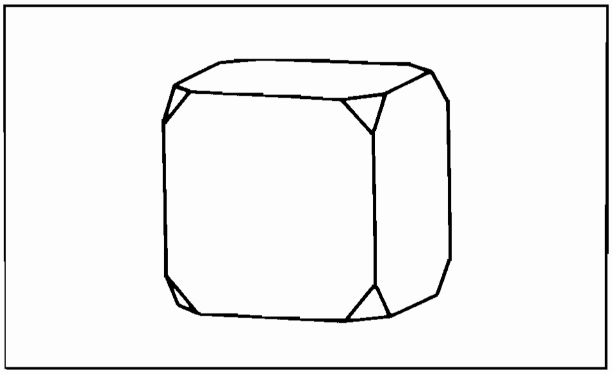


Fig. 15: Galena cleavages are parallel to cubic faces, here shown with octahedral modification

by rail. Rock specimens containing ore and gangue minerals can be found on the rock-dumps near the old workings. The ore-zone was in a folded gneiss complex of regional dimensions, derived from volcanic and sedimentary rocks; it was located along a contact between gneissoid quartzite and an overlying hornblende gneiss, both members of the Sherridon group. The contact had been intruded by a pegmatite sill, with numerous offshoots breaking through the footwall gneiss and hanging wall quartzite. The East and West orebodies replaced pegmatite both in the sill and in many dykelike offshoots. The total length of the mineralized contact zone was about 5 km, with a gap of 1100 m between the two orebodies. The ore consisted of a coarse aggregate of massive to disseminated sulphides (plate 14). These, in order of abundance, were pyrite, pyrrhotite, chalcopyrite, sphalerite and minor cubanite. Pyrite was approximately twice as plentiful as pyrrhotite. Small amounts of marcasite and galena were also present. Owing to their inaccessibility by road, the rock dumps at Sherridon still provide many interesting rock and mineral specimens. The ore-minerals are found in rocks of gneissic appearance. The pegmatite is composed of white to pinkish plagioclase, colourless to pink quartz, and muscovite mica; some greyish white calcite is also present. Red garnets, 1 cm in diameter, are abundant in the gneiss. Other non-metallic minerals that can be found on the dumps include graphite, chlorite, dark green pyroxene, hornblende, epidote, pale green tremolite, biotite and occasional grey scapolite.

References: Bailes 1971a; Bateman & Harrison 1946; Davies *et al* 1962, pp 92-102; Farley 1948; Lang *et al* 1970, p 198; Sabina 1972, pp 48-50; Stockwell 1963, p 88

LYNN LAKE REGION

Until 1976, the Lynn Lake mines of Sherritt Gordon Mines Limited produced nickel-copper ore, and they are described subsequently under that heading. Exploration of the Lynn Lake greenstone belt in the nineteen sixties indicated, however, that copper-zinc mineralization was relatively widespread, and two major copper-zinc mines - Fox and Ruttan - began production in the nineteen seventies. Sherritt Gordon's **Fox Mine** (L 2), located 43 km southwest of Lynn Lake at the end of highway 396, came into production in 1970. The mine is a short distance northwest of Fox Lake which is about 1 ½ km west of Snake Lake. Outcrops in the vicinity showed only "a sparse dissemination of fine pyrrhotite...in a small exposure of recrystallized, dark grey, very impure garnetiferous quartzite" (Stanton 1949). The only suggestion that there might be a greater concentration of pyrrhotite at depth came from the observed magnetic effects *(ibid).* An airborne geophysical survey of the area by Sherritt Gordon in 1960 showed electromagnetic as well as magnetic responses. The company followed up with detailed ground surveys, diamond drilling programmes and feasibility studies. A small lake was then drained and a rough roadway built from Lynn Lake, after which shaft-sinking was undertaken to an eventual depth of 715 m (1968). Diamond drilling from the surface indicated a copper-zinc orebody dipping steeply northwest. Subsequent underground drilling outlined an ore-zone extending down to the 870 m level. The zone contains two lenticular orebodies and is conformable with the enclosing gneisses, which are of mainly volcanic origin with minor sedimentary beds. These rocks were intruded by dykes and sills of gneissic diorite-gabbro, one of which occurs along the footwall of the ore-zone. The rocks underlying this intrusion are quartz-hornblende and biotite gneisses. These gneisses also form the hanging wall. The orebodies are enveloped however by a zone of wall-rock alteration, about 75 m in width, in which the host-rocks have become more micaceous. The wall-rock minerals, in order of abundance, are: quartz, muscovite, albite, sericite, biotite, amphibole, talc and chlorite. Approximately 70 percent of the ore is of the massive sulphide type, and 30 percent of the disseminated type. Pyrrhotite and pyrite are the main sulphides and they occur in varying proportions, but with pyrrhotite, on the whole, predominant. Sphalerite is more abundant than chalcopyrite but both are major ore-minerals. The minor metallic minerals are ilmenite, magnetite and arsenopyrite. The massive ore consists of medium-grained granular pyrite with interstitial pyrrhotite, chalcopyrite, sphalerite and arsenopyrite; inclusions of quartzo-feldspathic gangue material are also present. Disseminated ore consists of the same metallic minerals but with a greater proportion of silicate minerals, especially biotite, amphibole and chlorite, In the high-grade zinc sections of the ore-zone, the massive ore shows layering due to interbanding of sphalerite-pyrite-pyrrhotite with gangue minerals; this banding is conformable with that of the enclosing gneissic rocks. Some of the disseminated ore is copper-rich, but in general it consists of pyrrhotite, pyrite, chalcopyrite, sphalerite and arsenopyrite, with biotite, muscovite, sericite, talc, amphibole, quartz and albite. Coarse-grained ore composed of these same metallic minerals cuts and replaces both massive and disseminated ore at some localities. Quartz-epidote veins in the diorite-gabbro dykes contain galena and arsenopyrite with which some silver tellurides and native gold have been found.

References: Coats *et al* 1972, pp 45-52; Gale & Koo 1977; Grice 1976, pp 129, 136-137; Milligan 1960, append. C, maps 4 & 10; Phillips 1978, map T; Sherritt Gordon Mines Limited 1974a; Stanton 1949; Zwanzig 1977

The **Ruttan Mine** (J 4) of Sherritt Gordon Mines Limited is one of the largest open-pit mines in Manitoba. It is located 24 km east of the town of Leaf Rapids on highway 391, between Thompson and Lynn Lake. The discovery of a possible orebody originated in 1968 when Sherritt Gordon flew an airborne geophysical survey over the Rusty Lake greenstones, a large area immediately southeast ot the Lynn Lake greenstone belt. Gossans were known to be abundant around Rusty Lake since mapping by Burwash in 1960 had outlined extensive sulphide zones, which he described as pyrrhotite-bearing tuffs, between Rusty Lake and Opachuanau Lake. The area became particularly attractive for prospecting when it was known that highway 391 would pass through it. Ground surveys by Sherritt Gordon were followed by claim-staking and the orebody was confirmed by diamond drilling in 1969-70. At that time, over 60,000 m of drilling had outlined an orebody about 820 m long, with an average width of 35 m, and estimated to contain nearly 50 million tonnes of ore grading 1.47 percent copper and 1.61 percent zinc down to the 600 m level. The ore-zone dips steeply southeast and is conformable with the layering of the metamorphic host-rocks, which are of volcanic and sedimentary origin. These rocks have undergone shearing in a northeasterly direction. Dykes of granite, gabbro, diabase and andesite intersect the ore-zone and the amphibolitic wall-rocks. The major orebodies are two parallel sulphide lenses *en echelon*, both plunging 45° to the east. These lenses are composed of massive to semi-massive and disseminated sulphides, predominantly pyrite with chalcopyrite and sphalerite; the less abundant metallic minerals are ilmenite, pyrrhotite, arsenopyite, galena and magnetite. Tiny blebs of cubanite have recently been identified in sphalerite. Pyrite (plate 27) occurs as coarse irregular aggregates in the massive ore, and as well shaped crystals in disseminated ore, which varies from fine to coarse grained. Chalcopyrite and sphalerite are subordinate and interstitial to pyrite. Pyrrhotite, where present, accompanies pyrite (plate 28); the latter is rarely replaced by arsenopyrite. Ilmenite needles and blebs are fairly common, often occurring with lesser amounts of magnetite and rutile. The most abundant gangue minerals are quartz, feldspar, chlorite, biotite, sericite, staurolite and garnet. According to the company's informational brochure, the open pit will have an eventual length of 990 m, a width of 590 m and a depth of 220 m. The open-pit operation was planned for a production capacity of 9000 tonnes of ore per day. The first copper and zinc concentrates were sent to the railhead at Lynn Lake in 1973, and underground mining was scheduled to follow 6 years of open-pit mining. Construction of a decline to eventually intersect the ore-zone beneath the open pit was started in 1972, and it is possible *(ibid)* that underground mining may commence before the open-pit operation is completed.

References: Burwash 1962; Gale & Koo 1977; Grice 1976, pp 130, 137; Phillips 1978, map S; Scott 1977; Sherritt Gordon Mines Limited 1974b; Steeves & Lamb 1972, map 71-2-6

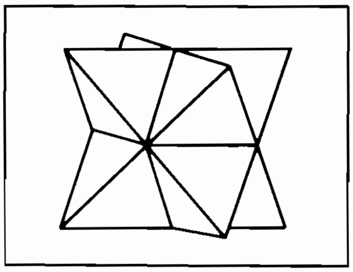


Fig. 16: Tetrahedrite showing tetrahedral penetration twinning

13) Large crystals of pyrite surrounded by chalcopyrite in pyrrhotitic groundmass (Stall Lake Mine)

14) Pyrrhotite with sphalerite, chalcopyrite and pyrite (Sherridon mine)

15) Chalcopyrite ore with graphitic gangue material (Mandy mine)

16) Sphalerite ore with minor pyrite and white plagioclase (Chisel Lake Mine)

17) Massive, fine-grained pyrite, veined by sphalerite (Flin Flon Mine)

18) Galena crystals, showing cubic form and cleavage (Museum)

19) Galena with pyrite and chalcopyrite, in vein cutting andesite (Chisel Lake Mine)

20) Chalcopyrite in chlorite schist (Flin Flon Mine)

21) Argillaceous host-rock showing pyrrhotitic and pyrite-chalcopyrite-rich bands (White Lake Mine)

22) Pyrite crystals and cubic aggregates, partially oxidized to rusty brown goethite (Baker Patton deposit)

23) Pseudomorphic pyrrhotite in chalcopyrite groundmass (Anderson Lake Mine)

24) Pyrrhotite with chlorite-biotite gangue, accompanied by chalcopyrite and large pyrite crystals (Stall Lake Mine)

Nickel — Copper Ore Suites

F) Bands of fine-grained pyrrhotite in andesite (Dumbarton mine)

The essential nickel-bearing ore-minerals in Manitoba are pentlandite and pyrrhotite (fig. 17) which often occur in intimate intergrowths. These primary sulphides may be accompanied by substantial amounts of pyrite or chalcopyrite (fig. 18), giving rise in the latter case to the nickel-copper ores. The nickel minerals gersdorffite and violarite are commonly present in minor amounts.

Pyrrhotite has been described under the copper-zinc heading, but it is mainly in the nickel ore-suites that it becomes economically important owing to its intimate association with pentlandite. Pyrrhotite (plates 29, 30) may contain up to one per cent pentlandite, in usually microscopic intergrowths, and is thus significant as a possible indicator of nickel mineralization.

Pentlandite occurs in massive or granular aggregates intergrown with pyrrhotite, usually on a microscopic scale (plate 31). It is yellowish bronze with a pale bronze streak, and closely resembles pyrrhotite in appearance, but can be often distinguished by its octahedral parting and lack of magnetism. The other nickel minerals to be noted are either or secondary origin or are quantitatively minor.

Smythite, originating as a low-temperature oxidation product of pyrrhotite, is a major ore-mineral at Manibridge. It is a secondary iron-nickel sulphide, seen as a black replacement around the edges of pyrrhotite aggregates, and extending irregularly inwards.

Violarite is a relatively common nickel-iron sulphide that tarnishes rapidly from grey to a distinctive violet-grey or copper-red.

Mackinawite is a rare iron-nickel sulphide, occurring at the Pipe Mine as a minor alteration product of pentlandite; it is pale grey when fresh, but tarnishes rapidly bronze; the streak is black.

Gersdorffite (plate 32) is a hard, silvery white sulfarsenide of nickel, often resembling pyrite in the shape of its pyritohedral crystals.

Nickeline (niccolite) is a pale copper-red arsenide of nickel (plate 33); it may be coated with green nickel bloom, a secondary oxidation product of some nickel minerals.

Maucherite is a less well known nickel arsenide, silvery grey but tarnishing copper-red; it may occur as a secondary mineral with nickeline.

LYNN LAKE AREA

The first company to produce nickel ore in Manitoba was Sherritt Gordon Mines Limited when they moved all portable plant, machinery and buildings from Sherridon to Lynn Lake in the early nineteen fifties. This major re-location was done by winter tractor-train before the railway reached Lynn Lake in 1953, leading to the opening up of Manitoba's northernmost mining district. Prospectors from Sherridon had begun reconnaissance of the Lynn Lake region in the early nineteen thirties, and in 1941 Austin McVeigh found a mineralized outcrop that is now preserved as the "discovery outcrop" of the **Lynn Lake Mine.** It is overshadowed by the headframe of the "A" shaft (L 3) and shows gabbro and amphibolite with gossan derived from oxidation of sulphide stringers and disseminations. The "A" orebody was subsequently located by magnetometer survey and confirmed by diamond drilling. Nickel-copper ore was produced from the 610 m shaft of the "A" mine from 1953 to 1969; the ore came from a cluster of several irregularly shaped orebodies in the Lynn Lake gabbro. The Farley shaft (L 4), 1 km to the south, is located in the same mass of gabbro. This shaft reached a depth of 1050 m and remained in production from 1961 to 1976. A 25° decline was driven from the 900 m level in 1972 to reach the lower orebodies at a depth of 1130 m. At least ten orebodies were mined from the "A" and Farley shafts. They were located in a small stock, about 3.5 km long and 1.5 km wide, that intruded the Lynn Lake greenstones. The rocks comprising the stock are mainly gabbro and diorite, but amphibolite, peridotite, norite and quartz-hornblende diorite are also present. In general, actinolite is the chief ferromagnesian mineral in the mafic rocks and labradorite is the most abundant plagioclase. Peridotite occurs as irregular lenses in the vicinity of the orebodies; it is dark, medium-grained, and considerably altered to a rock containing much serpentine or talc. Occasional fragmented remnants of enstatite-bearing norite occur in or near some of the ore-zones. As four of the orebodies lay close to the surface, some open-pit mining was done in the early years. The former East Lynn Lake was drained for this purpose. The "Upper B" open pit (L 5), a few hundred metres west of the Farley shaft, illustrates various types of ore and waste-rock. The latter is mainly amphibolite, gabbro and quartz-hornblende diorite. Most of the ore is in amphibolite and some in the quartz diorite. The ore was of three types:

(a) massive ore in which the sulphides made up more than half the rock, the rest consisting of rounded gangue remnants;

(b) breccia-ore consisting mainly of broken rock penetrated by a stockwork of sulphide veinlets or stringers;

(c) disseminated ore in which the sulphides are scattered through the host-rock in relatively small grains comprising 5 to 10 percent of the rock; most of the ore mined was of this type.

The principal sulphides, in order of abundance, were dark bronze pyrrhotite (plate 29), medium bronze pentlandite and pale brassy chalcopyrite (plate 34). The minor metallic minerals were magnetite, ilmenite, pyrite and marcasite. The pentlandite occurs as grains in pyrrhotite and as flame-like projections along fractures; it is extensively altered to violarite in the zone of weathering. The pyrite, rarely found in well formed crystals, is considerably replaced by marcasite. The ilmenite is associated with irregularly shaped magnetite.

The "EL" shaft (L 6), about 2.7 km south of the Farley shaft, was sunk to 300 m to reach a separate small but rich orebody; it produced nickel-copper ore (plate 31) between 1954 and 1963. Open-pit mining of the upper part of the orebody was completed in 1962. This orebody was located in a smaller plug of gabbro, approximately 400 m in diameter, situated 900 m southeast of the larger stock. The "EL" orebody and its host-rocks were similar in composition to those already described, but the average grade of the ore (initially 2.50% nickel and 0.93% copper) was considerably higher.

Zones of shearing and brecciation were traced southeast through the gabbro stock. Their effects were observed underground and some ore was concentrated in highly brecciated rocks.

References: Campbell *et al* 1970, map 3; Coats *et al* 1972, pp 40-45; Gilbert 1977; Grice 1976, pp 130, 137; Milligan 1960, append. C, maps 1 & 10; Phillips 1978, sec. H, map T; Pinsent 1977a, 1977b; Scott 1977; Sherritt Gordon Mines Limited 1973

THE NICKEL BELT

The International Nickel Company of Canada Limited, generally known as INCO, began reconnaissance in Manitoba in 1946, and in 1951 their airborne geophysical survey indicated a possible concentration of magnetic minerals in the Thompson area, which was duly staked by the company in 1954. The Thompson orebody was intersected by diamond drilling in 1956 and the mine was officially opened in 1961. In fulfillment of its commitment to the Province, INCO provided a sub-divided and fully serviced townsite which became the city of Thompson, a comprehensive nickel-producing centre where mining, concentrating, smelting and refining operations are co-ordinated. The nearby Birchtree Mine, less than 6 km west of Thompson Mine, came into production in 1969, and significant developments also took place at the Soab and Pipe mines further south in the Nickel Belt.

The Nickel Belt is a 5 km wide zone of gneissic and other rocks, trending northeast-southwest for approximately 145 km, in which significant nickel mineralization has been found. The precise definition of the major rock-unit that contains the Nickel Belt is controversial. Some Manitoba geologists have considered the Nickel Belt to coincide with rocks assigned to the Wabowden subprovince, the boundaries of which are however in places indefinite. Nevertheless it may be useful as a starting point to consider the Nickel Belt as that part of the Wabowden subprovince in which substantial nickel deposits have so far been described. The subprovince extends northeast-southwest for well over 160 km, with a width varying from 8 to nearly 30 km. It includes the Manibridge Mine, 27 km southwest of Wabowden, and the Moak mining property 30 km northeast of Thompson. Geophysical data indicate that the Wabowden belt extends considerably further, both southwest and northeast, beneath the younger Palaeozoic dolomites.* The belt's northwest boundary is clearly defined southwest of Thompson by the Setting Lake - Ospwagan Lake fault zone. Northeast of Thompson the southeast boundary is also marked by a fault zone, parallel to the Burntwood River. Elswhere the boundaries are problematical. The rocks of the Wabowden subprovince are characterized by strong, throughgoing, northeasterly faults, distinctive geophysical properties, and by a large number of serpentinized peridotite bodies which bear a genetic relationship to the nickel deposits. The predominant rocks of the subprovince are, however, migmatites, crushed recrystallized gneisses, and granulites, interlayered with minor amphibolites and intruded by sills and dykes of quartz monzonite. A larger mass of hornblende-quartz monzonite (100 square km) occurs between Wabowden and the southeast end of Setting Lake. Hornblende-rich gneisses are characteristic at the southwest end of the Nickel Belt, while to the northeast the rocks are generally richer in biotite. The altered sedimentary rocks that crop out intermittently between Moak Lake and Setting Lake are known informally as the Thompson belt metasediments; the predominant type is a feldspathic quartzite. They are most extensive in the Thompson area, where they occupy a zone about 5 km wide, but they can also be seen around Ospwagan and Upper Ospwagan Lakes. In places they are in contact with mafic volcanic rocks which are well exposed at Upper Ospwagan Lake. Deformed pillow lavas are common, accompanied in places by greenstones and tuffs.

The rocks of the Wabowden subprovince are penetrated by zones of intense shearing and shattering that may be hundreds of feet thick; sedimentary and other rocks have been extensively converted to mylonite by the severe deformation. One of the latest events in the complex geological history of the subprovince is represented by an elongated mass of granodiorite, about 20 km long by 2.5 km wide, extending from Thompson to the north end of Mystery Lake; it is known to intrude the metasediments near Thompson. Coarse pegmatitic phases around Ospwagan Lake cut across mylonites and other rocks.

Owing to their susceptibility to weathering, the serpentinites and serpentinized peridotites rarely form good outcrops, but several hundred are known to be larger than 300 m by 30 m, and innumerable smaller bodies occur along the entire length of the Nickel Belt. One of the largest bodies has been detected by geophysical surveys and diamond drilling beneath Ospwagan Lake, but only a few small exposures can be seen there. The nickel deposits in general occur in or near lenticular pods of these serpentine-rich rocks that tend to be strung out in line along northeasterly fault zones. The ultramafic rocks are enclosed within metasediments and gneisses, and are commonly intruded by dyke-like bodies of granite and pegmatite which in places contain sulphides. The Thompson and Birchtree orebodies are classified as breccia sulphides in metasedimentary rocks. The majority of the known deposits are classified however as disseminated sulphides or veinlets in serpentinized peridotites, and examples of this type will therefore be described first.

References: Bell 1971a, 1971b; Coats *et al* 1972, pp 53-63; Davies *et al* 1962, pp 103-106; Lang *et al*, 1970 p 181; Phillips 1978, map Q; Quirke *et al* 1970, pp 6-8, fig. 2 & map; Scoates *et al* 1977

An outcrop of nickel-bearing, serpentinized peridotite on the southwest shore of **Mystery Lake** (I 5), 11 km northeast of Thompson, is the only surface exposure of well mineralized peridotite or serpentinite in the Nickel Belt. The outcrops, as described by Gill, appear only along the shoreline, over a distance of 130 m within a maximum width of 15 m. Unmineralized peridotite is dark grey on weathered surfaces, but becomes brown where there are sulphide concentrations. Freshly broken rock is greenish black, medium-grained, equigranular, and contains numerous sulphide specks. The sulphide minerals are chiefly pyrrhotite and pentlandite, with minor amounts of chalcopyrite and violarite. Rounded pseudomorphs of serpentine have replaced olivine and some are enclosed by sulphides. The ground was staked in 1949, and drilling by INCO subsequently outlined a large tonnage of low-grade, nickel-bearing serpentinite beneath the lake. The

**An extensive airborne geophysical programme by AMAX and other exploration companies in the nineteen sixties led to the discovery of a mineralized body of serpentinite about 30 km north-northwest of Lake Winnipeg. The serpentinite lies beneath the dolomites and was drilled by AMAX in 1969. The geophysical techniques and results were described by J. Roth in the C.I.M.M. bulletin of September 1975.*

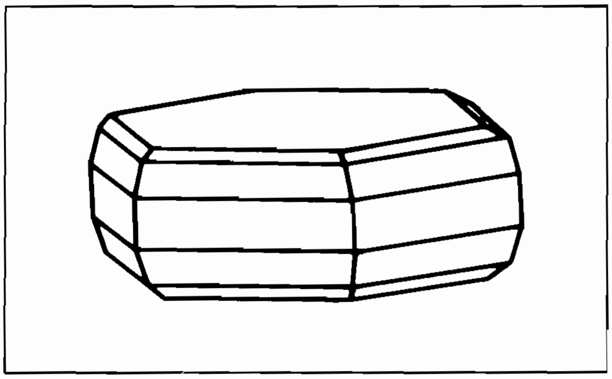


Fig. 17: Tabular crystal of pyrrhotite

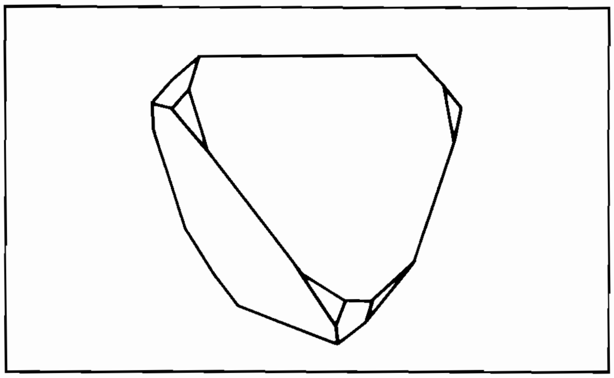


Fig. 18: Typical chalcopyrite crystal

claims are at present held by Mystery Lake Nickel Mines Limited on behalf of INCO.

References: Coats et *al* 1972, p 86; Gill 1951; Patterson 1963; Phillips 1978, sect. F

The **Moak** shaft (I 6) is 17 km northeast of the Mystery Lake outcrops and about 30 km by road from Thompson. It is the most northerly underground development on the Nickel Belt. The deposit, about 1 km north of Moak Lake, was discovered in 1955 by INCO and an exploration shaft was sunk to 400 m, but work was suspended when the company began developing its Thompson Mine. The sulphides, mainly disseminated pyrrhotite and pentlandite, occur in variable concentrations within a folded, sill-like body of serpentinite. The adjacent rocks are metasediments that have been largely converted to gneisses and mylonites. The nearest outcrops are well-banded, grey to white gneisses on the north shore of the lake, about 900 m south of the shaft. Massive sulphides occupy fracture zones in the serpentinite but they are impersistent and rarely exceed a few inches in width. The rock-dumps show various types of serpentinite, commonly with magnetite-filled fractures. Mineralized specimens show mainly pyrrhotite and pentlandite with minor amounts of chalcopyrite and violarite. Specimens of mylonite and crushed gneiss, which form the wall-rocks to the serpentinite, are abundant on the waste-dumps.

References: Coats et *al* 1972, pp 71, 72, 87; Davies et *al* 1962, pp 106, 109; Patterson 1963, p 47

The two **Pipe Mines** (I 7) are about 1.5 km apart, 35 km southwest of Thompson. Both were brought to the production stage in 1970, but the Number 1 (underground) mine was temporarily closed in 1971 in adjustment to the international nickel market. The 1970-71 production was from a 545 m, 3-compartment shaft (No. 1) which is on the north side of the access road. The Number 2 mine, at the end of the road, was planned for open-pit and subsequent underground operations. Production has been maintained from the open pit since 1970, and a shaft has been sunk (1973) to 945 m for future underground mining. The eventual area of the open pit has been quoted by the company as 670 m by 490 m, with a final depth of 220 m. The orebody is confined to a serpentinized lens of peridotite enclosed by complexly folded metasediments, predominantly biotitic quartzites. Some iron formation, and recrystallized calcareous sediments known locally as skarn, are interbedded with the quartzites which also contain bands of amphibolite-gneiss. On the west side of the pit, biotite gneisses are in contact with the serpentinite. The gneisses and sedimentary rocks have been variably altered to mylonite along local shear zones. The major ore-minerals are pyrrhotite and pentlandite; common accessories are magnetite, chromite, mackinawite, violarite, cubanite and chalcopyrite. There are smaller amounts of gersdorffite, nickeline, maucherite, sphalerite, goethite, rutile and graphite. Disseminated sulphides are the most widespread type of ore. They consist of small specks and blebs of pyrrhotite (plate 35), pentlandite and minor violarite, closely associated with serpentine pseudomorphs which have almost totally replaced the original olivine and pyroxene of the peridotite. Some of the ore, especially in sheared serpentinite, is in the form of stringers, some of them several metres in width, composed essentially of pyrrhotite, pentlandite and pyrite; massive sulphides (plate 36) of this type are well developed on the west side of the pit. In general, the pentlandite occurs as fractured grains, or as microscopic, flame-shaped intergrowths with pyrrhotite; it is considerably altered along fractures to mackinawite and very fine violarite. In the massive sulphides and veins, gersdorffite, with inclusions of nickeline and maucherite, appears as small grains in pyrrhotite. Cubanite and chalcopyrite have been detected only as tiny grains in pyrrhotite or pentlandite. Well-formed crystals of magnetite, some with chromite cores, are found with carbonate in some of the sulphide stringers.

References: Coats *et al* 1972, pp 72-74; Godard 1966b, Map 63-1; Grice 1976, pp 99, 114-115; Quirke *et al* 1970, pp 42-44; Scott 1977

The two **Soab Mines,** some 35 km further southwest, are on the west side of the highway, about 3 km apart. Aero-magnetic surveys in 1951 drew attention to this area, and shafts were sunk to 500 m (Soab North) and 620 m (Soab South) after ground surveys and diamond drilling. Production took place from both shafts between 1967 and 1971, and the two mines have been maintained by INCO on a standby basis since then. The principal ore-minerals are pyrrhotite and pentlandite, with pyrite, chalcopyrite and magnetite. The host-rock at **Soab North** (H 1) is serpentinized peridotite and the egg-shaped orebody contains massive to disseminated sulphides. Some schist and pegmatite are also mineralized. The **Soab South** orebody (H 2) is irregular in shape and not well defined; relatively massive ore occurs in narrow zones within various host-rocks. Mineralization has been reported in gneisses, metasediments and serpentinized peridotite. There is an interesting outcrop of serpentinized peridotite 10 km southwest of Soab South, on the northwest shore of Setting Lake. It is a medium-grained, dark bluish grey, fractured rock with a rough, brownish, pitted surface; it is cut by veinlets composed of magnetite, serpentine, carbonate and sulphides. As the rock apparently contains minor amounts of nickel (Godard 1968), this outcrop has been shown as a gossan occurrence on Map H.

References: Coats *et al* 1972, pp 63, 74; Godard 1968, p 11 & map 64-5; Lang *et al* 1970, p 181; Quirke *et al* 1970, p 45; Sabina 1972, pp 71-72

The **Bowden** deposit (H 3) of Bowden Lake Nickel Mines Limited is located 35 km south of the Soab South Mine, on the west shore of Bowden Lake, about 1.5 km northwest of Wabowden. After airborne and ground geophysical surveys had drawn attention to a possible orebody beneath Bowden Lake, Falconbridge Nickel Mines Limited began diamond drilling through the ice in 1962, and a shaft was sunk to 105 m in 1970-71. From these sources it was concluded that a sill-like body of serpentinized peridotite, approximately 3 km long, had intruded gneisses under the southwest part of Bowden Lake. The peridotite is cut by granitic pegmatite and contains a mineralized zone nearly 2 km long and about 320 m thick. Within this zone, massive and disseminated sulphides, mainly pyrrhotite, pentlandite, chalcopyrite and pyrite, are thinly dispersed. Feasibility studies indicated that further development of the deposit was not warranted at that time.

The **Bucko** deposit (H 4) of Bowden Lake Mines Limited is less than 5 km south-southwest of Wabowden, at the south end of Bucko Lake which lies on the contact between migmatitic gneiss and a large body of quartz monzonite. Nickel mineralization in serpentinized peridotite was discovered when Falconbridge Nickel Mines Limited drilled through the ice in 1964, following geophysical surveys. In 1971 a shaft was sunk to 340 m and diamond drilling was done from underground. In summary, a peridotite body, about 150 m thick and dipping steeply with the flanking gneisses, was found to contain some high-grade zones of mineralization *en echelon* over a length of about 685 m. The mineralization consists of pyrrhotite, pentlandite, chalcopyrite and pyrite, in massive and disseminated form. Some nickel values were also reported from the adjoining gneisses. Further geophysical work was undertaken in 1975.

References: Man. Min. Res. Div. 1977

The **Manibridge Mine** (H 5) of Falconbridge Nickel Mines Limited, 32 km southwest of Wabowden, was discovered by the company in 1963 following airborne and ground exploration programmes, and was in production from 1971. Outcrops in the vicinity of the 435 m shaft are mainly amphibole gneiss with interlayered amphibolite, and biotite granite gneiss. Some outcrops show augen gneiss and nearly all are cut by coarse pink pegmatite. The gneisses have been intruded by a sill-like body of dark green, serpentinized peridotite which is the host-rock for the nickel orebodies. The serpentinite dips steeply southeastward with the gneisses and is underlain by a 15 m thick mylonite zone which originated from the crushing of the gneisses during faulting. The serpentinite is irregular in shape but is over 1.5 km long and up to 900 m in width. It is cut by pegmatite dykes with the composition of biotite granite, some as much as 15 m wide. Locally, coarse biotite makes up almost one fifth of the pegmatite. Minor amounts of pentlandite, pyrite and, to a lesser extent, pyrrhotite and chalcopyrite, are associated with the biotite in places. Where the serpentinite has been intruded by pegmatite dykes, the contact zones have become enriched in chlorite, phlogopite, tremolite or anthophyllite. The zone of mineralization within the serpentinite is roughly 450 m long and contained a number of lens-shaped orebodies which varied in their nickel content from less than one percent to more than three percent. The primary ore-minerals, in order of abundance, were pentlandite, pyrrhotite, pyrite and chalcopyrite. The texture of the ore, as imparted by the sulphide minerals, varied from disseminated, to network, to semi-massive. In the first two cases, serpentinized pseudomorphs of olivine and pyroxene have been clearly preserved, surrounded by interstitial sulphides. The pentlandite occurs as blocky plates up to 0.5 cm across, and is partially replaced by violarite along its octahedral partings. Coarse patches of pyrrhotite, typically found between the pentlandite crystals, have been extensively replaced by flame-like tongues of smythite, a nickel-enriched oxidation product. Pyrite occurs as wispy veinlets and irregular areas within pentlandite. Magnetite is abundant as veinlets along the pentlandite partings, and as stringers cutting across all sulphides. Hematite is also present, as a red powder and as specularite. Other accessory minerals are chalcopyrite, marcasite, ilmenite and goethite. Non-metallic minerals found at the mine include green chrysotile asbestos, as narrow veinlets in massive serpentine, and also some picrolite, a columnar type of serpentine. Some serpentine is coated with white calcite. Fibrous actinolite, chlorite, orange-red feldspar and quartz can be found in various types of waste-rock.*

References: Coats & Brummer 1971; Coats *et al* 1972, pp 74-79; Grice 1976, pp 117-119, 122-123; Quirke *et al* 1970, pp 22, 55; Sabina 1972, p 70

One hundred and thirty kilometres to the northeast, INCO's **Thompson Mine** (I 8) is the largest mine on the Nickel Belt, and is also the best known example of a nickel deposit in mainly metasedimentary host-rocks. The principal host-rocks are schist, skarn, quartzite and concordant peridotite, all of which are interlayered with abundant gneisses and minor iron formation. The entire sequence has been folded into an anticline and cut by pegmatite. The gneissic rocks are mainly biotite gneiss and granite gneiss with some amphibole gneiss. Quartzite, which occupies the core of the anticline, has a variable content of feldspar, mica, zircon, apatite and sphene. Biotite schist (plate 37) is persistent throughout the ore-zone which is about 5.5 km long; constituents of the schist include quartz, feldspar, garnet and sillimanite. The skarn is a pale green, banded rock with prominent coarse diopside and silky phlogopite; carbonate, clinozoisite, tremolite and microcline are frequently present. The iron formation shows bands of coarsely crystalline quartz alternating with dark bands composed of garnet, amphibole, carbonate, biotite, pyrrhotite and magnetite; in places the banding is obscured by coarse garnet, amphibole and pyroxene. The peridotite rarely shows unaltered olivine or pyroxene, as these original minerals have been almost entirely replaced by pseudomorphic serpentine which is the principal constituent of the rock. The pegmatites (plate 38) consist of coarse aggregates of quartz, orthoclase, sodic plagioclase, large biotite flakes and minor muscovite. The ore is composed mainly of pyrrhotite, pentlandite and pyrite, with minor to trace amounts of magnetite, chalcopyrite, sphalerite and gersdorffite. Ore from the fold-limbs generally contains fine-grained (less than 0.5 mm) sulphides in disseminated or network patterns. Coarser (up to 3 mm), massive sulphides are found mainly at the fold-noses. Breccia-sulphide ore is typical in the metasedimentary host-rocks; this term refers to the numerous rock-inclusions or remnants contained in both coarse and fine-grained ore (plates 39, 40). In quartzite, the inclusions may be 10 cm or more in diameter, and the sulphides tend to form coarse-grained masses and stringers. In schist, on the other hand, fine-grained breccia-sulphide may contain only speck-sized remnants. The mineralization in peridotite is not of ore-grade, as the sulphides are either disseminated or in scattered stringers and veinlets. Pentlandite, the major ore-mineral, is rarely found in well shaped crystals; some occurs as flame-like segregations in coarse pyrrhotite, especially along silicate grain-boundaries. Near the surface, some pentlandite is altered to violarite and magnetite. Coarse-grained specimens from underground show replacement of pyrite by pyrrhotite, but this is much less pronounced in fine-grained ore from the fold-limbs. Near the surface, moreover, some of the pyrrhotite has been altered to pyrite and magnetite. Fractures in many places are lined by graphite, and some of the ore is cut by marcasite-carbonate veinlets. The best-formed crystals of magnetite are from the coarse-grained ore, but it is also common as disseminated grains and stringers in serpentinite. Chalcopyrite and sphalerite together fill fractures in pyrite and in silicate minerals. Chalcopyrite also occurs as small grains in pentlandite. Gersdorffite is disseminated as tiny blebs in pyrrhotite and pentlandite.

References: Coats *et al* 1972, pp 63-71; Grice 1976, pp 106-113, 125; Lang *et al* 1970, p 181; Patterson 1963, pp 42-47; Quirke *et al* 1970, pp 10-21; Sabine 1972, pp 74-75; Scott 1977

**Over a million tons of ore were eventually extracted before the ore ran out and the Manibridge Mine closed in April, 1977.*

INCO's **Birchtree Mine** (I 9), 5 km southwest of the city of Thompson, has been in production since 1969 from an 855 m shaft. A nearby development shaft (420 m) was converted to an air-intake shaft. The characteristics of the ore are similar in some respects to those of the Thompson Mine, 6.5 km to the west-northwest. Some of the ore is in biotite schist and is of the breccia-sulphide type, but some is in serpentinized peridotite. The tabular-shaped ore-zone is conformable with the flanking schists and folded metasediments, dipping steeply west. Samples studied by Grice were mostly medium to coarse-grained, massive sulphides, but finer-grained stringer and breccia ore are also present. From this study *(ibid)*, the major metallic minerals were defined as pyrrhotite, pyrite and pentlandite, and the accessory minerals as magnetite, chromite, ilmenite, galena, marcasite, sphalerite, gersdorffite, nickeline, maucherite and tellurobismuthite. Pyrite in the massive ore is partially replaced by pyrrhotite and chalcopyrite, or in some cases by marcasite. Well formed pyrite crystals in silicate minerals are apparently of a later generation. Much of the pentlandite is in flame-like intergrowths with pyrrhotite; there is also some coarse-grained pentlandite. Magnetite is a common accessory mineral in the ore, occurring as grains, as fracture-fillings in sulphides, and as an asbestiform replacement in silica minerals. Some magnetite has grown around cores of earlier chromite. Some of the chromite has been replaced by minor amounts of ilmenite. Gersdorffite, and the associated arsenides maucherite and nickeline, are common in the massive, coarse-grained ore, but were not observed in the interstitial or network sulphides. Some nickeline has been replaced by maucherite, and blebs of both these minerals are contained in gersdorffite, which was the last to crystallize and is much more plentiful than the arsenides. Galena and tellurobismuthite are rare at the Birchtree Mine; they appear to have been late in the crystallization sequence, like the arsenides with which they are associated.

References: Grice 1976, pp 113-114, 125-127; Lang et *al* 1970, p 181; Man. Min. Res. Div. 1977; Sabina 1972, p 73

SOUTHEAST MANITOBA

Nickel-copper mineralization in the Bird River - Cat Lake area was first discovered in 1917, on the **Mayville** claims (B 10), 5.5 km north-northeast of Maskwa Lake. This deposit which contains pyrrhotite, chalcopyrite and pentlandite, is in a gabbro-andesite contact zone, closely associated with the northern limb of the Bird River sill. Ten kilometres to the east-southeast, the **Eagle (New Manitoba)** property (B 11) contains similar sulphides, mainly in the gabbro. Copper and nickel sulphides were discovered on the Eagle claims in 1943 and, after surface exploration and diamond drilling, a 3-compartment shaft was sunk to 193 m in 1957 by New Manitoba Mining and Smelting Company Limited. The shaft is located 2.5 km west of Cat Lake and just south of provincial road 314. Construction of a concentrator reached an advanced stage before operations were suspended in 1957. By that time about 7600 m of diamond drilling had been reported. In 1971, Cat Lake Mines Limited was formed to undertake further geophysical work and diamond drilling, and an Explored Area Lease was subsequently applied for by the present holding company, Fundy Chemical International Limited. The deposit lies close to a major granite-greenstone contact, and the early diamond drill cores were logged as medium to coarse-grained basalt showing sections of massive chalcopyrite and pyrrhotite up to 30 cm in width. Further exploration was reported to have shown pyrrhotite, pentlandite and chalcopyrite disseminated through a gabbro plug in the basalt. Outcrops of the gabbro appear on the Eagle claims.

References: Davies et *al* 1962, p 43; Man. Min. Res. Div. 1977; Springer 1950, pp 5-6; Theyer 1977

Other nickel-copper deposits were found near faulted segments of the southern limb of the sill, in a zone extending westward from Bird Lake. Most of them are located near the contact of the sill, or associated greenstones, with a large mass of younger granite, known as the Great Falls Pluton. There is a close association between the gabbro-peridotite of the sill and the altered andesites and basalts of the narrow greenstone belt that it has intruded. The Bird River deposits in general have the form of sulphide lenses, mostly in amphibolite (derived from andesite). Some of the lenses are nickel-rich, some are copper-rich, and some contain only iron sulphides. The most important deposits were those of the **Dumbarton Mine** (B 12) which produced nickel-copper ore from 1969 to 1976, after many years of diamond drilling by Maskwa Nickel Chrome Mines Limited (controlled by Falconbridge Nickel Mines Limited). Dumbarton Mines Limited was formed jointly by Maskwa and Consolidated Canadian Faraday Limited to mine the deposit, which is located less than 1 km from the north bank of the Bird River, and about 50 km northeast of the town of Lac du Bonnet. The Dumbarton orebodies fell within a mineralized zone up to 15 m wide, extending some 3 km along the granite-greenstone contact. The main rock-types at this mine are andesite, iron formation, tuff and basalt. There were at least four orebodies, consisting of disseminated and massive sulphides in irregular, steeply dipping lenses. Pyrrhotite is abundant; chalcopyrite and pyrite are often visible; pentlandite, sphalerite and cubanite are present in minor amounts, mostly in microscopic forms. The principal host-rock was a massive, fine-grained amphibolite or altered andesite (plate F) containing disseminated pyrrhotite, and magnetite with ilmenite. Breccia-ore, on the other hand, consisted of massive pyrrhotite with fragmented inclusions of amphibolite. Some of the amphibolite is coarsely recrystallized, and large crystals of hornblende (partially replaced by actinolite), up to 10 cm long, occur in massive pyrrhotite (plates 30, 41). Blocky grains of pentlandite were occasionally seen alongside pyrrhotite, but most of the pentlandite was microscopically intergrown in pyrrhotite.

Unusually large amounts of magnetite in the amphibolite orebodies were accompanied by up to 25 per cent ilmenite. In places these oxides were in massive or banded form. Thin chert-like layers (possibly interbeds of altered tuff) in the amphibolite were minor host-rocks for disseminated sulphides - pyrrhotite, chalcopyrite, minor pentlandite and rare sphalerite. The proportion of chalcopyrite in the chert-like layers was much higher than in the amphibolite. Gangue minerals in these interbeds were mainly quartz and albite, with minor biotite and amphibole. Other metallic minerals at Dumbarton are secondary violarite and marcasite, found at near-surface levels, and minor pyrite in calcite veins that cut all host-rocks. The underground operations were carried out by means of a decline-shaft, completed in 1969, at an angle of 15° from horizontal. Ore-trucks were driven up and down this shaftway which has a length of 600 m and reaches a depth of 165 m.

The Maskwa West open pit, which was operated by the Dumbarton company in 1975-76, is 1200 m west-northwest of the Dumbarton mine; its surface area is about 275 m by 85 m, and its maximum depth 65 m. As it was located near a swamp, it had to be constantly pumped dry, and it became flooded when operations ended. Steep outcrops on the north side of the pit, and large piles of waste-rock, are likely to remain above water-level however. The main rock-type at the pit is peridotite at the base of the Bird River sill. Sulphides became increasingly abundant towards the lowermost part of the sill, and massive sulphides were found in places along the basal contact. The underlying andesites were impregnated with sulphides within a metre or two of the sill. Pyrrhotite was the principal sulphide, accompanied by minor pentlandite and chalcopyrite. The metallic oxides were hematite and chromite.

In summary, excellent specimens of pyrrhotite, magnetite and ilmenite may be found in the Dumbarton area; some solid masses of pyrrhotite were almost 1 m long, and many contain striking black crystals of hornblende. Owing to the proximity of the granite contact, pegmatitic specimens are plentiful; some contain muscovite crystals 1 cm across, and giant black tourmaline prisms, 30 cm or more long. Specimens of asbestos, 1 m or more in length, have been collected from shear zones cutting basic rocks in the ore-zones.

References: Broughton 1975; Davies et *al* 1962, pp 37-38, 43, table 6, fig 10; Karup-Møller & Brummer 1971; Man. Min. Res. Div. 1977; Theyer 1977

The **Wento** property (B 13) is about 3 km west-southwest of the Dumbarton mine and 1 km southeast of provincial road 314. Like the Dumbarton orebodies, the Wento deposit is situated along the granite-greenstone contact, but the ore is copper-rich and contains very little nickel. The main rock-types are amphibolite and iron formation. The claim was staked for copper in 1920, and by 1923 a 9 m drift had been excavated at the bottom of a shaft some 7.5 metres in depth. At least ten trenches and a few test pits were also dug. Lens-shaped bodies containing massive sulphides, stringers and disseminations were reported both in the greenstones (sheared andesite and tuff) and also in intrusive gabbro. The sulphides are chalcopyrite with pyrrhotite, cubanite and a little sphalerite. Some small lenses in the gabbro are composed of massive chalcopyrite. The gabbro also contains masses of titaniferous magnetite. There are granite outcrops just north of the deposit, and both gabbro and andesite are cut by small stringers of granite. In 1953, diamond drilling confirmed that the sulphide bodies, though small, are of good grade. In 1973 the property was assigned to Maskwa Nickel Chrome Mines Limited.

References: Davies 1955; Davies et *al* 1962, p 43; Man. Min. Res. Div. 1977; Theyer 1977

25) Pyrite-chalcopyrite ore with minor magnetite (Stall Lake Mine)

26) Large aggregates of fine-grained pyrite in chalcopyrite-pyrrhotite-pyrite groundmass (Osborne Lake Mine)

27) Large pyrite crystals surrounded by pyrrhotite in chalcopyrite ore (Ruttan Mine)

28) Polished slab showing pyrite-pyrrhotite inter-banded with dark hematitic gangue material (Ruttan Mine)

29) Pyrrhotite accompanied by vein quartz with pink feldspar (Lynn Lake Mine)

30) Pyrrhotite accompanied by large black hornblende crystals and cut by small chalcopyrite veinlet (Dumbarton mine)

31) High-grade pentlandite ore with much pyrrhotite and chàlcopyrite (Lynn Lake Mine)

32) Gersdorffite crystals with plagioclase (Museum)

33) Specimen of massive nickeline (Museum)

34) Chalcopyrite-rich ore with minor pyrrhotite and small amphibole crystals; gabbroic gangue (Lynn Lake Mine)

35) Serpentinite with minor pyrrhotite (Pipe Mine)

36) Massive pyrrhotite ore crossed by pyrite veinlet and containing insets of magnetite (Pipe Mine)

Gold Ore Suites

Gold is one of the few elements that occurs mainly in its native state, as free gold. Practically the only other minerals in which this metal occurs are the gold tellurides. Native gold generally has the form of irregular plates, scales, or shapeless masses that are called nuggets if large enough. Gold crystals, which are rare, are mostly octahedral (fig. 19) and randomly distorted, passing into filiform, reticulated and dendritic shapes (fig. 20). Most native gold contains about ten percent of other metals, mainly silver, mixed in solid solution as a kind of natural alloy. Gold containing unusually large amounts of silver (20 to 40 percent) is known as electrum, as found in small quantities at the Flin Flon Mine. Electrum is pale yellow and usually has a specific gravity of 13 to 15, compared with 19 for pure gold. Gold is distinguished from the yellow sulphides, such as pyrite, by its much higher specific gravity, its softness and malleability. These tests are not easily applied in the field, with positive results, owing to the generally minute size of specks that require testing; but they are useful for eliminating "fool's gold". Prospectors utilize the high specific gravity of gold when panning, a process that consists of swilling a sample of fine-grained sand around in water. The lighter particles reach the edge of the pan first and are gradually discarded, whereas the gold, if any, tends to accumulate as a heavy residue. Failure of the metallic grains to dissolve in nitric acid would prove that they were in fact gold, and not pyrite or chalcopyrite.

The placer gold deposits are sandy beaches of any age in which gold particles have been concentrated after being dislodged from their source-rock by weathering processes, and carried away by stream erosion. A typical location would be in sand dropped by a stream where the current slowed down at a bend. The heaviest fragments would be the first to drop, and small particles of gold would accompany larger grains of lighter minerals such as quartz and feldspar. Primary (non-placer) gold falls into two broad categories: free gold (plate 42) filling cracks in quartz grains or occupying interspaces between sulphide grains (usually pyrite); and invisible gold that has become trapped within pyrite or chalcopyrite. In the latter case the gold may be liberated by natural weathering (plate 43) which breaks the sulphides down to rusty oxidized material (gossan) on outcrop surfaces, while the gold itself remains immune to oxidation. Unweathered sulphides may be crushed, roasted and panned by prospectors when looking for gold. The origin of the gold, sulphides, quartz and other vein minerals is generally attributed to deposition by superheated hydrous fluids that had been circulating at depth in the host-rocks. Such hydrothermal fluids may be broadly compared with the hot springs that reach the surface in volcanic terrains, bearing in mind that greatly elevated temperatures and pressures would apply at depth.

TELLURIDES are characteristic of many gold-ore suites and, if in significant quantities, they may be valuable ore minerals. Laboratory tests are generally required for positive identification, but the following species have been described in Manitoba:

Sylvanite is a tin-white to steel-grey, gold-silver telluride with a brilliant lustre. It may occur in lath-shaped crystals but is more likely to be seen as a thin, skeletal coating (that may resemble writing) on other vein minerals. It has perfect cleavage and is soft enough to mark paper; its streak is the same as its colour.

Petzite is a slightly harder, silver-gold telluride, but can easily be scratched with a knife. It is steel-grey to iron-black but often tarnished, and is usually in massive-granular form.

Altaite is a lead telluride with perfect cleavage that may be found in veins with native gold. It is tin-white with a yellowish tint, and tarnishes bronze; the streak is black and it can easily be scratched with a knife.

Tellurobismuthite (wehrlite) is a telluride of bismuth and usually contains some sulphur; it occurs in foliated masses or irregular plates, sometimes in quartz veins with native gold. Its colour and streak are pale lead-grey and its lustre splendent. It has perfect cleavage and is soft enough to mark paper.

Arsenopyrite (plates 44, 45) is a hard, silvery white sulfarsenide of iron that is frequently found in gold and copper ores. Crystals are pseudo-orthorhombic (fig. 21) but massive forms are more common. The streak is black and, when struck with a hammer, the faintly garlic-like odour is distinctive. While characteristically found in gold-bearing quartz veins in Manitoba, arsenopyrite is also a minor constituent of some copper-zinc ore suites, as at the Flin Flon, White Lake, Chisel Lake and Fox mines. Occasionally, also, it is found in massive form, unaccompanied by other metallic minerals, as exemplified 2 km north of Gods Lake Narrows (0 1). Arsenopyrite is here disseminated throughout a feldspar porphyry dyke that intrudes quartzo-feldspathic schist of sedimentary origin. The dyke, which has a maximum width of 8 m, crops out on the north shore of a small peninsula and is exposed for 50 m to the southeast. Its dip is 65° southwest, and along the footwall side, where fractures are filled with quartz veinlets, arsenopyrite locally makes up 40 percent of the rock, occurring in places as massive lenses. The arsenopyrite zone is less than 1 m thick but extends for a considerable distance along the footwall side of the dyke. An assay showed only a trace of gold.

Reference: Barry 1961, p 28

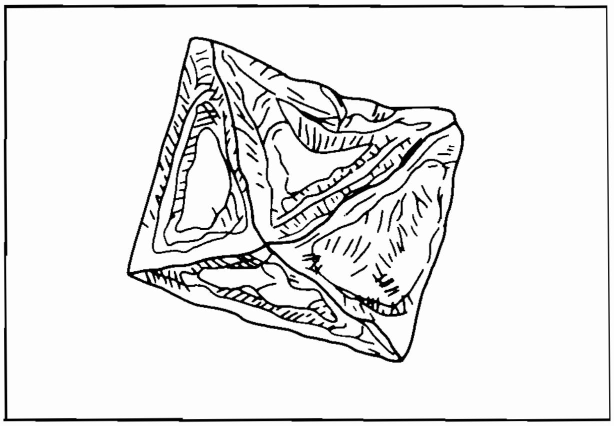
Molybdenite is a soft black sulphide mineral found occasionally in granite but more often in quartz-rich pegmatites and quartz veins. Some gold-bearing quartz veins contain minor amounts of molybdenite and the mineral is described here for that reason. No large deposits are known in Manitoba, but elsewhere the mineral is mined as the only source of molybdenum, which is extensively used in the iron, steel, chemical and petroleum industries. Iron and steel usages, including alloy and other applications' account for over 90 percent of world consumption. Molybdenite usually forms platy or leaflike crystals with perfect micaceous cleavage (fig. 22). It feels greasy and is soft enough to leave a bluish grey mark on paper; as a lubricant, it is comparable with graphite. Its black colour is generally modified by a lead-grey bluish tone, and the streak is normally greyish black. On glazed porcelain, however, it leaves a dark greenish mark. Molybdenite could be confused with graphite, but the latter has a brownish rather than bluish tinge, and leaves a black mark on glazed porcelain. During the first world war, large crystals of molybdenite (plate 46), were extracted by hand-cobbing from pegmatites, granitic dykes and quartz veins west of Barren Lake (A 1)*; the old pits can still be seen but they are now practically devoid of visible molybdenite. Large spectacular clots of molybdenite have been described in the Rat River area (J 5), but they are very localized and relatively inaccessible owing to flooding. On a small island in Island Lake (P 1), a quartz vein in sheared andesite shows coarse molybdenite and pyrite; these minerals are also present in the adjoining granite. A little molybdenite has been recorded in wall-rocks at the San Antonio gold mines. Other minor occurrences (not shown on maps) have been reported in gold-bearing quartz veins at Gold Lake, also 11 km east of Bissett, further east at Wallace Lake, and again near Garner Lake (map C). Similar occurrences have been recorded in gold-bearing quartz veins around Brunne and Copper Lakes (map E); and also near the west shore of the Narrows at the south end of Crowduck Bay (map G).

**Nearby scheelite deposits, in shear zones that cut the greenstones northwest of Barren Lake, have been described in Volume I (Phillips 1978, map A)*

References: Davies *et al* 1962, pp 23, 35; Godard 1963; Schledewitz 1972, map 71-2-2; Springer 1952; Vokes 1963

Manitoba's metallic mining industry owes its beginnings to the pioneer work of the early gold prospectors who became active in the last few years of the nineteenth century. Equipped with a canoe, a gold pan, and a pick for hammering the outcrops, these men found innumerable gossans during the next half-century. Most of the gossans were barren, but a few contained gold or other valuable metals such as copper, zinc or nickel. The contrast between iron sulphides and gold in their resistance to weathering tends to bring about a relative increase, with the passing of time, in the proportion of gold in a gossan. The relative concentration of gold in gossans has been the cause of many disappointments when subsequent excavation or drilling has shown that the fresh rock beneath the gossan may contain much pyrite but only trivial amounts of gold. Initial reports of high gold values on claims that subsequently proved valueless can often be attributed either to this factor or to the

Fig. 19: Distorted octahedral crystal of gold

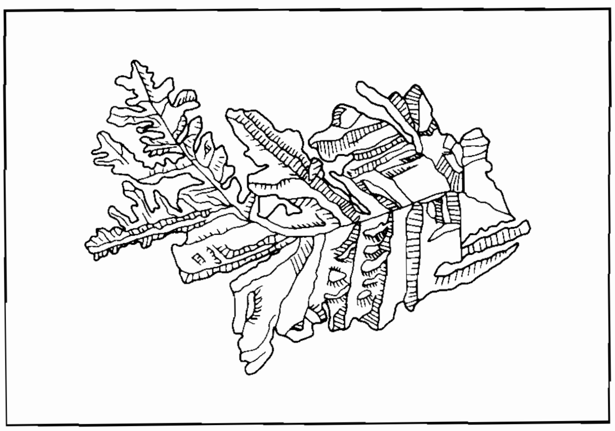


erratic distribution of gold in quartz veins: gold may be locally concentrated in small pockets but the total quantity is rarely large enough to warrant mining operations.

SOUTHEAST MANITOBA

The area around **Falcon and West Hawk Lakes** was intensively prospected for gold throughout the first half of the twentieth century. The large number of old pits and trenches in the greenstone belt that trends parallel to Falcon Lake is evidence of these activities; most of them were excavated before 1920. Most of the gossans that were investigated (map A), including those in the sedimentary rocks of Star and West Hawk Lakes (see Goethite), were derived from iron formation containing pyrite or pyrrhotite; a few of these gossans contain traces of gold, but most were found to be barren. More promising gold-quartz prospects, none of which have to date become productive, were found associated with the Falcon Lake stock (see Phillips 1975, fig. 3). Some are within the stock and others are near its intrusive contact with the greenstones. The **Sunbeam** property (A 2) is located near the quartz monzonite core of the stock. A shaft was sunk there in 1938 to a depth of 120 m. The deposit is a pipe-like body of silicified quartz monzonite with a surface area of about 205 m^2, increasing with depth. Fractures due to faulting are filled by quartz, and pyrite is disseminated throughout the silicified rock; minor quantities of other sulphides, and a little gold, are concentrated along some smaller fractures. The 150 m shaft on the **Waverley** property (A 3), less than 0.5 km to the southeast, was sunk in 1945-46. It is located in the granodiorite ring that surrounds the core of the stock. A silicified shear zone on the claim had long been known to contain small amounts of gold-bearing pyrite, but structural details from the principal mineralized outcrops are not well known,

Fig. 20: Dendritic gold



since they have been covered by the rock-dump. It was reported however that several hundred thousand tonnes of material approaching ore-grade were contained in three closely spaced bodies within the granodiorite ring. The **Moonbeam** claim (A 4), 300 m northwest of the Sunbeam shaft, also adjoins the quartz monzonite; a silicified zone in granodiorite contains a considerable amount of pyrite, some of which carries small gold values. On the **Gold Coin** claim (A 5), 820 m northeast of the Sunbeam shaft, the host-rock is again silicified granodiorite, containing quartz veinlets, arsenopyrite, pyrite and minor amounts of gold.

The **Moore** property (A 6), 820 m northwest of the Sunbeam, is located on the volcanic-intrusive contact. It was the site of one of the earliest ventures in the area: considerable underground work, including the sinking of a 20 m inclined shaft, was done before 1915. The property was originally know as the Penniac Reef gold mine, and old company reports showed high gold values. Star Lake Gold Mines Limited reported encouraging results from diamond drilling in 1938 but these did not lead to further activity. The host-rocks are dark silicified agglomerate, located only a stone's throw from the Falcon Lake stock. The host-rock has been cut by scattered stringers of vein quartz and is mineralized with pyrite and small amounts of arsenopyrite and pyrrhotite. Similar veins occur in andesite-basalt on the **Sheba** and **Gem** claims 1 km to the southwest, again next to the intrusive contact. Two of the mineralized zones (A 7), trenched many years ago, are each about 150 m in length and strike northeasterly. The **Rad** claim is located in similar rocks, near the contact, about 2 km southwest of the Moore shaft. The mineralized zone (A 8) consists of two intersecting shears containing small lenses of quartz. The host-rocks are silicified and mineralized over widths of 1 to 6 m. Both the quartz veins and the silicified rock carry notable quantities of chalcopyrite and pyrite with a little gold. The intersection of the two shears has given rise to a V-shaped zone of mineralization. The northerly limb of the V trends east-west and is about 110 m long. The southerly limb trends southwest, parallel to the intrusive contact, for about 165 m. The **Boyes** claim is near the northwest end of Barren Lake (A 9), and a mineralized shear trends southwest for a short distance from the west shore. The host-rocks are basic lavas and the nearest outcrops of the stock are across the lake, 300 m to the northeast. The vein material is sugary quartz with pyrite. One of the veins on the claim yielded good gold values when sampled in 1919, but its precise location is uncertain. Similar volcanic host-rocks appear on the **Jewel** claim, less than 1 km to the west. Although the mineralized shear zone (A 10) is about 900 m from the stock, its strike (west-southwest) is comparable to that of the contact deposits. The shear zone is up to 3 m wide and is exposed for about 230 m. The mineralization is marked by lenses and stringers of quartz; both the quartz and wall-rocks contain pyrite, arsenopyrite and lesser amounts of chalcopyrite, sphalerite, pyrrhotite and galena. The width of the mineralized portion of the shear is not more than 30 cm or so. Two prospect shafts were sunk on this vein around 1900, and assays conducted by the mining recorder in 1912 showed a little gold and silver.

The **Falnora** property, at the east end of Falcon Lake, is not related to the Falcon Lake stock, but is located in volcanic rocks about 140 m north of their contact with an intrusive, pink, porphyritic granite. The principal gold location (A 11) is less than 1 km from the western tip of a prominent east-west peninsula. The mineralization occurs at the west end of a 4 m wide shear zone that has been traced for more than 250 m parallel to the east-west granite contact. A 2 m wide dyke of quartz-feldspar porphyry cuts dark, find-grained greenstones on the north side of the shear zone. The greenstones have been described as sheared tuffaceous rocks interbanded with andesite. The most abundant rock in the shear zone is sericitic schist, but a hard, dense, grey, siliceous rock, 1 m in width, is sandwiched between the schists in the mineralized portion of the zone. The hard grey rock shows very little vein-quartz but is mineralized with pyrite over a length of some 150 m at the west end of the shear zone; the eastern half of this section shows the heaviest mineralization, consisting of seams and disseminations of pyrite, with considerable amounts of pyrrhotite and some chalcopyrite. The deposit has been exposed along its length by an open cut, and a deep pit was sunk in the heavily mineralized section. Fifty tonnes of ore taken from the open cut many years ago yielded a few kilograms of gold. A second mineralized shear (A 12), about 900 m to the east, may represent an extension of the mineralization exposed in the open cut, but is less well known. Sheared, silicified rock, cut by quartz stringers and mineralized with pyrite, is exposed over a width of 3 to 4 metres, and a little gold is known to be present.

References: Davies 1954; Davies et *al* 1962, pp 30-34; Janes 1977; Phillips 1975 fig 3, 1978 map A; Stewart 1977 & *in prep.*

The most productive gold-mining district in Manitoba was the **Rice Lake - Beresford Lake area,** around Bissett and southeastwards, almost to the Ontario border about 130 km due north of Falcon Lake. Since recent highway construction has given good access to this area, brief descriptions are given here of the once-productive mines, and also of some nearby prospects where visible gold has been documented. As there are many old shafts, pits and trenches in this area, the numerous rock-dumps are noteworthy sites for mineral collectors. Some of the dumps are however being depleted or dispersed owing to new road construction. The first significant discovery was made in 1911 when free gold was found in a quartz vein on the north shore of Rice Lake. This led eventually to the establishment at Bissett of the well known San Antonio Mine which produced 37,392 kg of gold and 5978 kg of silver between 1932 and 1968, thus accounting for 80 percent of the total output from the seven principal gold mines of the Rice Lake - Beresford Lake greenstone belt. The numerous gold occurrences are in quartz veins, lenses and stringers, mostly located along shear zones, either in volcanic (occasionally sedimentary) rocks of the Rice Lake Group, or in igneous rocks that have intruded them. The intrusive host-rocks are mainly dykes or sills of gabbro, diabase or diorite, but some of the deposits are in the marginal zones of a large tonalitic batholith known as the Ross River quartz-diorite pluton. Quartz is the predominant gangue mineral in the gold-bearing veins, some of which contain up to ten percent metallic minerals, mainly sulphides.

References: McRitchie & Weber 1971; Stewart 1977

The **San Antonio mine** (C 12) was located at the town of Bissett on the north shore of Rice Lake. The San Antonio claim was staked by Desautels in May 1911, two months after the staking of the nearby Gabrielle claim by Pelletier. In 1926 the Wanipigow Syndicate explored four veins seen in outcrops on the San Antonio claim near the lake-shore. Shaft # 1 was sunk to 50 m near the water's edge. It penetrated a thick diabase sill which occupies the shoreline at this locality for nearly 1 km, and which subsequently proved to be the major host-rock for the gold-bearing quartz veins (plates 42, 47). The San Antonio company was formed to develop the property in 1927. The first shaft was abandoned in 1928 and operations were started at # 2 shaft, 300 m to the southeast, situated on a small island that has since been connected to the mainland by a causeway of waste-rock. This shaft penetrated the sill to a depth of 188 m, and in 1930 its effective depth was extended to 290 m by means of an inclined winze. A mill was built at about this time. The main, 3-compartment shaft (# 3) was begun in 1933 however, reaching down to 498 m in 1938; it is

75 m east of # 1 shaft and located in the same diabase sill, near its northerly contact with schistose sedimentary rocks. A vertical winze had reached to 470 m in 1937. The working depth was increased to 760 m in 1940 by means of an internal shaft (# 3 winze), and to 1255 m in 1947 (# 4 winze). A fifth winze was sunk, from the main shaft, to a depth of 1640 m in 1960, in order to develop a new ore-zone leased from the adjoining property of Forty Four Mines Limited.

The diabase sill reappears on the shoreline 320 m to the west on the Gabrielle claim. There, a 16 m prospect shaft was dug near the shoreline before 1920. The Gabrielle main shaft was put down through drift 115 m to the northeast; it intersected a northerly dipping vein (known as Gabrielle # 6) in the diabase at a depth of 100 m. A power line was connected to this shaft from San Antonio in the early nineteen thirties. Gabrielle Mines Limited sank a new shaft to a depth of 105 m in 1934; it is located in porphyritic andesite, 250 m east of the main Gabrielle shaft, and about 320 m north of the sill's nearest outcrop. When San Antonio Gold Mines Limited bought the Gabrielle property in 1935, they drove a cross-cut 550 m north-northwest from the 140 m level of their # 3 shaft to enter Gabrielle's new shaft which became known as San Antonio's # 4 shaft.

The rocks exposed on the San Antonio, Gabrielle and nearby claims, as described by Stockwell, include tuffaceous sediments, arkose, lava flows, volcanic breccia and igneous intrusions. The sedimentary rocks are well exposed on Hares Island, 0.5 km south of shaft # 2. They strike northwest with northerly dips, and are overlain by a thin flow of pillow-basalt, followed to the north by a thin layer of volcanic breccia, and then by a thick mass of coarse, porphyritic andesite. The sedimentary rocks along and near the lake-shore have been intruded by a large sill-like body of dark green to grey diabase, the major host-rock at the mine. The diabase is considerably altered, locally to chlorite schist. The feldspar is identified microscopically as altered laths of oligoclase to labradorite; fibrous crystals of green hornblende are plentiful, and quartz can be seen in some hand specimens. The sill strikes northwest and dips northeasterly at about 45 degrees. It extends for about 2 km across the property, and shows its maximum width of 150 m on the San Antonio claim. The sedimentary rocks in contact with the sill are highly sheared sericite schists.

Some thirty four gold-bearing veins were found on the property of San Antonio Gold Mines Limited, including ten on the Gabrielle claim. All veins were within the diabase sill except for Gabrielle # 3 vein which was in porphyritic andesite (shaft # 4). Almost the entire production, however, was from veins in the thickest part of the sill, on the San Antonio claim. The veins were classified into a set which strike northwesterly, with almost vertical dips, and a northeasterly set dipping northwest. The northwesterly veins follow fracture zones that show brecciation but little or no shearing; the largest, and main ore-producer (vein # 26), was over 200 m long with an average width of nearly 3 m; it was mined from # 3 shaft down to the 230 m level. The northeasterly veins follow shear zones and the wall-rocks are chlorite schists. The biggest of these veins, and the mine's second largest ore-producer (vein # 16), was 190 m long with an average width of 1.2 m; it was mined down to the 460 m level from shaft # 3. Wall-rock alteration adjoining both types of vein included the addition of much pyrite and small amounts of magnetite and molybdenite, but in other respects the wall-rocks were markedly different. In contrast to the chlorite schists of the northeasterly set, the wall-rocks of the northwesterly set were altered to grey rocks rich in albite, ankerite and sericite, derived from the normally dark green diabase. The vein in porphyritic andesite at # 4 shaft strikes west-northwest; wall-rock alteration is marked by much rusty-weathering ankerite and scattered cubes of pyrite. In the principal ore-veins, the gold, some of which was visible, occurred mainly with fine granular pyrite set in cherty quartz. Some gold was closely associated with ankerite, albite and tourmaline. The best values were reported to have come from banded pyrite in which gold was interstitial and seldom visible. Other sulphides commonly found with the ore were chalcopyrite, sphalerite and galena. Occasionally, native gold, in the absence of pyrite, was accompanied by magnetite together with the gold-silver telluride, petzite. Tellurobismuthite has also been identified. The common gangue minerals include chlorite, albite-oligoclase, potassic feldspar and calcite.

Within 3 km east of Bissett, between Rice Lake and provincial road 304, there are several rock dumps around old shafts that were taken over by Wingold Mines Limited in the nineteen thirties. The rocks on these claims are mainly porphyritic andesite to dacite and trachyte breccias. Most of the claims had been staked twenty years earlier on quartz veins within the porphyry. Adjoining the road, less than 1 km east of the Bissett fire-tower, the Gold Cup shaft was sunk about 25 m into a porphyry ridge, in an unsuccessful attempt to intersect a shear zone that follows a narrow diabase dyke to the southeast. Most of the material on the dump is sheared porphyritic andesite, cut by quartz stringers, much altered to carbonate, and containing cubes of pyrite. About half a kilometre further east, and 180 m south of the road, the **Goldfield** shaft (C 13) was sunk to 85 m by the Wingold company who installed mining plant there and had electric power laid on from the San Antonio mine. The shaft is at the foot of a large hill of coarse andesite porphyry in which a group of quartz veins follow a northwesterly shear zone. White quartz on the mine-dump is sparsely mineralized with disseminated pyrite but visible gold, although reported underground, is hard to find. The best surface values were reported to be in concentrations of brecciated pyrite. Ankerite is an important gangue mineral and the quartz is crossed by many lines of fine-grained black tourmaline; sericite and fuchsite are also present. The wall-rock porphyry has been altered to sericitic and chloritic schists containing pyrite; some specimens show large broken feldspar crystals surrounded by fine-grained chlorite and carbonate. Several other old shafts, from 12 m to 30 m deep, were located in porphyritic andesite on the Wingold group of claims south of the road and north of Rice Lake, but none of them revealed significant mineralization.

References: Amukun & Turnock 1971; Davies *et al* 1962, pp 47-52; Marr 1971; Stephenson 1971; Stewart *in prep;* Stockwell 1938, 1945; Traill 1970; Weber 1971a; Wright 1932, pp 50-91

Visible gold has been documented at several properties south and west of Gold Lake which lies 3 km southeast of Rice Lake. There was intense prospecting activity in this area between 1914 and 1923, as well as some underground development and minor production. Visible gold can still be found on rock-dumps around some of the old shafts, as at the **Ranger** property (C 14), about 1.5 km southeast of Rice Lake and a similar distance west of Gold Lake. The volcanic host-rocks are here crossed by porphyry and diabase dykes; these rocks have been variably affected by northwesterly shear zones which are in places occupied by vein quartz. The principal host-rocks on the property are sheared rhyolite and dyke-rocks. Most of the surface prospecting, including the 18 m shaft and some 15 pits, was done during the first world war. The rock-dump shows white quartz with a little pyrite and occasional specks of gold. The wall-rock specimens are dark grey chlorite-sericite schists. Rusty-weathering ankerite is prominent both in the veins and wall-rocks. The 23 m **Chicamon** shaft (C 15), less than 1 km west of Gold Lake, dates back to the same period. It was sunk in a narrow fracture-zone passing through rhyolite and porphyritic dacite, as exposed in outcrops northwest of the shaft. Brecciation of the wall-rocks is indicated by numerous pyritized fragments in the white quartz veins. In addition to pyrite and minor chalcopyrite, some vein specimens on the rock-dump show occasional specks of visible gold.

References: Stephenson 1971, 1972; Stockwell 1938, 1945.

Spectacular free gold was seen many years ago at the **Gold Pan** property (C 16), about 1.5 km southwest of Gold Lake, and this small mine became the first producer in the area, in 1916. Sporadic small-working activites ceased in 1930 and no production figures are available. The outcrops in this vicinity are porphyritic dacite and trachyte breccias which are cut by a diabase dyke, 9 m wide, striking northeast across the claims. The main 60 m shaft, subsequently deepened by a 25 m winze, was sunk where the dyke is intersected by a narrow shear that strikes north-northwest. Impressive amounts of visible gold had been reported in a quartz vein that follows the shear zone northwest as far as the dyke. Outcrops around the shaft are now covered by the rock-dump which shows specimens of diabase impregnated with pyrite. Just south of the shaft, the vein was mineralized with chalcopyrite and gold, accompanied by minor sphalerite and galena. A small prospect shaft, 90 m along the shear northwest of the dyke, failed to locate an extension of the ore-vein. About 400 m southeast of the main shaft, attempts were made to trace the vein beneath muskeg on the adjoining Gold Seal claim; quartz on the dump around this shaft is mineralized with pyrite.

The main volcanic-plutonic contact trends north-south less than 400 m east of Gold Lake, and one former small-working, the **Moose** property (C 17) lies very near the contact, 3 km south of the lake. Three lenses of quartz were found in sheared dacite breccia and the shaft was sunk to 30 m on the largest lens, 65 m from the contact. The quartz-diorite southwest of the shaft is shattered, and impregnated with quartz. Vein specimens from the rock dump show pyrite and chalcopyrite; some contain tiny specks of visible gold. The wall-rock schists contain quartz, oligoclase, ankerite, chlorite and sericite.

The **Gold Lake** property (C18) is located about 2.5 km southwest of Gold Lake and a similar distance northeast of Big Clearwater Lake. The trachyte and dacite breccias that underlie the claims are cut by a diabase dyke that trends southeast and north-northwest for 4 km. The east side of the dyke is followed by a throughgoing shear zone, known as the Pilot-Smuggler shear, and has been extensively converted to chlorite schist. Numerous small dykes of quartz-feldspar porphyry strike northeast into the diabase and some have been diverted along the shear zone. Around 1935 the main shaft was sunk to 98 m in the sheared contact rocks (diabase and dacite porphyry) where drilling had indicated relatively large bodies of mineralized quartz within the shear zone. The quartz is almost continuous for 275 m north and 135 m south of the shaft. Chlorite schist derived from the diabase contains much ankerite and considerable pyrite. The inner wall-rocks are altered however to pyrite-bearing quartz-sericite schists. The quartz veins contained much pyrite, considerable chalcopyrite and small amounts of visible gold.

About 3 km west of the Gold Lake property, at the **Pendennis** prospect (C 19) near the north shore of Big Clearwater Lake, an exploration shaft was sunk to 12 m where tabular quartz veins occurred in sheared quartz diorite. The wall-rocks are altered to quartz-chlorite schist. The vein sulphides are pyrite and minor chalcopyrite. The rock-dump shows white sugary quartz and a brecciated variety. Some of the weathered pyrite shows specks of visible gold.

Referecnes: Bailes 1971b; Davies 1953; Stephenson 1971, 1972

The **Packsack** property (C 20) is situated in the volcanic rocks 6.5 km west of Gold Lake. The 160 m shaft, half a kilometre west-southwest of Red Rice Lake, was sunk in the mid-nineteen-thirties for underground exploration of quartz veins on the Montcalm claim. Gold values were found to be erratic but the deposit was worked sporadically until 1940. The volcanic rocks that are extensive immediately south of the shaft strike northwest and consist mainly of porphyritic dacite breccia and andesite porphyry; a 25 m cliff near the shaft marks the northernmost volcanic outcrops. These are separated by overburden from the hilly outcrops of feldspathic quartzite immediately west of Red Rice Lake. The volcanic rocks are cut by numerous small diabase dykes, up to 15 m in width, striking north-northwest and east-west. Five lenticular quartz veins, less than 2 m wide, crop out on the Montcalm claim near the shaft; they occupy a northwesterly shear-zone that intersects porphyritic dacite and diabase dykes. Specimens from the large rock-dump around the shaft show that the wall-rocks are intensively altered chlorite-sericite-carbonate schists containing crystals of pyrite. Pyrite and subsidiary chalcopyrite are the principal metallic vein-minerals. Visible gold can still be found in some vein quartz specimens, and in pyrite, especially where the latter contains small quartz inclusions. The gangue minerals include much ankerite and lesser amounts of chlorite; tiny dark green crystals of tourmaline are also present.

References: Davies 1953; Stephenson 1971, 1972; Stockwell 1945

The **Poundmaker** shaft (C 21) is 8 km northwest of Rice Lake in a large mass of granite to quartz diorite. It was first staked as the Luleo claim in 1915, and most of the shaft-sinking was done by the Selkirk gold mining company who produced about 9 kg of gold in 1923-24. The 2-compartment shaft reached 100 m and the depth was extended to 160 m by means of a winze. The property was held by Poundmaker Gold Mines Limited from 1934 to 1942; they installed a hydro-electrically operated mill, but all efforts to achieve further production were unsuccessful. The host-rock is a sheared remnant of diabase within the quartz-diorite. The mineralized shear zone strikes northwest and contains tabular-shaped quartz veins, some of which are over 3 m wide. Pyrite is the principal metallic mineral, accompanied in the veins by minor chalcopyrite and little gold. Although some of the gold was visible, the best values were in banded pyrite containing microscopic gold. Ankerite is a widespread gangue mineral, with lesser amounts of chlorite, sericite and bright green fuchsite. Vein specimens from the mine-dump show greyish white quartz with some buff, coarsely crystalline ankerite that weathers dark reddish brown. The wall-rock specimens are chlorite schist, some of which feels soapy owing to the presence of talc. Diamond drilling by the Selkirk company in the mine-area showed minor concentrations of chalcopyrite and sphalerite at depth. An outcrop on the east side of Little Beaver Lake, a small lake 1.5 km southeast of the shaft, showed this type of mineralization in quartzose sediments cut by diabase dykes. Sheared, sulphide-bearing schists were again encountered by diamond drilling 150 m further southeast, but all such copper-zinc concentrations were considered too small for base-metal mining purposes.

References: Davies 1949, 1950; Stephenson 1971, 1972; Stockwell 1945; Wright 1932, pp 87-88

The **Vanson** shaft (C 22) is located by the north bank of the Wanipigow River, 3 km northeast of the Bissett fire-tower. An old road to the river opposite the shaft leaves the main road 2.5 km west of the fire-tower. Shaft-sinking was begun by a syndicate about 1926 and reached a depth of 148 m in 1935, after Vanson Gold Mines Limited had acquired the property. The site is 275 m south of a major granite contact and within the same greenstone belt as the San Antonio mine. The host-rocks are mainly

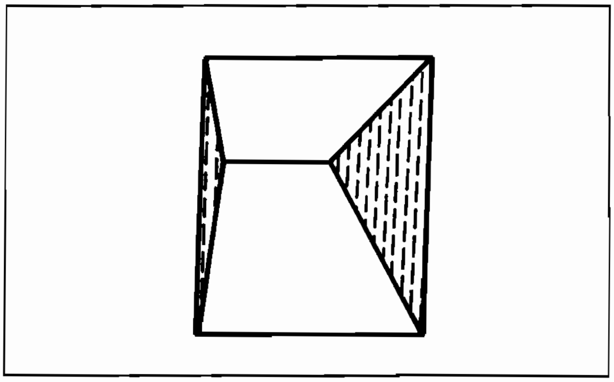


Fig. 21: Striated prismatic crystal of arsenopyrite

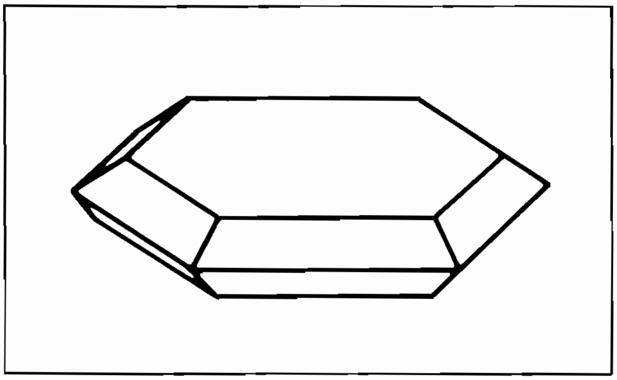


Fig. 22: Molybdenite showing micaceous cleavage

impure quartzites, apparently cut by small diabase dykes, and altered to quartz-sericite schist in shear zones. The gold-bearing quartz veins, less than 1 m thick, occupy shears and fractures in an east-west zone. The wall-rocks in general are quartz-chlorite-sericite schists, and the rock-dump shows abundant chlorite schist, apparently derived from sheared, diabasic wall-rock. The metallic vein minerals are mainly pyrite, with minor amounts of pyrrhotite and chalcopyrite and occasional small specks of visible gold. The rock-dump shows cherty and greyish white quartz containing fine-grained chlorite, epidote and fuchsite. Although electrically operated mining plant was installed, and residential buildings put up by the Vanson company upon completion of the shaft, all operations ended abruptly in 1935.

References: Davies 1950; Stephenson 1971, 1972; Stockwell 1945

The **Jeep mine** (C 23) was 14 km east of Bissett, and the site is 1.5 km north of provincial road 304. The mine was a subsidiary of the San Antonio company and the ore was trucked to Bissett for processing. Between 1948 and 1950, 432 kg of gold were produced from the 180 m shaft, sunk into a large, L-shaped xenolithic body known as the Jeep gabbro, which is at least 25 km long and practically surrounded by younger granitic rocks. Outcrops around the mine are mostly medium-grained diorite showing white irregular grains of plagioclase in a dark greenish grey, micaceous groundmass. The diorite is accompanied by subsidiary black gabbro mottled with patches of white feldspar. Wall-rock alteration next to the veins has produced dark grey, schistose rocks containing much chlorite and some specks of pyrite. The ore-body was located in several parallel shears in the diorite. The main shear zone, which passes 30 m south of the shaft, strikes west-northwest and has been well exposed for about 90 m by trenching. It is less than 1 m wide and contained narrow, irregular lenses of quartz from which some high-grade ore was obtained. Pyrite made up more than 75 percent of the metallic vein minerals, and was accompanied by pyrrhotite, arsenopyrite and minor chalcopyrite. A little scheelite was also present. The gold, some of it visible, was preferentially associated with arsenopyrite. Ankerite, calcite and chlorite were very minor gangue minerals. The mine-dump shows some weakly mineralized specimens of glassy white quartz; dark grey, cherty quartz is also present. Some quartz specimens show fine chlorite partings with which tiny specks of gold are associated. Wall-rock specimens of quartz-chlorite schist, containing pyrite and carbonate, can also be found on the dumps.

References: Marr 1971; Russell 1948; Stephenson 1971, 1972; Stewart *in prep;* Weber 1971a

Ten kilometres to the southeast there was considerable activity in 1925 following the discovery of coarse particles of free gold 3 km southwest of Wallace Lake, between Moore and Bennett Lakes. An exploratory shaft was sunk in sheared andesitic pillow lavas at the **Cryderman** property (C 24), where a shear zone up to 9 m wide had been traced northwest for 450 m. Lenticular quartz bodies in the zone are up to 2 m in width and small but rich concentrations of free gold were found locally. Underground work from an 80 m shaft, and diamond drilling to the west, showed however that the average gold content of the quartz bodies was low. A smaller, sub-parallel shear zone to the northeast is exposed for 180 m; it also contains vein quartz with a little free gold. Trenches 15 m northeast of the shaft show glassy and brecciated quartz with a little fine-grained pyrite and chalcopyrite (plate 48). The wall-rocks are quartz-ankerite-sericite schists. Minor tellurides were reported with the rich gold concentrations in the early days.

At the **Moore Lake** property (C 25), 2 km to the southeast, a 12 m shaft was sunk (1928) in a 5 m wide shear zone cutting the pillow lavas. The shear was traced northwest for 450 m. A pit about 100 m east of the shaft shows white quartz lenses with patches of black quartz and a little pyrite and chalcopyrite; the wall-rocks are pyritized chlorite schists. These are again exposed in a pit 150 m east of the shaft, showing well formed pyrite crystals 0.5 cm or more in diameter, next to the white quartz veins, which are sparsely mineralized with pyrite and chalcopyrite. Carbonate is abundant both in the veins and wall-rocks. A third pit, 15 m to the south, shows better mineralization: pyrite and chalcopyrite are relatively abundant and the veins contain traces of sphalerite and galena, as well as some specks of free gold.

References: Stephenson 1971, 1972; Wright 1932

The **Ogama-Rockland mine** (C 26), 0.5 km north of the east end of Long Lake, produced 1555 kg of gold, mainly between 1948 and 1951, from the Ogama shaft which reached a depth of 315 m in 1950. Claims in this area, including Ogama, Rockland and Onondaga, were first staked in 1915 to cover a group of mineralized horsetail shears that fan out to the northwest from the throughgoing Long Lake shear which trends east-west for about 5 km. Small amounts of gold were mined up to 1934 from the 30 m Onondaga shaft, 500 m southeast of the Ogama shaft (C 26) and 1 km north of Wadhope. The Onondaga rock-dump now shows the quartz-chlorite schist wall-rock but very little vein material. The Ogama shaft lies on the same shear, where it passes through a tongue of "quartzeye granite" (grey quartz diorite) that forks off from the Ross River pluton. The quartz diorite in this vicinity is cut by numerous dykes of granitic porphyry. The Ogama shaft was first put down to 35 m in 1941, but gold production was soon interrupted by wartime priorities. The Rockland shaft is located 600 m to the northwest on an adjacent shear. Some gold was probably recovered from this site in the early days, but shaft-sinking to 83 m in 1948 did not lead to further production. Quartz diorite next to the quartz veins was altered to quartz-sericite schist, as seen on the Ogama and Rockland rock-dumps. Veins and wall-rocks were mineralized with scattered grains of pyrite and chalcopyrite, with a little sphalerite, galena and arsenopyrite. The richest ore was found where pyrite and arsenopyrite were both present. Specks of gold can still be found in vein quartz on the Ogama rock-dump. Traces of molybdenite occur in the wall-rocks. Gangue minerals include sericite, with a little inconspicuous potassic feldspar and ankerite.

The **Valley Vein** property is less than 1 km northeast of the Ogama shaft, located in the same tongue of "quartz-eye granite". Pits were dug in a northwesterly shear zone containing narrow quartz veins, and a prospecting shaft was sunk to 10 m in 1928, immediately northeast of the shear. A pit 15 m west of the shaft shows a little pyrite and chalcopyrite in vein quartz. The wall-rock is sericitized quartz diorite with abundant veinlets of ankerite. Some quartz specimens on the rock-dump show traces of galena and occasional specks of free gold. The **Elora** property, 1.5 km north-northeast of the Ogama shaft, lies near the plutonic contact, in a northeasterly shear zone that passes through greywacke and a dyke of granitic porphyry, 3 m in width. One hundred and eighty tonnes of ore were reported to have been extracted in 1922 from a trench, 5 m deep, extending northeast for 30 m along the shear from a shallow prospect shaft. A stamp mill on the property was reported to have recovered 3.6 kg of gold from this ore. Coarse gold was reported to occur with arsenopyrite, but the trench is now waterlogged. The dump material is mainly greywacke and some grey cherty quartz with sparse pyrite and chalcopyrite. The **Eldorado** property (C 27) is located in the Ross River pluton 2.5 km northwest of the Ogama shaft. Claims were staked in 1916 when abundant free gold was found in quartz lenses in a narrow shear zone striking northwest. Two prospect shafts, less than 1 km apart, were sunk in the shear zone; the 15 m-deep, northwesterly shaft is less than 400 m south of Halfway Lake. The southeasterly shaft (C 27) was deepened to 160 m, but although electric power was brought in from the east, and extensive drifting done at various levels, the work had to be abandoned in 1928 when it became clear that good gold values were confined to small veins at the surface and at the 40 m level. Native gold can be found however in many specimens on the rock-dump, associated with pyrite and chalcopyrite. The principal gangue minerals are sericite, chlorite, ankerite and calcite. The wall-rocks are intensely altered to quartz-sericite schist but some specimens still show the blue quartz eyes that are typical of the unaltered quartz diorite.

References: Davies et *al* 1962, p 52; Russell 1952a; Stephenson 1971, 1972; Stewart *in prep;* Stockwell & Lord 1939; Weber 1971b; Wright 1932

The **Central Manitoba mine** (C 28) produced 4977 kg of gold between 1927 and 1937 from eight deposits about 5 km northeast of Long Lake. Hence its output was exceeded in southeast Manitoba only by the San Antonio mine. It has been calculated that about 30 km of diamond drilling, and 15 km of drifting and cross-cutting were carried out before the mine was closed down. The deposits lay within a narrow east-west belt, 2.8 km long, and were mined at various times from five shafts. Most of the ore was above the 115 m level. The Kitchener orebody was one of the richest; the shaft (C 28), next to the mill, reached a depth of 277 m and was located 90 m southeast of the former townsite of Wadhope, of which little trace now remains. There are numerous rock exposures in prospecting pits to the east, as far as the Tene shaft, 1 km east-northeast of Wadhope. This shaft was 105 m deep with a winze extension to 230 m. The Rogers shaft, 150 m south-southeast of the Tene, is a 50 m decline with a vertical depth of 145 m. The Hope shaft, 145 m deep, is half a kilometre east-northeast of the Tene shaft. The 120 m Growler shaft is less than 400 m southwest of Wadhope.

The deposits fall within the southerly limb of a large folded sill of diorite and gabbro which is over 1 km wide. The sill strikes easterly for nearly 10 km to the foldnose, whence it curves northwesterly. Most of the gold deposits were on or near the northern contact of a band of pillowed andesite and tuff, 180 m wide, that lies within the sill. The various orebodies all consisted of gold-bearing quartz veins situated in a zone of shearing that extends east-west for nearly 3 km with a width of about 200 m. The mineralized shear zones are individually up to 730 m long and 7 to 8 m wide. The vein complexes are up to 640 m long and typically 1 to 1.5 m in width. A band of cherty tuff was host to several of the more productive veins. Some deposits consist of much smaller gold-bearing quartz lenses *en echelon*. Wall-rock alteration, which was particularly intense next to the Hope vein, produced pyritized quartz-chlorite-carbonate schists. The iron sulphides were mainly pyrite with some pyrrhotite. Chalcopyrite was relatively abundant, and minor amounts of marcasite, arsenopyrite and sphalerite were also present. Some gold was in pyrite and chalcopyrite, and some was in a free state, but none could be seen without a microscope. Most of the gold was in blue-grey quartz veins and some of the orebodies were cut off at depth by white quartz. Gangue minerals included alkalic feldspar, ankerite, chlorite and sericite.

The Growler and Kitchener orebodies, respectively 340 and 240 m in length, lay in the same shear zone and were only 35 m apart at their extremities. The former was worked from the Growler shaft until 1929, and then by cross-cuts from the Kitchener shaft. The host-rocks for both orebodies were mainly tuff, but some veins branched off into gabbro and diorite near the Kitchener shaft. The Rogers orebody lay in a similar position on the tuff's northern contact with the sill. The ore-vein, less than 1 m wide and composed of blue quartz, was traced for 85 m through tuff at a depth of 30 m. To the east the vein passes into underlying, fine-grained diorite. The Tene orebody, 150 m to the north, lay entirely within altered diorite and was characterized by lenses of bluish quartz, 6 m or more in length, as seen in outcrops and trenches 120 to 230 m east of the Tene shaft. Below the 100 m level, the blue quartz is crossed by streaks of white quartz and carries hardly any sulphides or gold. Four hundred and fifty metres to the northeast, the Hope shear zone cuts altered diorite; it was traced east-west for 685 m at the surface. The mineralized zone contained at least six orebodies, represented by lenses of bluish quartz containing disseminated pyrite and grains of chalcopyrite. Pyrrhotite was not abundant, except in barren quartz lenses to the west, but some large blebs of chalcopyrite were very rich in gold. Some of the blue quartz lenses were crossed by gash veinlets of white quartz, and some white quartz contained spots and patches of blue quartz.

The **Mirage** property (C 29), 4 km south of Wadhope, and less than 1 km east-southeast of Bidou Lake, is of interest for the crystalline gold specimens recorded there in 1927. By 1929, an inclined prospect shaft and 44 pits or trenches had been excavated. The quartz veins, which are less than 1 m thick, and lenticular in shape, occur in two shear zones, about 2 m in width, which strike west-northwest through a gabbro sill. The sheared wall-rocks have been altered to sericite schists containing quartz, chlorite, ankerite and a little pyrite. Within the veins, finely crystalline gold occurs along fractures in irregular lenses of glassy and smoky quartz. The gangue minerals include coarse tourmaline with a little chlorite, fuchsite and carbonates. Free gold was abundant in a quartz lens near the east end of the northerly shear zone, which was traced for 300 m along strike, and museum specimens of crystalline gold were obtained from this locality. The inclined shaft, which was sunk to a depth of 10 m, showed that the gold-bearing quartz lens had little downward extent. According to Russell, who was there in 1949, the shaft was sunk in a zone of talc-serpentine schist, and he also noted altered serpentinized rock in a surface pit near the shaft. Flay-lying joints in this rock were reported to contain "a large amount of visible gold in a gangue of quartz and carbonate"

37) Biotite schist containing fine-grained pyrrhotite (Thompson Mine)

38) Pegmatitic feldspar accompanied by pyrrhotite with biotite (Thompson Mine)

39) Coarse breccia-ore showing large biotite-quartz fragment in pyrrhotite-pyrite-biotite groundmass (Thompson Mine)

40) Polished slab of pyrrhotite breccia-ore showing black gangue fragments (Thompson Mine)

41) Pyrrhotite and minor chalcopyrite associated with large hornblende crystals (Dumbarton mine)

42) Free gold in quartz (San Antonio mine)

43) Gold in limonitic veinlets cutting vein quartz (Elbow Lake)

44) Arsenopyrite crystals accompanied by quartz prisms (Museum)

45) Arsenopyrite crystals with quartz (Museum)

46) Bluish black, platy molybdenite (Barren Lake)

47) Gold-bearing pyrite in quartz (San Antonio mine)

48) Gold-bearing chalcopyrite in blue quartz (Cryderman property)

(ibid); no sulphides were noted with the gold. The southerly shear zone, widening locally to 6 m, was followed for 600 m but showed relatively little vein quartz, except at the west end where free gold was found in the early days in a vein, 50 cm wide, with a length of 60 m.

References: Cambell 1971; Davies *et al* 1962, p 51; Russell 1952a; Stephenson 1971, 1972; Stewart *in prep;* Stockwell & Lord 1939; Weber 1971a, 1971b; Wright 1932

The **Oro Grande mine** (C 30) was located near the north end of Beresford Lake, 10 km east of Long Lake. The inclined shaft, 78 m deep, is about 400 m west of the lake; it is connected, at the 40 m level, to the Solo shaft, which is 160 m deep and located 150 m to the southeast. All shaft-sinking was done, in stages, between 1923 and 1933. The ore was in quartz-filled openings along the Oro Grande shear zone where it cuts a large diorite sill near the eastern contact with overlying volcanics of the Rice Lake Group. The Oro Grande shaft is at the south end of a ridge of diorite which rises above the nearby swamps. The Solo shaft is also in the sill, but less than 50 m from its contact with tuffaceous sediments. The shear zone, which strikes northwesterly and dips to the east, contains veins, up to 6 m long, of sugary quartz. These veins, exposed in outcrops on the ridge, yielded free gold during the early prospecting. The shear zone was subsequently traced to the north by trenching, and there is a 15 m prospect shaft 120 m north of the inclined shaft. Trenches and an open stope in this vicinity showed white, cherty and glassy quartz lenses, bordered by sheared gabbro, which has been altered to dark grey quartz-chlorite-carbonate schists, with minor biotite schist. The veins and the rusty-weathering wall-rocks contain coarse pyrite cubes, also pyrrhotite and minor chalcopyrite. Coarse gold was reported underground at many locations down to 70 m. Visible gold and rare sphalerite were found in a recent survey of surface material (J.W. Stewart, *pers. com.*). The presence of specular hematite in the chloritic wall-rock appears to indicate high-temperature mineralization. The mill operated from 1932 to 1934, and 1938 to 1940, producing 164.9 kg of gold and 16.3 kg of silver.

The **Gunnar mine** (C 31), which was at the south end of Beresford Lake, less than 1 km west of the shore, produced 3101 kg of gold between 1936 and 1942. Owing to the good vertical extent of the ore-zone, the main, 3-compartment shaft reached a depth of 625 m. A second shaft, 210 m to the northwest, was down to 114 m. The mineralization is in andesite and basalt, including some pillow-lavas, near the south end of a dykelike body of albite granite, about 45 m wide, that trends northerly for 2.5 km. Some smaller porphyry dykes, 3 m or so in width, strike north-northwest through the volcanics. The main shaft is located immediately north and east of the intersection of one such dyke with the principal mineralized shear zone, which was traced roughly east-west on the surface for 820 m by numerous pits and trenches. The lavas within the shear zone have been altered to chloritic schist and soft, greenish grey carbonate schist. The pits reveal a lenticular vein, less than 1 m thick, consisting of grey sugary quartz and ankerite, and well mineralized in places with pyrite and chalcopyrite. Sixty metres west of the main shaft, the shear follows a contact between andesite and an easterly projection of the granite. The richest orebody was located near this contact. Although nearly 5 m wide in the volcanics, the shear is weakly defined where it crosses the granite, widening again in andesites to the west. The wall-rocks, as seen in the pits, are heavily carbonated chlorite schists showing disseminated cubes of pyrite; they also contain quartz and andesine. Pyrite was the most abundant metallic mineral in all the ore-veins, but chalcopyrite, pyrrhotite, arsenopyrite, sphalerite and galena were also present. Visible gold was common in the quartz; the highest values were found in grey sugary quartz where cut by veinlets of glassy quartz. Another indication of high-grade ore was finely granulated, streaky pyrite along cracks in sugary quartz; chalcopyrite, sphalerite and galena tended to accompany gold in streaks along these cracks. In the shear zone adjoining the smaller shaft, some large but low-grade masses of pyrite were found in packed grains up to 1 cm across. The gangue minerals in all veins included chlorite and carbonate with lesser amounts of albite, tourmaline, fuchsite and sericite. The rock-dumps have unfortunately been removed in recent years for road construction purposes.

References: Campbell 1971; Cole 1938; Davies *et al* 1962, p 51; Russell 1952a; Stephenson 1971, 1972; Stewart *in prep;* Stockwell & Lord 1939; Traill 1970; Weber 1971a, 1971b; Wright 1932

The **Diana-Gem Lake mine** (C 32), 18 km further south, was less than 1 km from the Ontario border. The site is 3 km south of Gem Lake and 300 m northwest of Kickley Lake. The 3-compartment shaft had reached 236 m in 1931. The earliest production was in 1928 but most of the mining was done between 1934 and 1936. Total production was 235.5 kg of gold and 13.2 kg of silver. The mine was closed in 1938 but minor salvage operations took place in 1941. Regionally, the orebodies were on the south limb of a large gabbro sill that had been folded with the enclosing greenstones. Locally, however, the intrusion is dykelike and dioritic. The gabbro around the shaft is rich in pyroxene and magnetite. Other rocks exposed in the vicinity include andesitic to basaltic pillow-lavas and tuffs, and some sedimentary interbeds, mainly quartzite. The main shears strike west-northwest through greenstones and gabbro. Gold-bearing quartz veins cropped out in shear zones at several localities which are now mostly covered with tailings. The most productive lens was exposed 65 m northwest of the shaft; its total length was 64 m and its average width less than 1 m. Numerous pits and trenches were dug in and across various shears in the mine-area, including an open cut about 35 m long, 180 m west of the shaft. The wall-rocks next to the veins are highly sheared, greenish grey, quartz-chlorite-calcite schists. Tiny gold particles were typically found in tourmaline-bearing white quartz. Smoky, grey and glassy types of quartz are also present. Pyrite and pyrrhotite were the most abundant metallic minerals, accompanied by chalcopyrite, arsenopyrite, sphalerite and galena. The rock-dump shows vein quartz and wall-rock specimens mineralized with pyrite and chalcopyrite with a little pyrrhotite and galena. Specks of gold can be found in some specimens of dark quartz. Ankerite, calcite and chlorite are abundant gangue minerals in the vein specimens. Most of the wall-rock specimens are strongly sheared chlorite schist.

References: Russell 1952b; Stephenson 1971, 1972; Stewart *in prep;* Weber 1971b; Wright 1932, pp 57-60

FLIN FLON - SNOW LAKE REGION

The town of Snow Lake, now the centre of a copper-zinc mining district, originated as a gold-mining camp for the **Nor-Acme mine** (G 7), which produced 19,176 kg of gold and 1,562 kg of silver between 1949 and 1958. The original claims were staked in 1927 and Nor-Acme Gold Mines Limited was formed in 1938 to hold and develop the property. Mining operations were delegated to the Howe Sound Exploration Company Limited, later renamed the Brittania Mining and Smelting Company Limited. The mine was serviced by a 5-compartment shaft, 600 m deep, and a mill was built on the site. Although the gold is too fine-grained to be normally visible, various interesting rocks and minerals can be found on the extensive rock-dumps. The principal rock-types are volcanics, schists and hornblendite. The ore consisted of native gold associated mainly with needle-like bunches of arsenopyrite, which was the most abundant metallic mineral. A small proportion of the gold occurred with pyrrhotite and pyrite; a little sphalerite and galena are also present. Interesting minerals to be found on the rock-dumps include: staurolite, garnet, hornblende, pyroxene, tremolite, epidote, black tourmaline, calcite, feldspar and serpentine; gypsum forms white rosette encrustations on some specimens. The geological setting of the Nor-Acme orebodies is somewhat complex, but in summary, they occur along a faulted contact between quartzo-feldspathic and basic pyroclastic rocks, both of which are cut by irregular basic intrusions. The quartzo-feldspathic rocks consist of feldspathic sediments interbedded with siliceous volcanics, including, near the mine, some flow-breccia. The basic pyroclastic rocks, as exposed a few hundred metres west of the mine, are well-bedded agglomerate, breccia and tuff. The basic intrusions, which are abundant in the pyroclastics, are hornblendite, gabbro and diorite. A contact between hornblendite and volcanic breccia was well exposed about 45 m north of the mine. Ore was distributed along an easterly fault (the Howe Sound fault) for a length of about 600 m, but was mainly concentrated in two orebodies about 300 m apart. These orebodies were located on and near a brecciated contact between the quartzo-feldspathic and pyroclastic rocks. Although breccia fragments were cemented by vein quartz, the ore was practically restricted to the fragments. The gold particles, rarely exceeding 0.1 mm, were mainly associated with arsenopyrite crystals up to 2 mm in length, especially where the latter mineral was cut or adjoined by small veinlets of carbonate, which was an important gangue mineral.

References: Davies et *al* 1962, pp 81-83 & fig 23; Harrison 1949; Russell 1957; Sabina 1972; Stewart *in prep.*

Elbow Lake is about 50 km west of Snow Lake and occupies the northern extension of the Grass River Provincial Park. A large island near the northwest shore is the site of an old gold property known as the **Century** mine (F 7). Claims at the northeast end of this island were staked in 1919. The country rocks in and around Elbow Lake are mainly basic lavas; some pillow lavas on Century Island have been altered to chlorite schists. Shear zones near the old workings strike south-southeast. From the north shore of the island, about 150 m from the shaft, a dyke of quartz porphyry, striking parallel to the shears, was traced in outcrops and test pits for about 300 m, with a maximum width of 3 m. Shearing has converted the margins of the dyke to sericite schist. Wherever exposed, the porphyry carries disseminated cubes of pyrite and is cut by quartz veinlets and lenses. Irregular bodies of white quartz, up to 2 by 1 m, contain angular inclusions of the porphyry, and some of the vein quartz is well mineralized with pyrite and chalcopyrite. Some mineralized stockworks extend into the chlorite schist wall-rocks. Carbonate is common in the gangue. Visible gold was observed in quartz and adjacent wall-rock. The whole vein complex was traced for 100 m or so along strike with a maximum width of 3 m. A prospect-shaft was sunk down a quartz vein in schistose andesite, 5 m east of the dyke, and in the nineteen forties this was deepened to 150 m. Drifting and cross-cutting were subsequently carried out at depths of 40 and 75 m. Camp buildings, a small mill and an assay office were constructed on the property. Some coarse gold was extracted from high-grade pockets, but total production was minor. Operations ceased in 1947, notwithstanding subsequent diamond drilling programmes. Most of the vein outcrops were covered by the buildings and rock-dump.

Visible gold also occurs in quartz veins that cut chloritic schists at the **Ding How** property (F 8) on a small island 4 km to the south-southeast. Two quartz veins, up to 60 cm in width, were explored in 1929 by means of a 14 m shaft. The veins had been traced to the northeast for 50 m along a shear zone. Schist in and near the veins carries pyrite. The outcrops, originally staked in 1921, were covered by a rock-dump and the shaft became waterlogged. Examination of specimens on the dump, and from exposed veins, showed fine to medium grained, white to grey quartz containing about one percent pyrite with a little chalcopyrite and sphalerite. Brown carbonate is a minor gangue mineral. Gold was observed in several quartz specimens, in some cases adjacent to small altered inclusions of wall-rock.

In 1933 coarse gold was found on the west side of Elbow Lake at the Gunwor claims which became known as the **Elbow Lake** property (F 9), located about 2 km southwest of Century Island, on the west shore of a long narrow bay. The country rocks are basic lavas with minor rhyolite flows, cut by dykes of rhyolite and quartz-feldspar porphyry. All these rocks are near the contact of a large batholith of younger quartz-diorite. The original discovery was of gold-bearing quartz veinlets in a dyke of quartz-feldspar porphyry. Some of the veinlets carry carbonate, pyrite and chalcopyrite. A veinlet of sphalerite containing abundant coarse gold was found nearby, in lava next to a rhyolite dyke. Subsequent exploration outlined a pattern of easterly and northerly shear zones containing quartz in branching veins and discontinuous lenses. The most important veins trend easterly, parallel to the dykes. A prospect shaft was dug 250 m southwest of the original discovery to trace a vein in a sheared rhyolite dyke containing brown-weathering carbonate. Outcrops of the vein had been found on a hillside near the shaft. After trenching through drift, another exploratory shaft was dug 100 m or so to the west, again in sheared rhyolite thought to be a faulted continuation of the same dyke. In general the quartz is medium-grained, white to grey, and forms over 95 percent of the vein material. Both the quartz and the sheared wall-rock contain pyrite, some of which, along the contact, hold microscopic specks of gold. The veins also carried coarse gold locally, and some was recovered by small scale operations in the early days.

References: McGlynn 1959; Stockwell 1935

Thirty kilometres to the southeast, and easily accessible from highway 391, gold prospects on **Fourmile Island** (F 10) in Reed Lake were thoroughly explored by numerous pits and trenches after visible gold and sulphides had been reported in milky white quartz veins cutting "quartzeye granite". Old workings on the southern shore include a 25 m trench nearly 5 m deep; free gold, if present there, is inconspicuous however.

References: Harrison 1949; Rousell 1970; Stewart 1977

The **Gurney mine** (E 12) is 40 km east of Flin Flon and 4 km southeast of the rail junction of Optic Lake. The mine-site is about 1 km north of the west end of Brunne Lake. The claims were first staked in 1919, but it was not until 1933 that Dominion Gold Mines Limited was formed to develop the property. They sank a shaft to 50 m which Gurney Gold Mines Limited deepened to 200 m after acquiring the property. A mill with a capacity of 113 tonnes per day was installed and the mine began production in 1937. Production totalled 783 kg of gold and 2,227 kg of silver by the time the ore reserves had become exhausted in 1939. The orebody was in an elongated strip of greenstones that strikes northeasterly for 10 km. These greenstones, which are cut by granitic dykes, are a detached segment of the Flin Flon volcanic belt and are surrounded by younger granite. Near the mine, quartz veins are widespread in shear and fracture zones that strike northeast through basic tuff and hornblende basalt. The tuffs have been altered to chlorite schist and the basalt has been silicified. Wall-rock alteration is characterized by chlorite, epidote, biotite, albite and quartz, with some carbonate, tourmaline, sericite and apatite. The mineralized veins are parallel to the shearing, and the orebody was located along the main quartz vein immediately north of an elongated body of biotite granite surrounded by the greenstones. The orebody was made up of mineralized quartz, altered tuff and a lesser amount of silicified basalt. Pyrite, the most abundant sulphide, is disseminated in tuff and schist, and also occurs in massive form. Pyrrhotite is common in the wall-rocks and partially replaces pyrite in the ore. Chalcopyrite and sphalerite are quantitatively minor. Galena, usually accompanied by chalcopyrite, was an indicator of the richest ore concentrations. It was fine-grained and practically restricted to cracks in quartz and pyrite. A little molybdenite was found locally. Gold was not normally visible but was revealed under the microscope as small particles in quartz, especially where galena was present. Some specks were also found in pyrite. The silver minerals were probably associated on a microscopic scale with galena, and possibly sphalerite; tellurides and ruby silver (sulfarsenide and sulfantimonide of silver) were reported but not confirmed.

References: Davies et *al* 1962, p 75; Hage 1944; Podolsky 1951; Stewart *in prep.*

Twenty two kilometres southeast of Snow Lake lies the ghost-town of Herb Lake, once the centre of a thriving gold mining district that included several small mines on the east side of Wekusko Lake. The area is accessible by boat from the south or west. The large rock-dump of the **Rex (Laguna) mine** (G 8), 2 km northeast of the ghost-town, makes a prominent landmark when approached from the lake. This was by far the largest mine in the area, producing 1,846 kg of gold and 190 kg of silver in four periods of operation between 1918 and 1939. The main shaft eventually reached a depth of 343 m; a smaller shaft (34 m) was put down 250 m to the south. The property was first staked upon discovery of a gold-bearing quartz vein in 1914, during the early months of a gold-rush that led to the tracing of a northeast-southwest belt, about 10 km long and less than 1 km wide, along which numerous claims were staked. The belt follows a row of elongated stocks of quartz-feldspar porphyry that have intruded andesitic, pyroclastic and sedimentary rocks. The deposits in this belt are located in the porphyries, along their contacts, or in country rocks less than 400 m from the contacts. Although there is some local schistosity, strong shearing is not characteristic of the gold deposits of the porphyry belt. The metallic ore-shoots at the Rex mine were in a quartz vein located within, and parallel to, a porphyry stock elongated northeast. The vein was at least 640 m long with an average width of less than 1 m. The wall-rocks on both sides were cut by many small quartz stringers and were locally schistose. Finely crystalline arsenopyrite, disseminated in quartz and wall-rocks, was the most abundant metallic mineral, accompanied by small amounts of galena, sphalerite, pyrite and free gold. Pyrrhotite, associated with chalcopyrite, was plentiful at depth. The quartz of the main vein was white to bluish, and varied in texture from coarse to sugary. Specimens showing vein quartz are abundant on the rock-dumps; black tourmaline, red feldspar and muscovite are minor gangue minerals that may be found with the quartz. Metallic minerals are not prominent on the rock-dumps; arsenopyrite is the commonest and it may be accompanied by lesser amounts of the sulphides mentioned above, or by occasional specks of free gold.

The **Moosehorn** mine (G 9), less than 1 km south of Herb Lake settlement, was Manitoba's first productive gold mine. In 1917 the Northern Manitoba Mining and Development Company shipped 25 tonnes of ore from the Ballast claim to the smelter at Trail, British Columbia, from which 3.36 kg of gold were recovered. Sporadic operations by various groups up to 1931 yielded an additional 2.67 kg. The ore-vein, on which a shaft was later sunk to 36 m, was found in a small outcrop of biotite lamprophyre; similar lamprophyre dykes cut the porphyry in outcrops to the east and west. Black tourmaline is abundant in the white quartz and concentrations of coarse gold were found with it in the early days. Native gold was also found in blue quartz which carried arsenopyrite and galena. Two or three hundred metres north-northwest of the shaft, a quartz vein is well exposed on the slopes of a hill of porphyry; at the top of the hill, several quartz lenses are spread over a width of 6 m. An old prospect pit at the foot of the hill showed quartz well mineralized with coarse and fine arsenopyrite, and small amounts of sphalerite, galena and pyrite. Chalcopyrite and a telluride, believed to be petzite, were also reported from the Moosehorn deposit. The shaft, and a small adjacent rock-dump, are 50 m north of the north end of a bay on the east side of Wekusko Lake.

The first discovery of gold at Wekusko Lake was in quartz boulders, on the beach, that were found to contain abundant free gold. The Kiski claims were staked in 1914 to cover the area where the boulders were believed to have originated. The **Kiski** shaft (G 10) is 3.7 km south of Herb Lake settlement, and 100 m from the east shore of a small bay. Numerous trenches, within a zone 450 m in length, had uncovered four quartz veins, and a prospect shaft was sunk on one of them to a depth of 16 m. Although all the veins were systematically sampled, it was eventually concluded that gold distribution was too erratic for mining purposes. The veins cut andesite and, to a lesser extent, quartz-feldspar porphyry. The principal metallic mineral is arsenopyrite which occurs both in the veins and wall-rocks. The veins also carry a little chalcopyrite, sphalerite, pyrite and tetrahedrite. Black tourmaline is common in the veins, and is also found in sericite schist derived from alteration of the porphyry. Some of the andesite near the veins has been epidotized; lumps of epidote measuring 30 cm across have been found in coarse andesite resembling diorite.

The **Bingo** shaft (G 11) lies along a northern extension of the porphyry belt; it is 820 m northeast of the Rex mine, to which it is connected by a trail. Another trail, 450 m long, leads to the locality from the south side of a small bay opposite Ballard Island. The property was staked in 1915 and a 120 m shaft was sunk after prospecting pits had revealed a quartz vein which had "unusually numerous showings of gold on the surface, with a fair amount of galena in narrow parallel fissures" (Wallace 1920). In 1926 a small mill was installed and nearly 4 kg of gold were produced, but it was concluded, after diamond drilling, that the gold was too localized for extended mining. The quartz veins at the site cut a small stock of quartz-feldspar porphyry that is about 310 m long and 120 m in width. Outcrops in the vicinity of the shaft show fine-grained schistose porphyry, in contact on both sides with arkose, conglomerate, volcanic breccia and tuff. The vein on which the shaft was sunk is covered by the rock-dump which consists mainly of massive grey and pale green schistose porphyry. Arsenopyrite is disseminated in these rocks, and some vein quartz specimens carry scattered grains and streaks of finely crystalline arsenopyrite. Some of the quartz also contains a little tourmaline.

The **McCafferty** vein (G 12) is located east of the narrows between Wekusko Lake and Crowduck Bay, and is about 6.5 km north-northeast of the Bingo mine. A 3 km trail from the McCafferty property reaches the lake shore about 5 km northeast of Ballard Island. The geological setting differs from the locations previously described, in the absence of quartz-feldspar porphyry. The predominant rock is biotite dacite that has been intruded by a large stock and small dykes of "quartz-eye granite"; the main granite contact is less than 400 m west of the shafts. The quartz vein staked by McCafferty in 1915 strikes northeast across dacite, and also cuts across granitic and lamprophyre dykes. The lamprophyres are mostly fine-grained, biotite-rich rocks, but some have large feldspar phenocrysts. Wall-rocks are altered to schist within a few centimetres from the quartz veins. Chlorite schist is plentiful and some of the quartz contains shreds of sericite schist. The deposit has been exposed by numerous trenches over a length of 485 m, and by two shafts 90 m apart. The deeper shaft to the northwest is 27 m deep and the shallow one 8 m. Visible gold was found in fractures in white quartz and was reported to be abundant in some specimens. In a pit just south of the deeper shaft, free gold was seen in quartz which also contained scattered grains of arsenopyrite, chalcopyrite, sphalerite and tourmaline. Some quartz specimens on the rock-dumps show crystals of arsenopyrite up to 1 cm in length, and also some needle-like crystals of black tourmaline. Specimens of wall-rock schist contain minor amounts of chalcopyrite, galena and pyrite.

The **Ferro** mine (G 13) produced 22.7 kg of gold in 1932-33, after the deposit had been staked in 1923 upon discovery of gold-bearing vein-quartz. The North British Mining and Milling Company did the mining after excavations had revealed a quartz lens with high gold values. They moved a small mill from the Bingo mine and built a summer access road approximately 5.5 km northeast from the Rex mine. The mineralized vein-quartz is located in sheared andesite within a zone of mineralized shears that trends north to northeast for 2.5 km with a width of about 400 m. Unlike the continuous quartz veins of the porphyry belt, the quartz in the sheared andesite is mostly in the form of small lenses and stringers. Andesite in the shears, some of which were traced for more than 100 m, has been converted to biotite schist. Some of the quartz within the zone of shearing is sparingly mineralized with pyrite, chalcopyrite, pyrrhotite and native gold, as at the Ferro mine. The general absence of arsenopyrite is in contrast to the deposits of the porphyry belt. Outcrops near the Ferro mine show dark green and grey hornblende andesites, some with feldspar phenocrysts. Most of the mining was done from an open pit, 18 m deep, 30 m long, and 3 to 6 m wide. The pit was excavated in a depression underlain by a shear zone, between steep walls of andesite. It is now flooded but the nearby rock-dumps shows andesite altered to biotite schist where cut by quartz. Some of this quartz carries small amounts of red feldspar, muscovite and pyrite, and is reported to contain free gold. The North British company also dug a pit, 9 m long, 75 m northeast of the main pit, and they sank a 50 m shaft

250 m southwest of the latter. There is also a pit 15 m southwest of the shaft, and another, from which gold has been panned, 25 m east of the shaft. Between 1944 and 1948, Wekusko Consolidated Limited deepened the shaft to 165 m. Between 1957 and 1960, Explorers Alliance Limited installed a larger mill and did some small-scale mining. Attempts were made in 1973 by Crowduck Bay Mines Limited to renew mining operations but the property was placed under receivership in 1974.

References: Davies *et al* 1962, p 83; Sabina 1972, pp 54-58; Stewart *in prep;* Stockwell 1937; Traill 1970, p 242; Wallace 1920, pp 33-36; Wright 1932, pp 74-88

EASTERN MANITOBA

Gold mining was commenced at Gods Lake and Island Lake in the nineteen thirties. **Gods Lake,** about 650 km northeast of Winnipeg, has an overall length of about 90 km and a maximum width of 30 km. A few prospectors visited the area between 1927 and 1931 but no discoveries were recorded until 1932, when gold was found on the north shore of **Jowsey Island** (O 2). Free gold was associated with pyrite and arsenopyrite in quartz stringers within a quartz-porphyry dyke. A parallel zone of schistose andesite is slightly mineralized. A shaft was sunk in 1935 by Jowsey Island Mines Limited to a depth of 65 m but there was no production. The site of the discovery is now covered by waste-rock from the excavations. Staking had meanwhile been extended eastward to the adjacent **Elk Island** (O 3) where Gods Lake Gold Mines Limited subsequently produced 4,990 kg of gold and 882 kg of silver between 1935 and 1943. Elk Island is 21 km long with a maximum width of 5 km, and is underlain by greenstones of the Hayes River group. Well preserved pillow-lavas, now composed mainly of hornblende, are predominant on the island, locally interlayered with minor beds of tuff. The volcanic rocks are intruded by east-west sills of diorite and gabbro, some of them several hundred metres in width. The mine (O 3) is located near the northerly shore in the central part of the island, and the orebodies are near the northern contact of an augite-diorite sill about 90 m wide, with a length of over 16 km. Outcrops of the sill show a coarse-grained, dark, banded rock with prominent crystals of hornblende. The augite has been largely replaced by amphibole. Coarse feldspar laths appear in the central portion of the sill, and large irregular lenses of epidote, up to 60 cm long, are scattered throughout. The sill and country rocks have been profusely intruded by dykes of quartz-feldspar porphyry, probably related to a large pluton of "quartz-eye granite" that crops out extensively south of Elk Island. West of the mine-area, the sill and country rocks have been cut by cross-faults, causing offsets of up to 140 m. The sill is flanked by narrow beds of tuff, rarely more than 2 m thick. The orebodies are located in tuff along the sill's northern contact. Here, the tuff band varies in width up to 5 m, and has been traced along strike for over 8 km. Three varieties of tuff were recognized:

(a) black slaty tuff forming the wall-rock cut-off

(b) coarser mafic tuff, converted to chloritic hornblende schists

(c) a coarser grained, cherty tuff in which all the ore-shoots occurred

The host-rock (c) has been riddled by quartz stringers which constituted 25 percent of the orebodies. Most of the metallic minerals were in the quartz but some sulphides were disseminated in the tuffaceous groundmass. Pyrrhotite was the predominant sulphide, with a considerable amount of pyrite, and a little chalcopyrite and arsenopyrite; sphalerite and galena were rare. Free gold was locally conspicuous underground. The mining was done from a 3-compartment shaft with a depth of 276 m. In 1941 an exploratory shaft was sunk, 2 km to the west, to a depth of 572 m, but no ore was found in its vicinity.

References: Baker 1935; Barry 1961; Davies *et al* 1962, pp 53, 59; Dix 1951; Stewart *in prep.*

The first recorded prospecting in **Island Lake** was in 1928 when gold-bearing quartz veins were discovered on, and east of, Confederation Island. In 1931 claims were staked on a group of small islands further east, leading to the production of 192.3 kg of gold and 14.3 kg of silver by **Island Lake Gold Mines Limited** in 1934; the mine (P 2) closed down in 1935. The islands are 40 km east of St Theresa Point, and 2 to 3 km west of Heart Island. Island Lake, which is 110 km long and up to 22 km wide, is partially underlain by a greenstone belt that includes altered volcanic and sedimentary rocks of the Hayes River group. These rocks, cut by small granitic and porphyritic intrusions, have, at the mine, been folded, sheared, fractured, and penetrated by mineralized quartz veins. The orebodies were located on a small islet, about 110 m long and 25 m wide, known as Gold Island, which was the site of the original discovery. The orebodies were reached by means of an 83 m shaft and crosscut from a larger adjacent island to the southeast. They are located in a deformed contact zone between sericite schist and black argillite schist. Large veinlike bodies of iron carbonate occur near this contact. Gold Island is underlain mainly by sericitic schists that also contain chlorite and carbonates. One quartz vein on the islet is terminated by a mass of iron carbonate to the southwest. Another was exposed over a distance of 15 m in the centre of the islet; its width is less than 1 m and it pinches out to the northeast. On either side of this vein, the wall-rocks contain lenses and stringers of quartz within surface areas up to 12 m long and 2 m wide. The quartz and adjacent wall-rocks were reported to be well mineralized with disseminated pyrite, galena, sphalerite and minor chalcopyrite. Sphalerite, incidentally, was reported to be conspicuous in quartz on the west side of the islet. At the mine, gold was associated with the sulphides but was not readily visible in hand specimens. Diamond drilling showed that the orebodies were too small for sustained mining operations. Some of the machinery and equipment was shifted in 1937 to **High Rock Island** (P 3), immediately southeast of Confederation Island, where Ministik Lake Gold Mines Limited sank a 72 m shaft on a quartz vein cutting across a volcanic contact; the shaft (P 3) is in granodiorite 25 m south of the contact. The quartz is sparingly mineralized with coarse pyrite, chalcopyrite and galena. Gold values were reported from a number of trenches and free gold from several of the test pits. Visible gold was also reported from crosscuts at depths of 40 and 70 m. The work was stopped however in 1937.

References: Davies *et al* 1962, pp 53, 59; Godard 1963; McMurchy 1944; Stewart *in prep.*

LYNN LAKE AREA

Although there has been no regular gold-mining in the Lynn Lake area, a great deal of exploration work has been done in recent years on the **Agassiz** property (L 7), located in greenstones 7 km northeast of Lynn Lake and 3 km north of provincial highway 391. Mineralization occurs in a zone of interlayered volcaniclastic beds, chloritic and cherty tuffs, and amphibolites. These mineralized rocks have been explored along a strike length of about 1 km and over a width of 150 m. They are sandwiched between altered andesites and basalts. The host-rocks have been intensely replaced by sugary quartz and carbonate, and penetrated by quartz stringers. The mineralization consists of pyrrhotite, pyrite and a little arsenopyrite, with sparse galena and sphalerite. Gold is microscopically disseminated within the mineralized belt which varies in width but is more than 10 m wide over considerable distances. The property was first staked in 1946, re-staked in 1950, and acquired by Royal Agassiz Mines Limited in 1955. In 1969 a 3-compartment shaft was sunk to 150 m, 1 km east of Dot Lake, and by 1971 a total of 22 km of diamond drilling had been done. Bulora Corporation Limited acquired a financial interest in the property in 1973, and in 1975 the 21-year lease was converted to a 10-year "explored area" lease.

References: Fielder 1976; Man. Min. Res. Div. 1977; Milligan 1960, maps 2 & 6; Stewart *in prep.*

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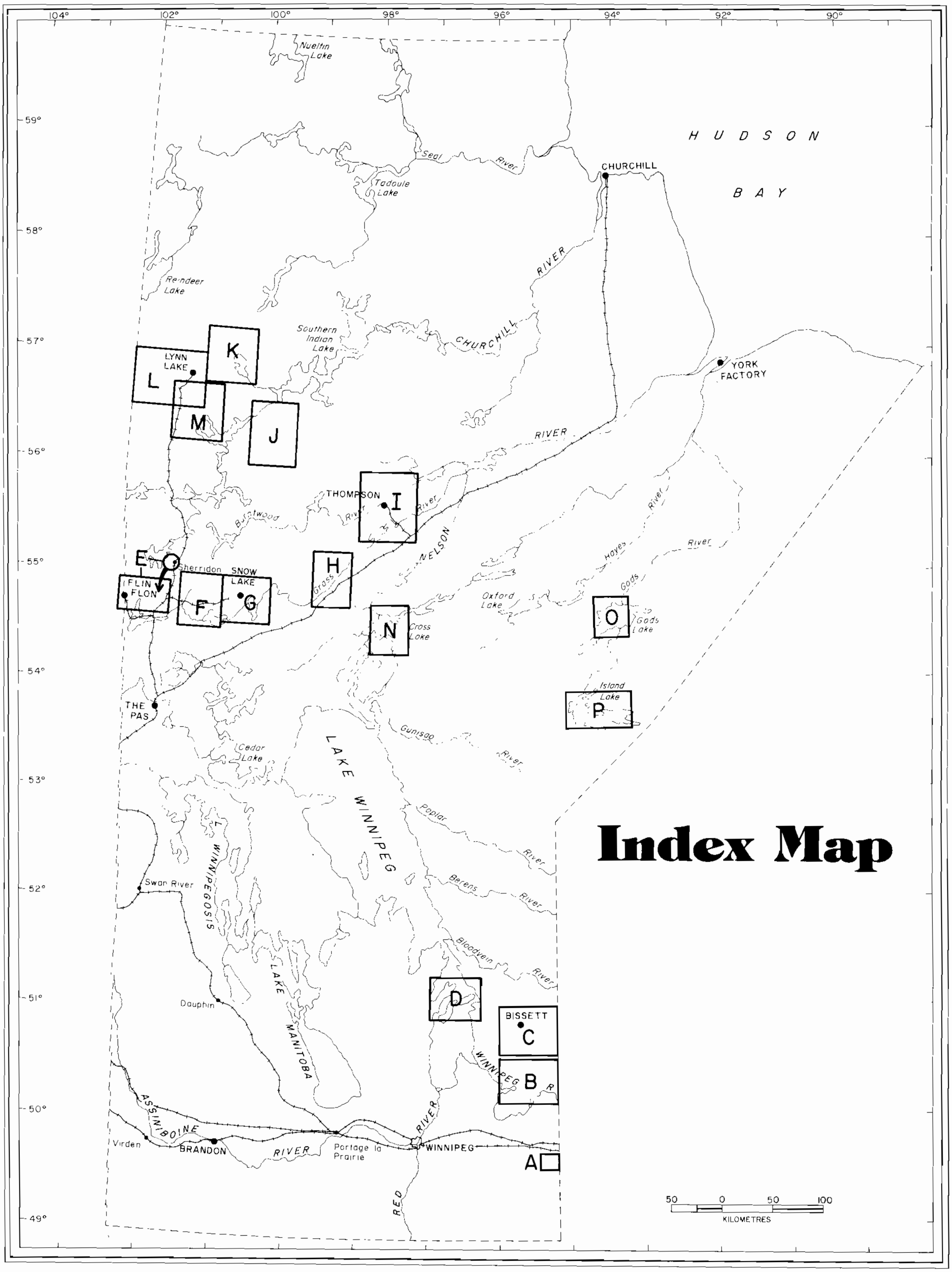
Mineral	Approximate Composition	Approximate Specific Gravity	Approximate Hardness	Cleavage	Transparency tp=transparent tl=translucent op=opaque	Lustre
Altaite	PbTe	8.2	2½	1 perfect	op	metallic
Arsenopyrite	FeS_2-$FeAs_2$	6.1	5¾	parallel to prism faces	op	metallic
Chalcopyrite	Cu_2S-Fe_2S_3	4.3	3¾	occasionally visible	op	metallic; irridecent tarnish
Chromite	Fe0-Cr_2O_3	4.6	5½	none	op	sub-metallic or pitchy
Copper	Cu	8.9	2¾	none	op	metallic; dull tarnish
Cubanite	Cu_2S-Fe_4S_5	4.1	3½	none	op	metallic
Electrum	Au, Ag	12.5-15.5	2¾	none	op	metallic
Galena	PbS	7.6	2½	perfect cubic	op	bright metallic
Gersdorffite	NiS_2-$NiAs_2$	5.9	5½	perfect cubic	op	metallic
Goethite	FeO(OH)	±4	5¼	1 perfect, 1 weak	op-tl	adamantine to dull or silky (fibrous)
Gold	Au	19.3	2¾	none	op	metallic
Hematite	Fe_2O_3	5.3	5¾	none	op-tl	metallic
Ilmenite	Fe0-TiO_2	4.7	5½	none	op	metallic to sub-metallic
Limonite	mixed hydrous ferric iron oxides	±3.8	±5	none	op-tl	earthy or vitreous
Mackinawite	$(Fe,Ni)_9S_8$	4.3	2½	1 perfect	op	metallic
Magnetite	Fe_3O_4	5.2	6	none	op	metallic
Marcasite	FeS_2	4.9	6¼	not prominent	op	metallic
Maucherite	$Ni_{11}As_8$	8.0	5	none	op	metallic
Molybdenite	MoAs2	±4.8	1¼	perfect basal	op	metallic
Nickeline	NiAs	7.8	5¼	none	op	metallic

Mineral	Streak	Colour	Crystalline System and Habit	Remarks
Altaite	black	tin white	isometric; crystals (rare) cubic or octahedral	a rare telluride found in some gold veins; usually massive
Arsenopyrite	black	silvery white	monoclinic; prismatic, striated; pseudo-orthorhombic and other twin forms	mispickal, arsenical pyrites; often massive
Chalcopyrite	greenish black	brassy yellow	tetragonal; often wedge-shaped with triangular faces; twins common	copper pyrites; usually massive or in aggregates
Chromite	dark brown	black	isometric; small octahedral crystals	usually massive, compact to granular
Copper	shiny pale red	copper red, dark tarnish	isometric; cube-like, octahedral, often distorted	malleable; often in flattened, twisted or wire-like forms
Cubanite	dark	bronze to brassy	orthorhombic; thick tabular or elongated prismatic	chalmersite; strongly magnetic; usually massive
Electrum	pale yellow	pale yellow	isometric; habit same as pure gold	gold containing 20-40% silver
Galena	black	blue-black to lead-grey	isometric; cubic crystals, some with octahedral faces	also massive or granular; often intergrown with sphalerite
Gersdorffite	greyish black	silvery white to tin-grey	isometric; octahedral, cubic and pyritohedral; faces often striated	usually massive or granular; often tarnished grey-black
Goethite	yellowish to brownish	dark brown to black	orthorhombic; prismatic, needle-like; or as thin flattened tablets	mostly colloform, concretionary, fibrous or earthy; see limonite
Gold	golden yellow	golden yellow	isometric; crystals (rare) octahedral, cubic or dodecahedral; often flattened or elongated	sectile; usually as grains, scales or nuggets; also dendritic, wire-like, moss-like, spongy, etc.
Hematite	red to brownish yellow	crystals steel-grey to iron black	hexagonal; rhombohedral, thin tabular; also flaky, micaceous (specularite)	usually red and earthy, often botryoidal or reniform (kidney ore)
Ilmenite	black to brownish	black	hexagonal; rhombohedral, thick tabular or thin platy crystals	usually massive granular; slightly magnetic
Limonite	yellow-brown	dark brown to black or yellowish	amorphous, concretionary, stalactitic or earthy; radiating fibrous structure	field term for hydrous iron oxide deposits, mainly goethite, plus clay etc.
Mackinawite	black	pale grey with bronze tarnish	tetragonal; basal plates or pyramidal combinations; crystals rarely seen	found as fine-grained alteration product in pentlandite
Magnetite	black	black	isometric; octahedral, dodecahedral	usually granular-massive; strongly magnetic
Marcasite	greyish black	pale yellow to tin-white	orthorhombic; tabular; pseudo-hexagonal if twinned (cockscomb and spear shapes)	white iron pyrites; often nodular, reniform stalactitic, or radiating fibrous masses
Maucherite	blackish grey	silvery grey; tarnish copper-red	tetragonal; flattened tabular or pyramidal	usually massive, radial or granular; associated with nickeline
Molybdenite	greenish tint	lead-grey to bluish black	hexagonal; platy or tabular, roughly six-sided, or short barrel-shaped prisms	micaceous leaves, scales or massive-radiating; marks paper bluish grey
Nickeline	brownish black	pale copper red; grey-black tarnish	hexagonal; small pyramidal crystals (rare)	niccolite; usually massive, reniform or disseminated

Mineral	Approximate Composition	Approximate		Cleavage	Transparency	Lustre
		Specific Gravity	Hard-ness		tp=transparent tl=translucent op=opaque	
Pentlandite	$(Fe,Ni)S$	±4.8	3¾	octahedral parting	op	metallic
Petzite	$(Ag,Au)_2Te$	±9.0	2¾	obscure	op	metallic
Pyrite	FeS_2	5.0	6¼	indistinct	op	metallic splendent
Pyrrhotite	$Fe_{11}S_{12}$ etc.	±4.6	4	none	op	metallic
Smythite	$(Fe,Ni)_9S_{11}$	4.3	±3	perfect basal	op	metallic
Sphalerite	ZnS	4.0	3¾	perfect in 6 directions	tp-tl	resinous to adamantine
Sylvanite	$(Au,Ag)Te_2$	±8.1	1¾	1 perfect	op	brilliant metallic
Telluro-bismuthite (Wehrlite)	Bi2Te3	7.8	1¾	1 perfect	op	metallic
Tetradymite	Bi_2Te_3	±7.3	1¾	perfect basal	op	metallic
Tetrahedrite	$3CuS\text{-}Sb_2S_3$	±4.9	3-4½	none	op	metallic, may be splendent
Violarite	Ni_2FeS_4	4.7	5	cubic	op	metallic

List of Mineral References in Text

Mineral	Streak	Colour	Crystalline System and Habit	Remarks
Pentlandite	bronze-brown	pale bronze-yellow	isometric; hexoctahedral but crystals rare	usually massive, in granular aggregates
Petzite	grey/black	grey to black	isometric; small cubic crystals (rare), usually massive or compact	a rare silver-gold telluride found in veins
Pyrite	brownish black	pale brass yellow	isometric; pyritohedra, octahedra, striated cubes (common)	also massive, granular, reniform, nodular or stalactitic
Pyrrhotite	greyish black	bronze	hexagonal, monoclinic or orthorhombic; tabular or pyramidal crystals (rare)	magnetic pyrites; nearly always massive, as granular aggregates
Smythite	dark grey	black	hexagonal (?); platy crystals with hexagonal outlines	oxidation product from pyrrhotite
Sphalerite	pale brown to white	brown, black, yellow, green red, grey	isometric; crystals varied, often tetrahedral with rounded faces; commonly twinned	zincblende; usually cleavable, granular and in massive aggregates
Sylvanite	pale grey	silvery white	monoclinic; thick tabular or short prismatic	gold-silver telluride; usually bladed or granular
Telluro-bismuthite (Wehrlite)	pale grey	pale lead-grey	hexagonal; flexible, inelastic laminae	bismuth telluride; usually in foliated masses or irregular plates
Tetradymite	pale grey	pale steel-grey	hexagonal; crystals pyramidal, indistinct	often contains sulphur (Bi_2S_3); usually bladed, foliated or massive-granular
Tetrahedrite	black to brown	steel-grey to iron-black	isometric; modifed tetrahedral; crystals common; may be twinned	also massive or granular
Violarite	grey	pale grey with violet grey tarnish	isometric; rarely if ever shows crystalline form	massive; granular to compact


Index Map
HUDSON BAY
CHURCHILL
YORK FACTORY
Nueltin Lake
Seal River
Tadoule Lake
Reindeer Lake
Southern Indian Lake
CHURCHILL RIVER
LYNN LAKE
THOMPSON
NELSON RIVER
Burntwood River
Sherridon
SNOW LAKE
FLIN FLON
Grass
Cross Lake
Oxford Lake
Hayes River
Gods River
Gods Lake
Island Lake
THE PAS
Cedar Lake
LAKE WINNIPEG
Gunisao River
Poplar River
Berens River
Bloodvein River
BISSETT
WINNIPEG R
L. WINNIPEGOSIS
Swan River
Dauphin
LAKE MANITOBA
ASSINIBOINE RIVER
Virden
BRANDON
Portage la Prairie
WINNIPEG
RED RIVER
A
B
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50 0 50 100
KILOMETRES

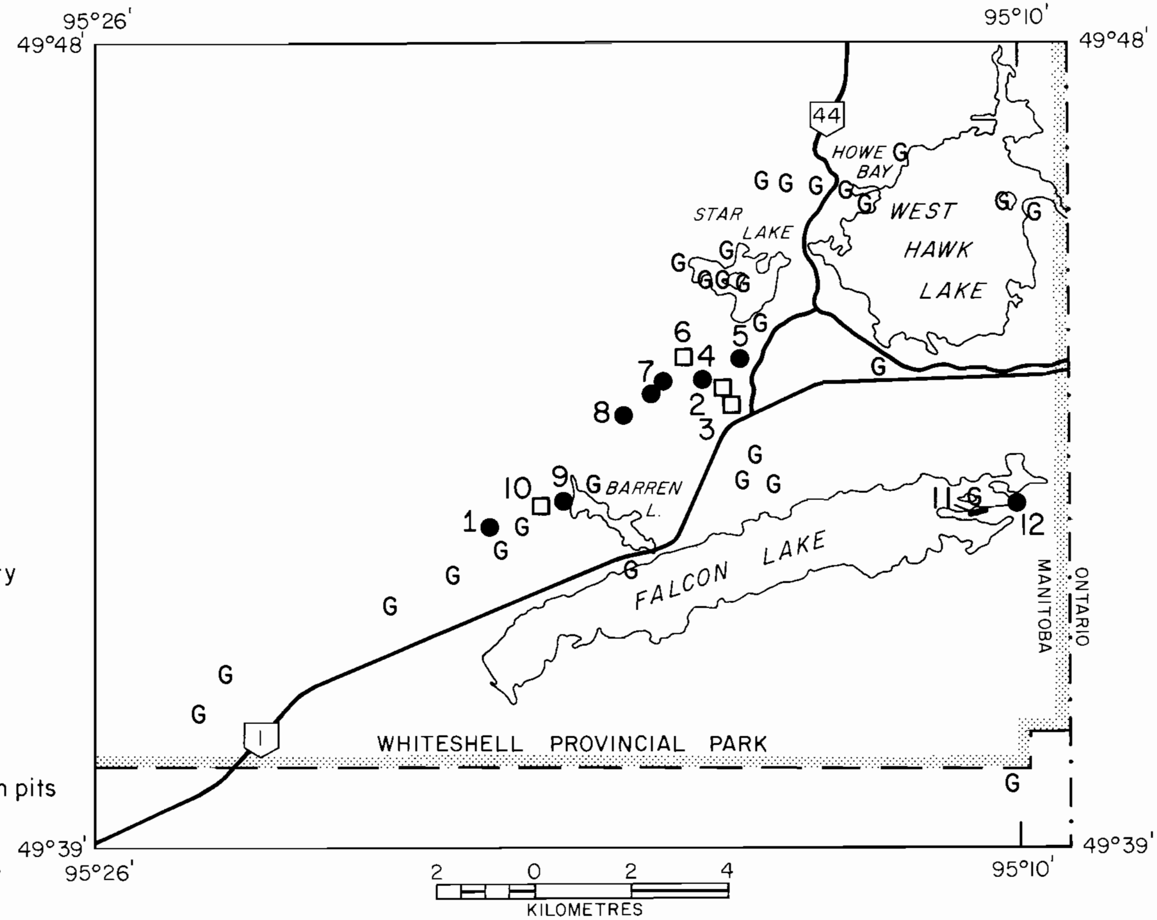
LEGEND

MOLYBDENITE — 1 Old workings

GOLD
- 2 Sunbeam property
- 3 Waverley property
- 4 Moonbeam property
- 5 Gold Coin property
- 6 Moore property
- 7 Sheba – Gem property
- 8 Rad property
- 9 Boyes property
- 10 Jewel property
- 11 Falnora property
- 12 Thompson extension property

SYMBOLS

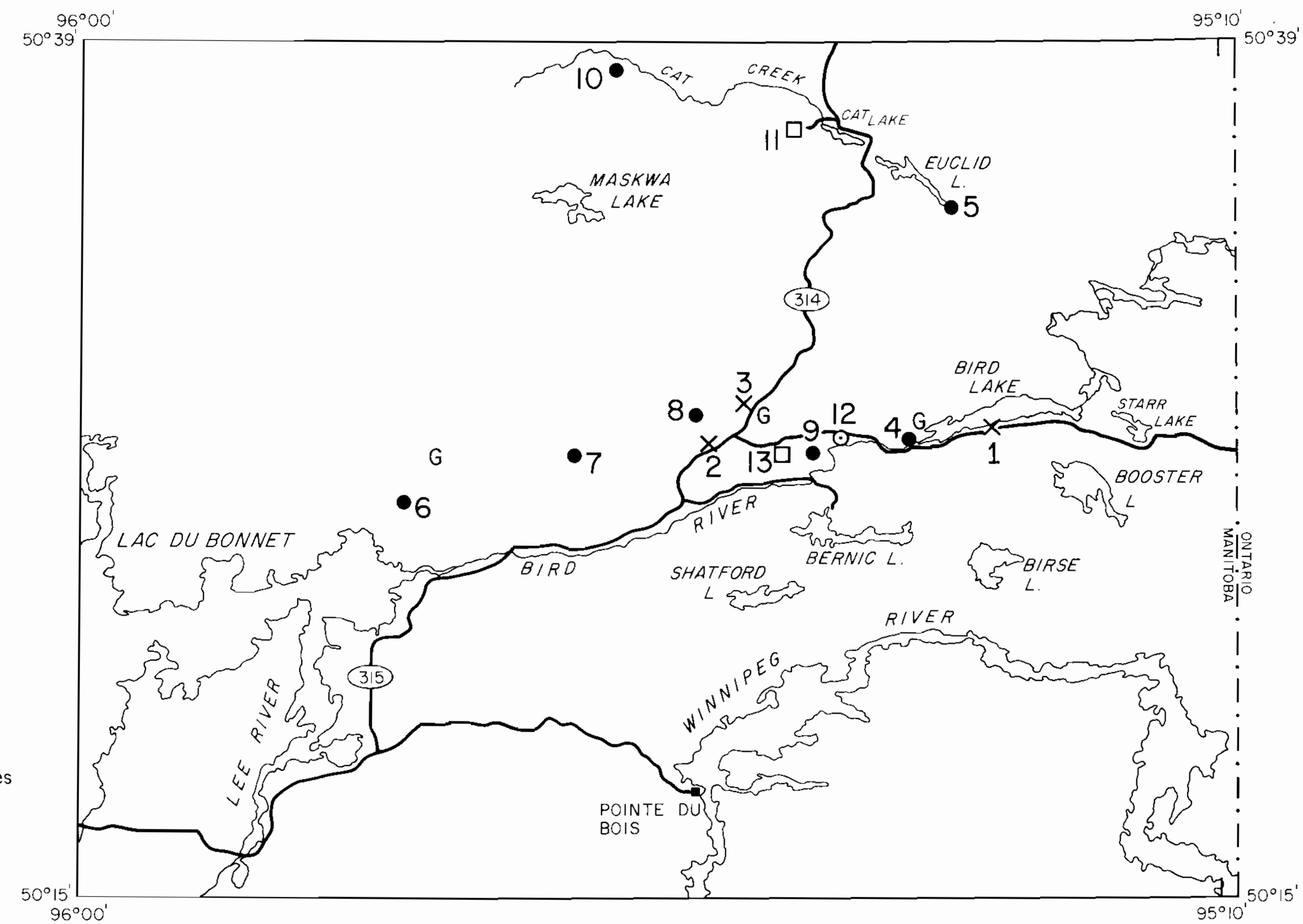
- □ Shaft
- Outcrop zone
- ● Mineral occurrence (mainly in pits or trenches)
- G Gossan or limonitic sulphides



West Hawk — Falcon Lakes Area

A

Bird River — Cat Lake Area



LEGEND

MAGNETITE — 1 Garnet – magnetite rock

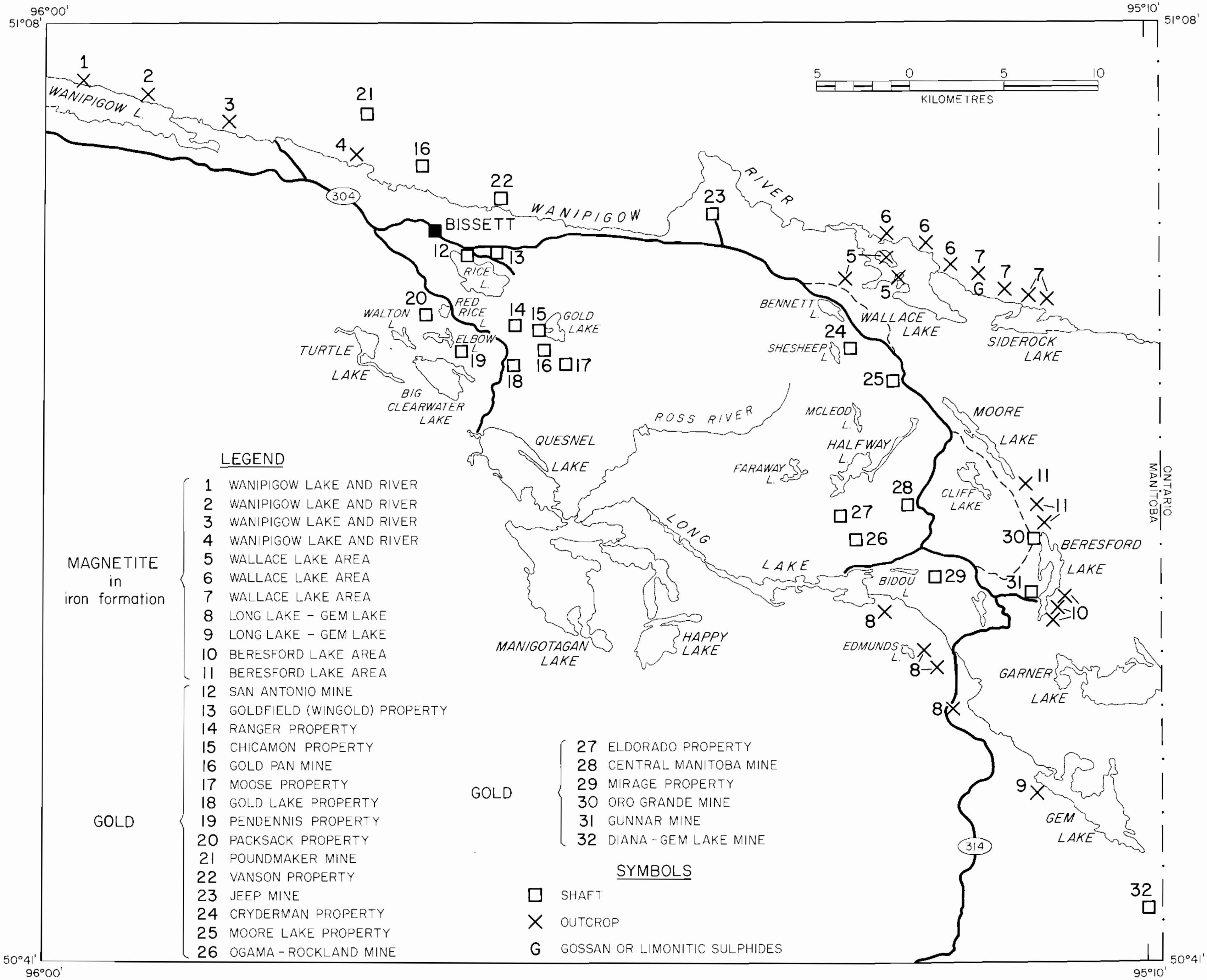
CHROMITE
- 2 Chrome property
- 3 Page property
- 4 Wolf property
- 5 Euclid property
- 6 Wards property
- 7 National property
- 8 Bell property
- 9 Queen property

NICKEL–COPPER ORE
- 10 Mayville property
- 11 Eagle property
- 12 Dumbarton mine
- 13 Wento property

SYMBOLS

- ⊙ Open pit
- □ Shaft
- × Outcrop
- ● Mineral occurrence (mainly in pits or trenches)
- G Gossan or limonitic sulphides

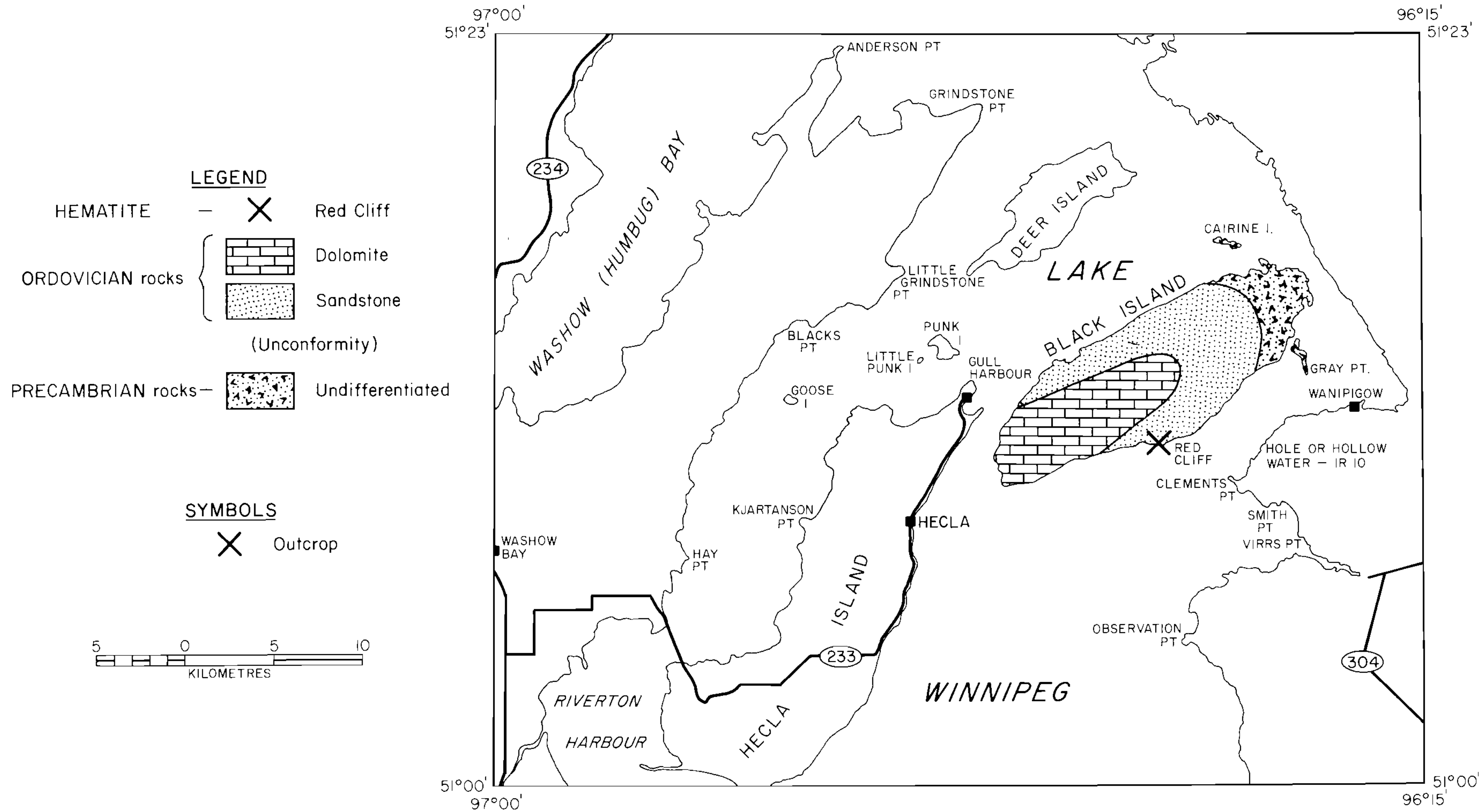
5 0 5 10
K'LOMETRES



Rice Lake — Beresford Lake Area

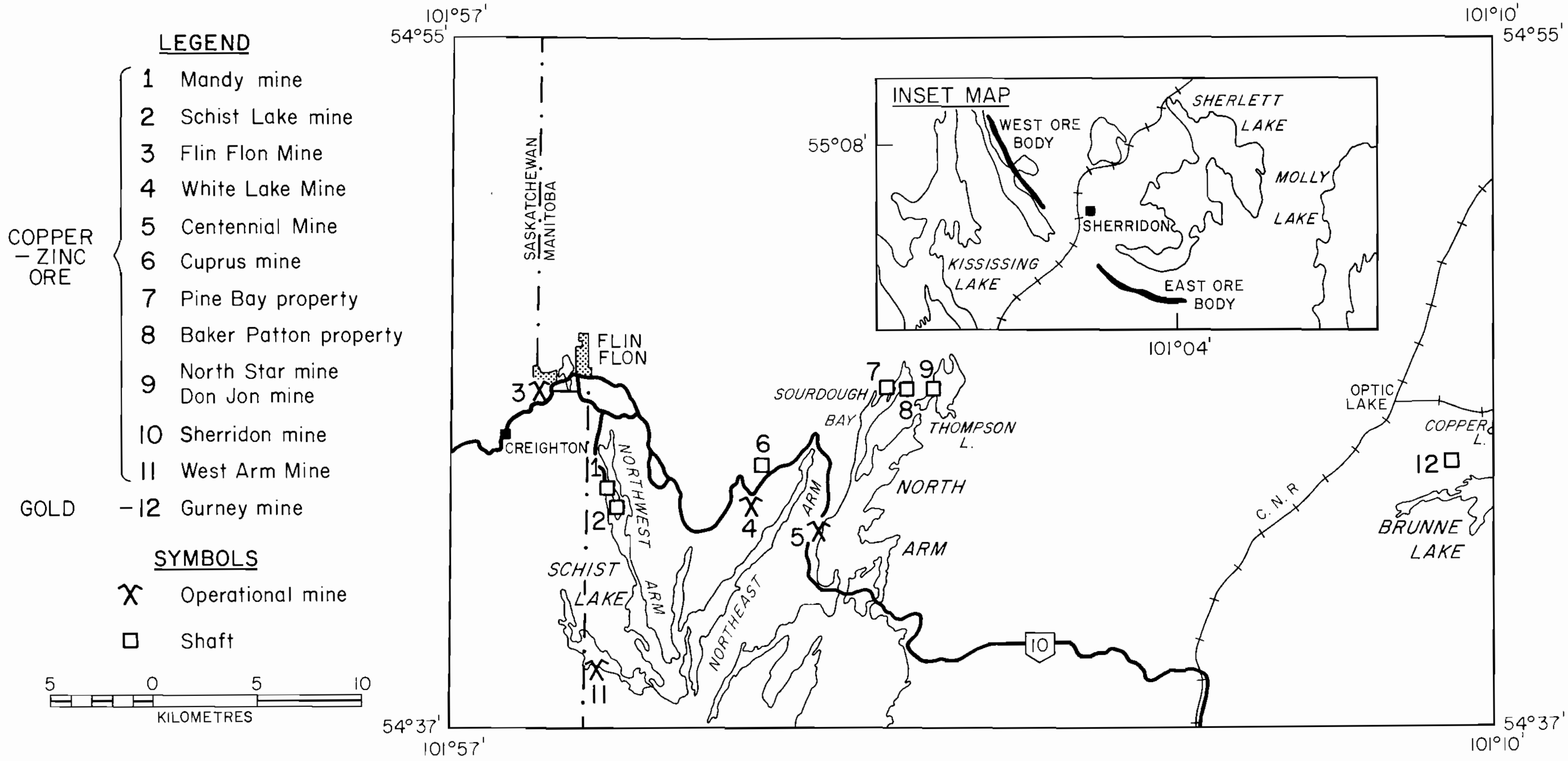
C

Black Island – Lake Winnipeg



Flin-Flon — Copper Lake Area

E



Elbow Lake – File Lake Area

F

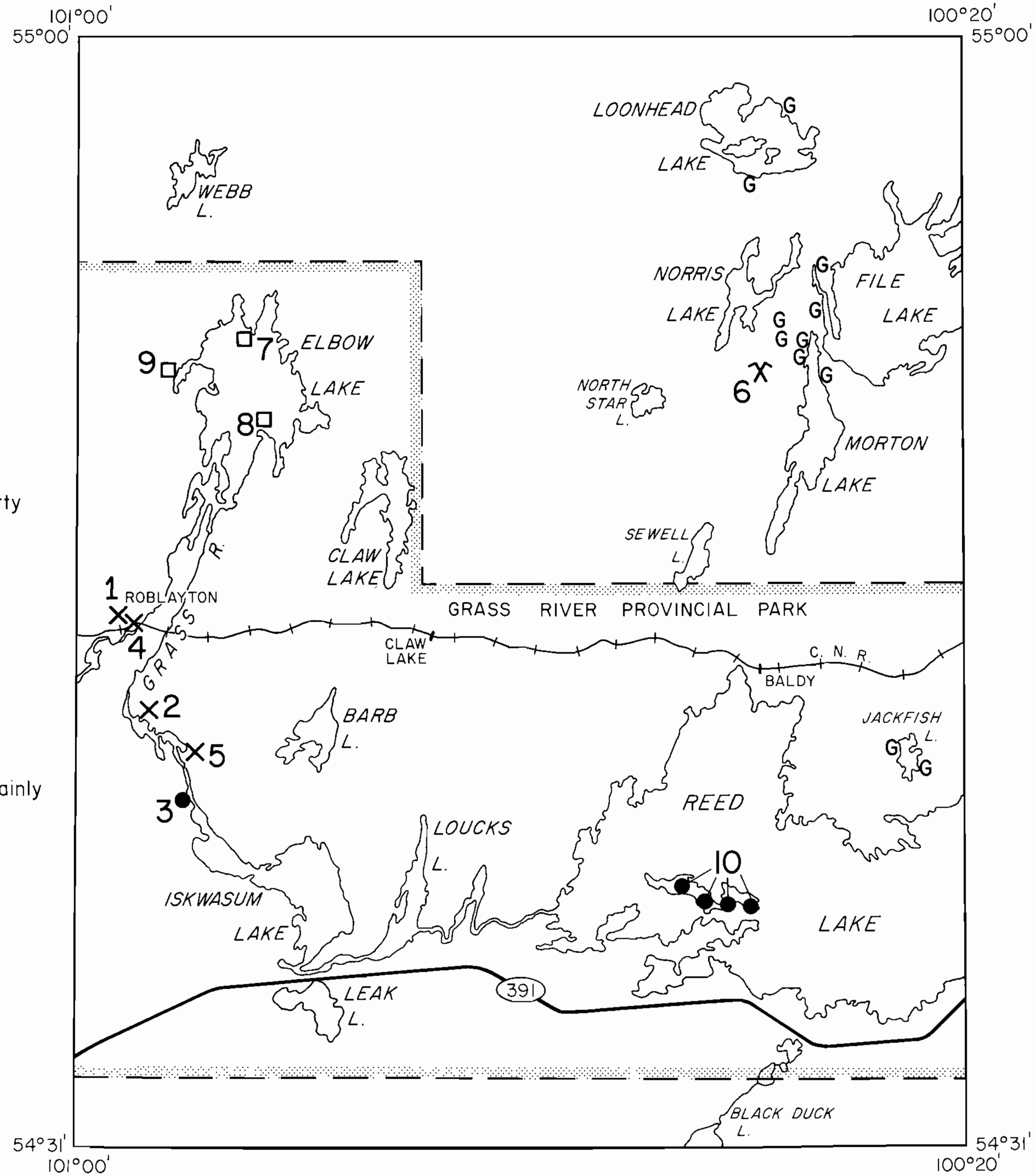
LEGEND

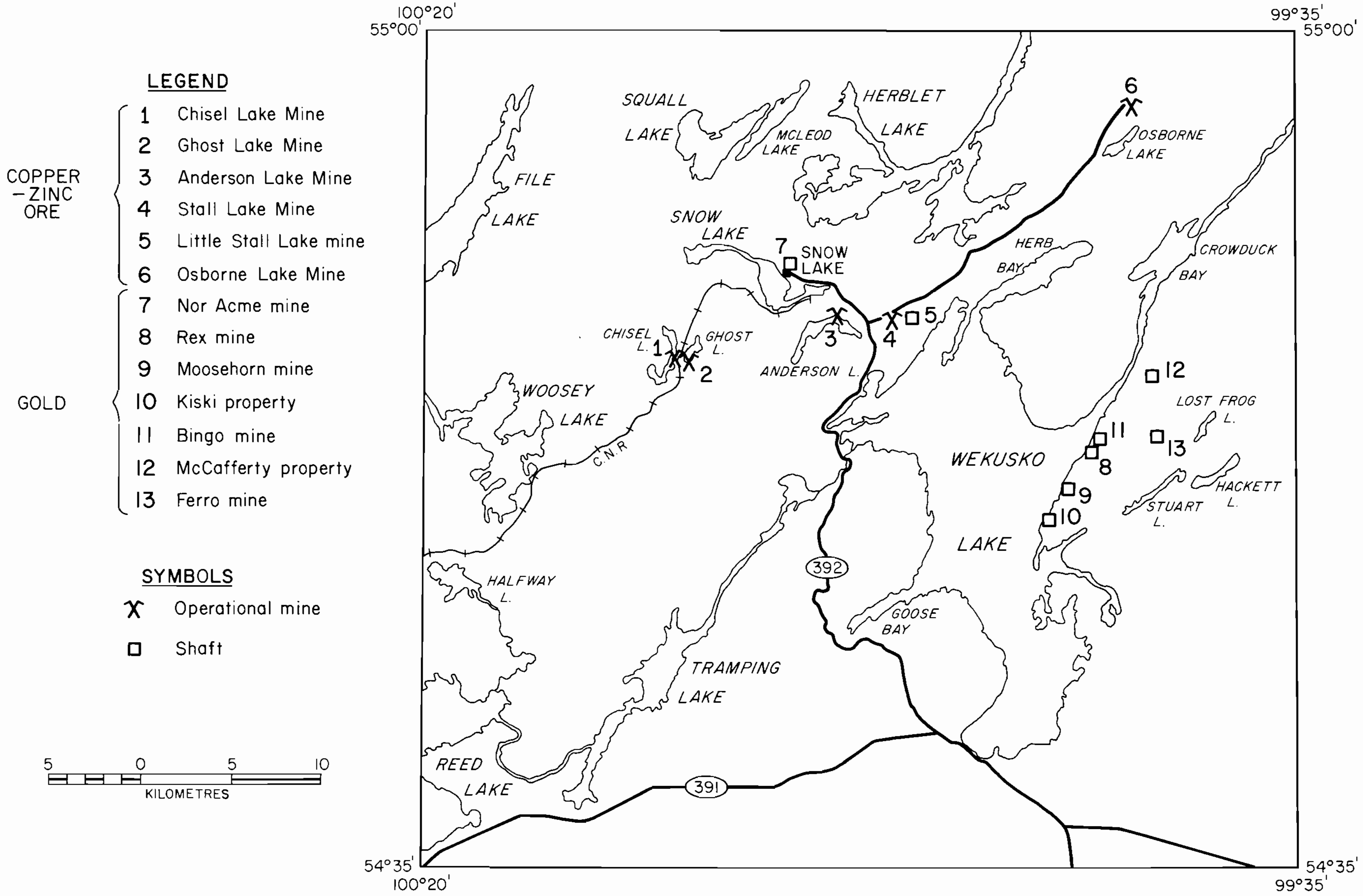
MAGNETITE in iron formation	1	Iskwasum Lake area
	2	Iskwasum Lake area
	3	Iskwasum Lake area
HEMATITE in serpentinite	4	Iskwasum Lake area
	5	Iskwasum Lake area
COPPER–ZINC ORE	– 6	Dickstone mine
GOLD	7	Century mine
	8	Ding How property
	9	Elbow Lake property
	10	Fourmile Island property

SYMBOLS

- ⚒ Operational mine
- □ Shaft
- × Outcrop
- ● Mineral occurrence (mainly in pits or trenches)
- G Gossan or limonitic sulphides

5 0 5 10
KILOMETRES

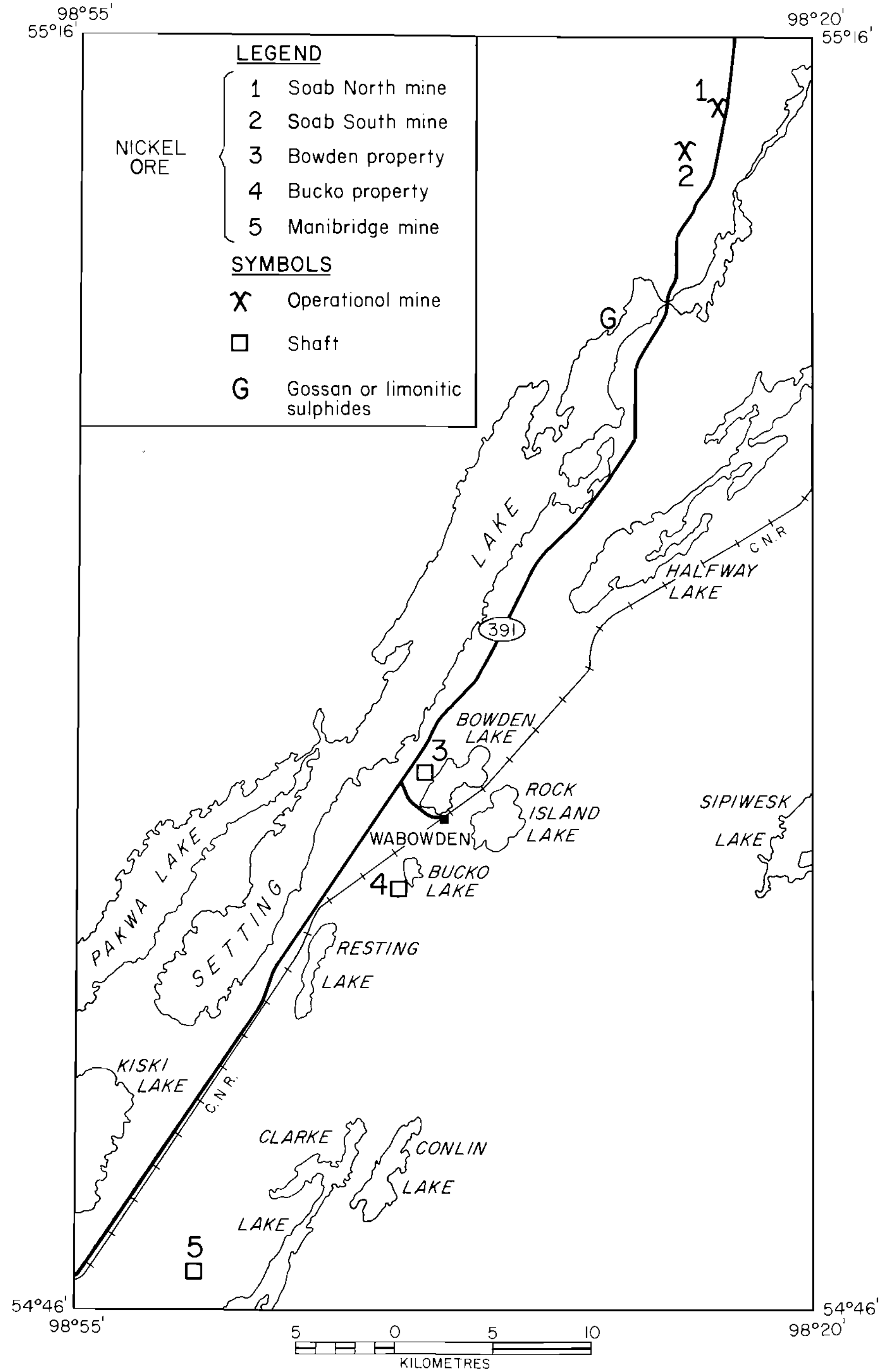


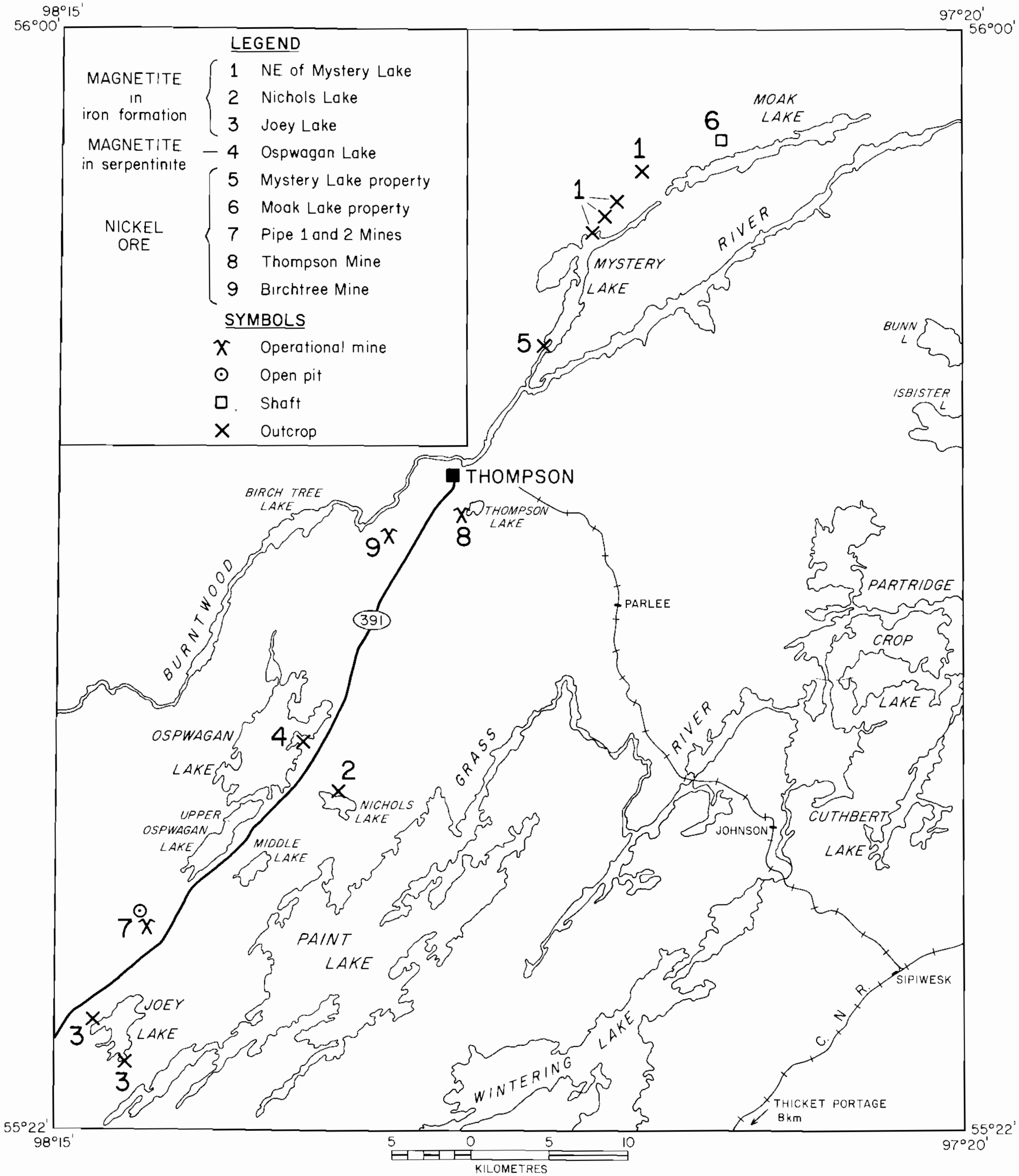


Snow Lake – Wekusko Lake Area

G

Setting Lake Area

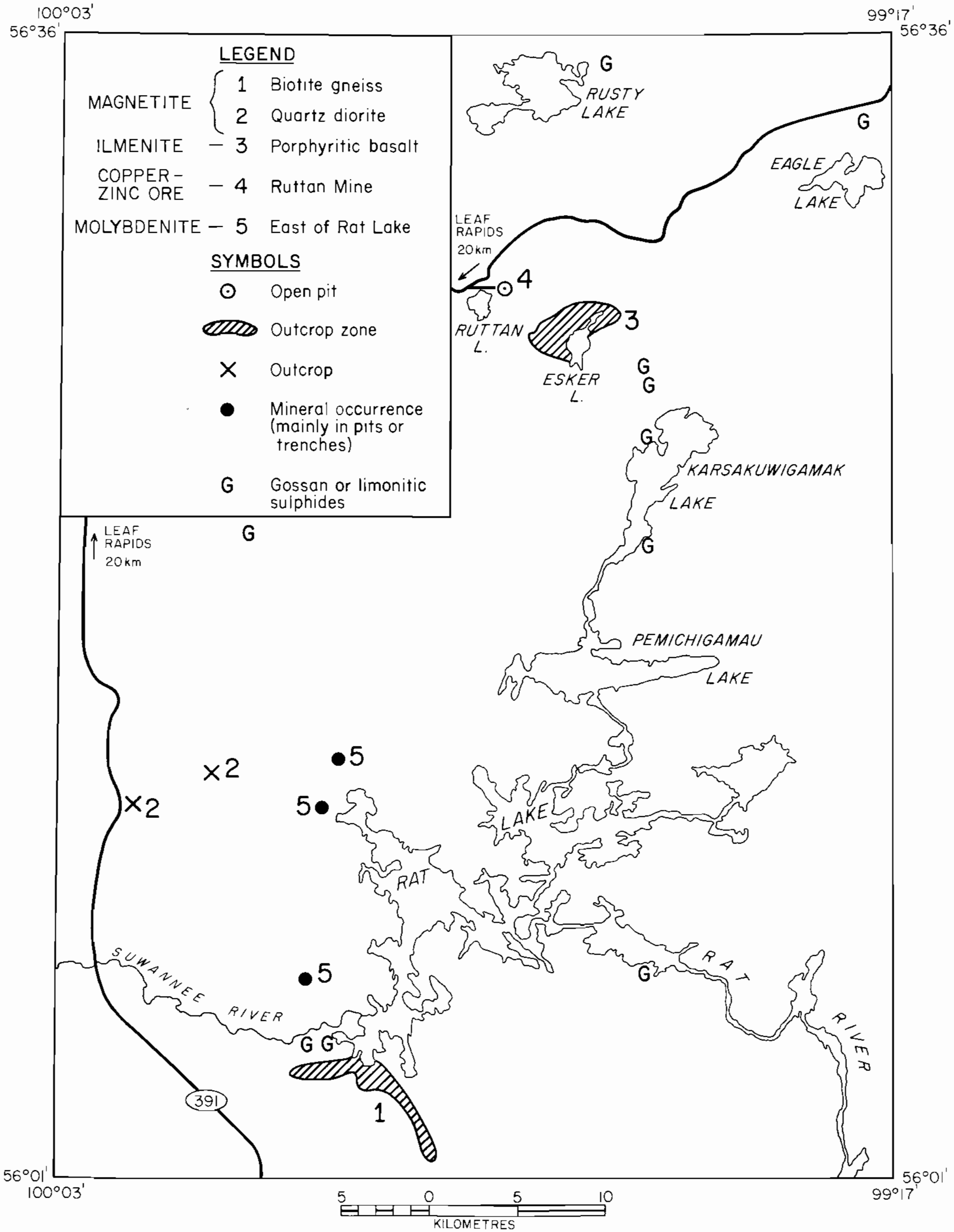




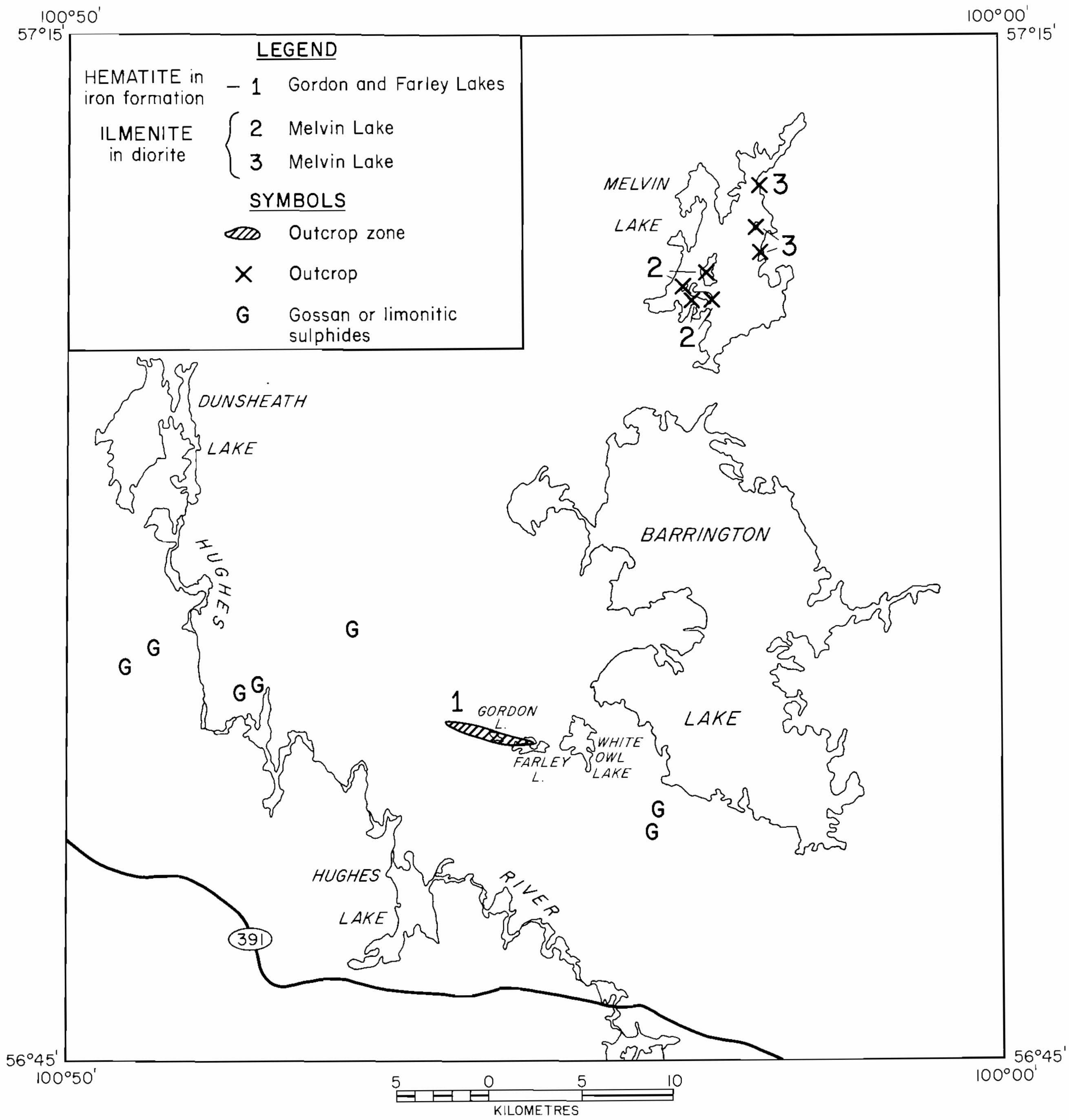
Thompson Area

I

Ruttan Lake – Rat Lake Area



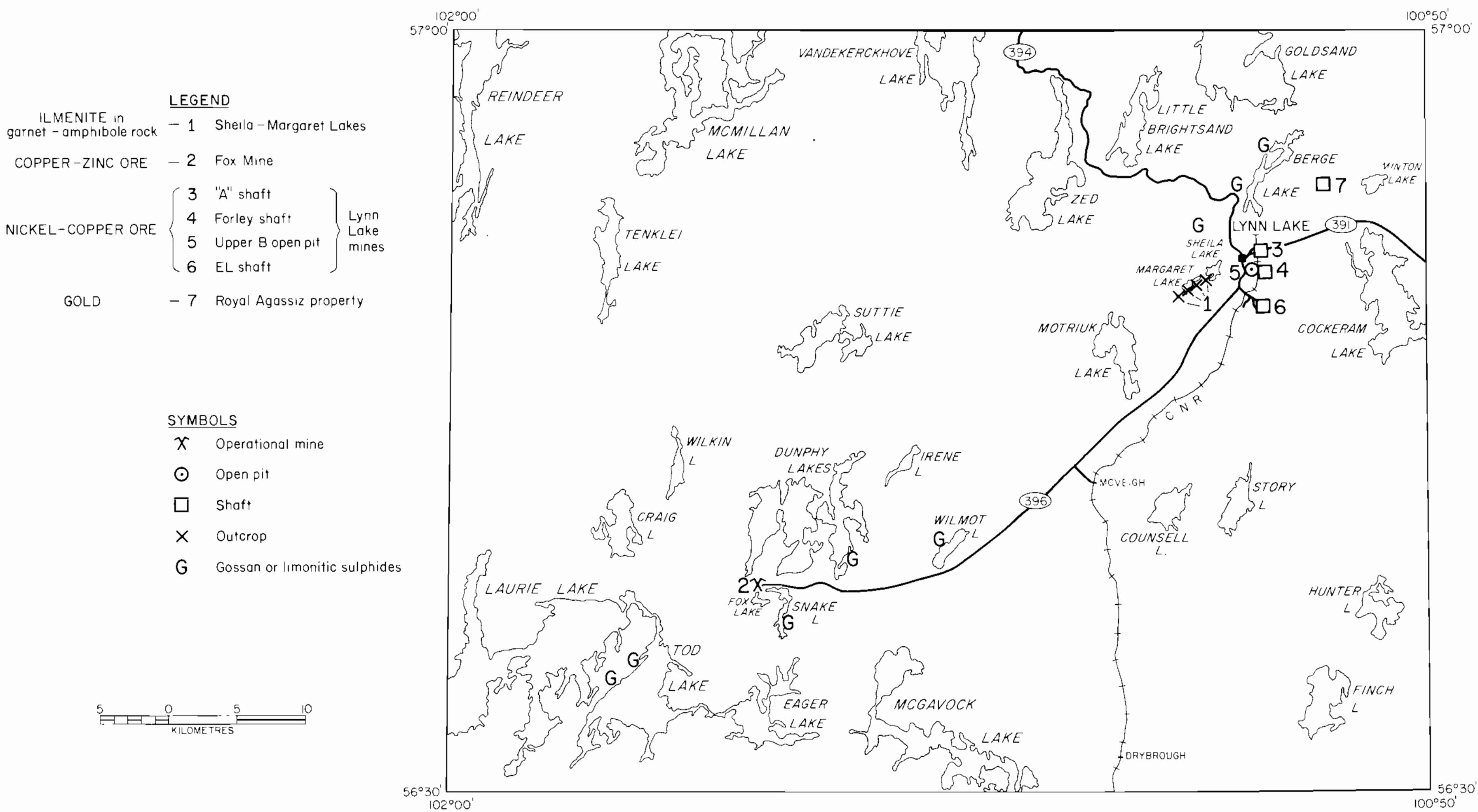
[Topography before Churchill River Diversion]



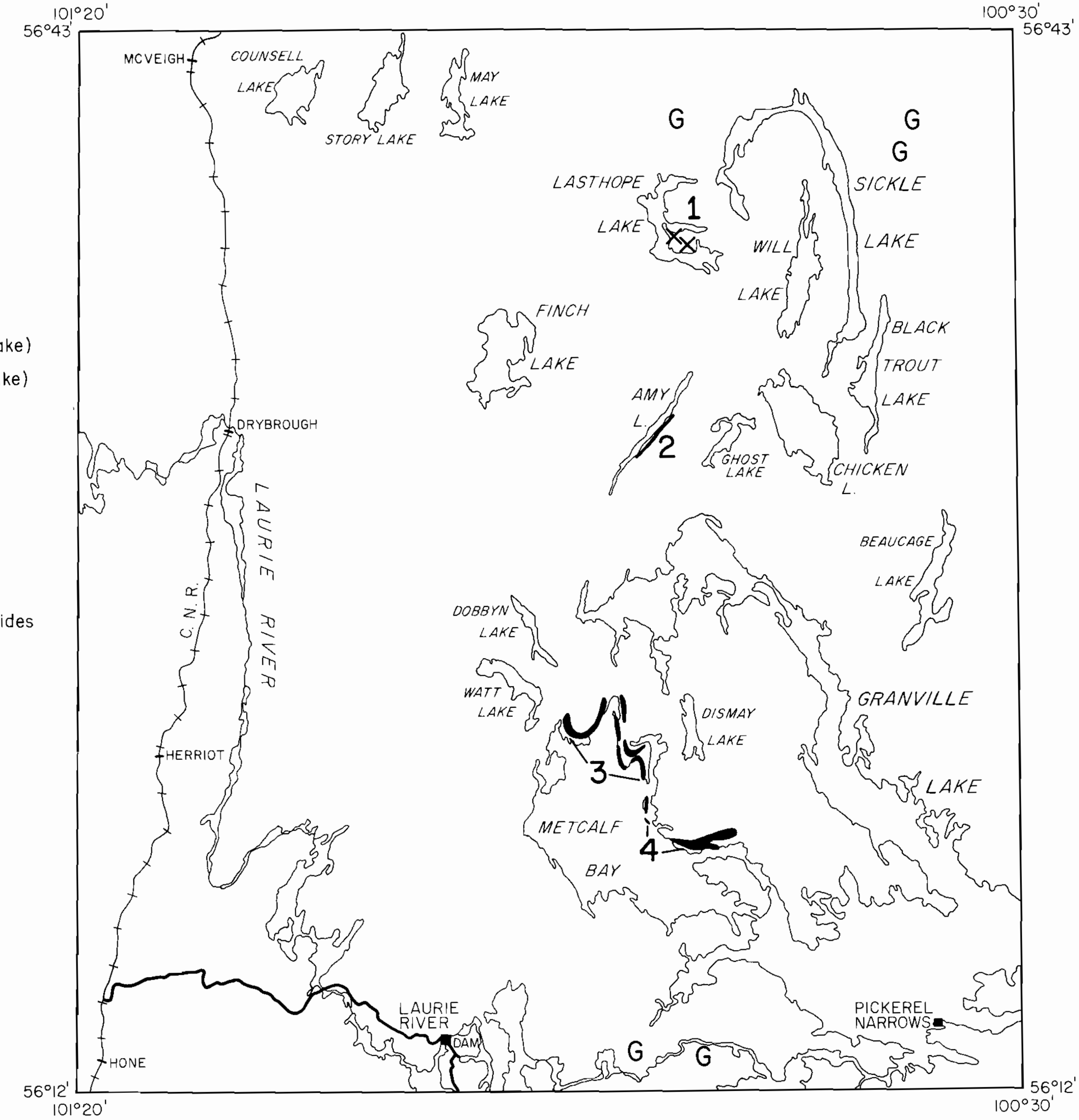
Barrington Lake Area

K

Lynn Lake – Fox Lake Area



Black Trout Lake Area



LEGEND

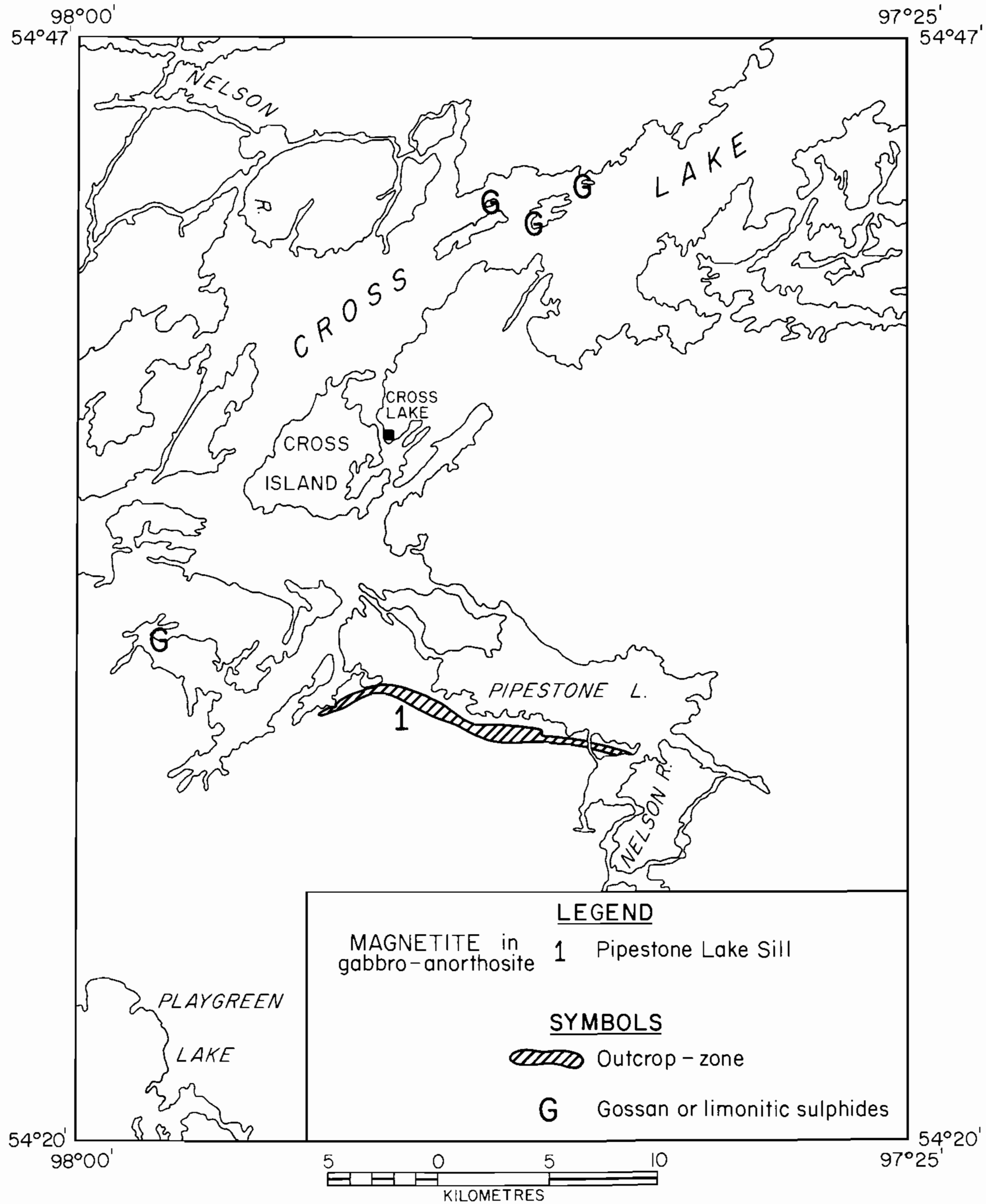
MAGNETITE – Black Trout Diorite
1 Lasthope Lake
2 Amy Lake
3 Metcalf Bay (Granville Lake)
4 Metcalf Bay (Granville Lake)

SYMBOLS

- (heavy line) Outcrop – zone
- X Outcrop
- G Gossan or limonitic sulphides

5 0 5 10
KILOMETRES

Cross Lake – Pipestone Lake Area



LEGEND

ARSENOPYRITE – 1 Feldspar porphyry dyke

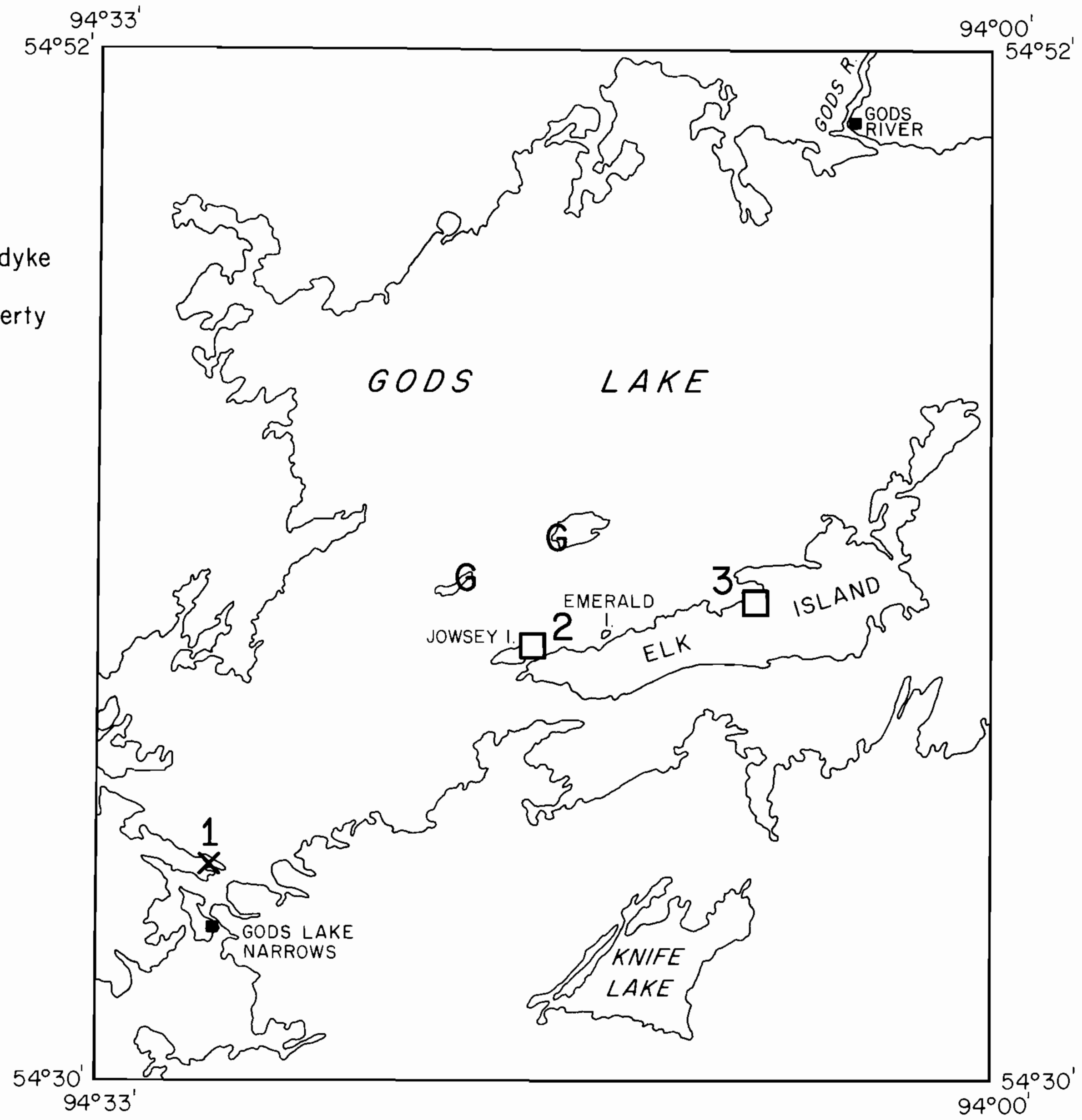
GOLD { 2 Jowsey Island property
3 Gods Lake mine

SYMBOLS

□ Shaft

× Outcrop

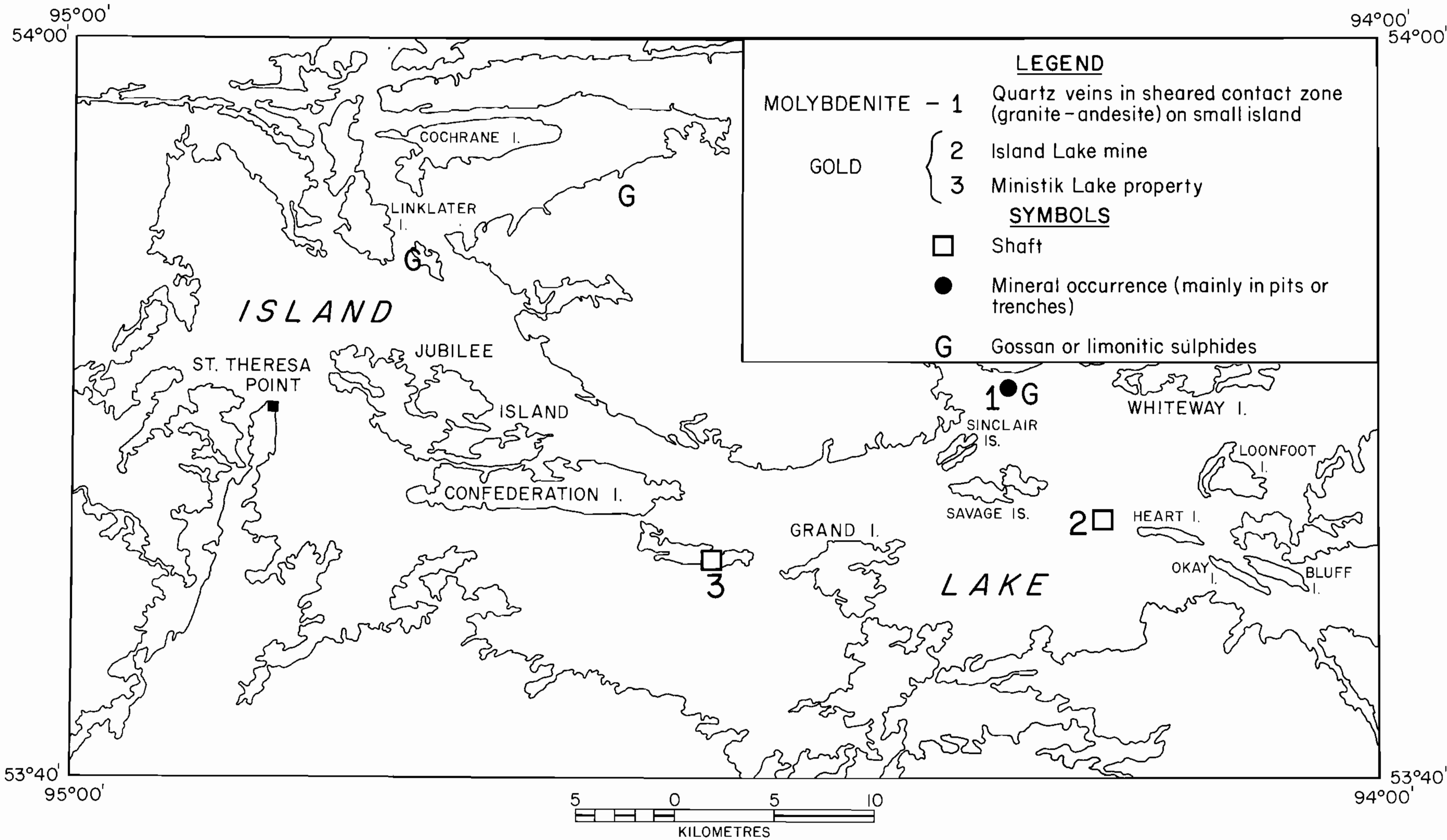
G Gossan or limonitic sulphides



Gods Lake

O

Island Lake



95°00'
54°00'
94°00'
54°00'
53°40'
95°00'
53°40'
94°00'
LEGEND
MOLYBDENITE – 1 Quartz veins in sheared contact zone (granite – andesite) on small island
GOLD
2 Island Lake mine
3 Ministik Lake property
SYMBOLS
Shaft
Mineral occurrence (mainly in pits or trenches)
G Gossan or limonitic sulphides
ISLAND
LAKE
COCHRANE I.
LINKLATER I.
JUBILEE
ISLAND
ST. THERESA POINT
CONFEDERATION I.
GRAND I.
SINCLAIR IS.
SAVAGE IS.
WHITEWAY I.
LOONFOOT I.
HEART I.
OKAY I.
BLUFF I.
G
G
1
G
2
3
5
0
5
10
KILOMETRES