GEOLOGY AND SCENERY

RAINY LAKE AND EAST TO LAKE SUPERIOR

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Cover *Kakabeka Falls on the Kaministiquia River. The waterfall occurs where the escarpment is made up of soft shales overlain by a capping, 2 feet thick, of harder chert-carbonate rock.*

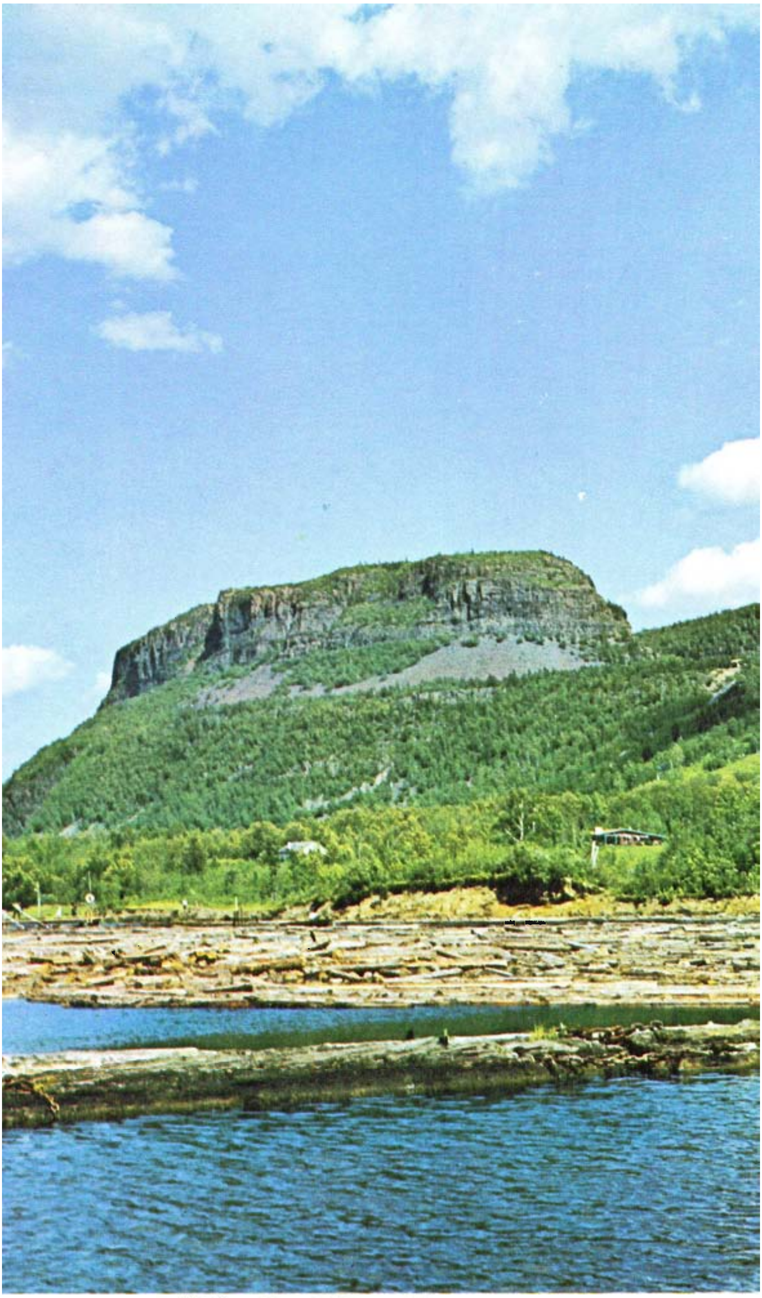

Photo 1 *Mount McKay, Fort William (Courtesy Ont. Dept. Tourism and Information).*

ONTARIO

DEPARTMENT OF MINES

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GEOLOGY AND SCENERY

RAINY LAKE AND EAST TO LAKE SUPERIOR

by E. G. Pye

Geological Guidebook No. 1

ONTARIO DEPARTMENT OF MINES

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PREFACE

In recent years, rock and mineral collecting has aroused the interest of hobbyists in all parts of Canada and the United States. At the same time, many people have become increasingly aware of our scenic attractions, and their attention has been directed to the part geology has played in the development of the landscape. Others have recognized the impact of the mining industry on our national economy, and have requested geological information to help them understand better the nature of our mineral resources. The Ontario Department of Mines has undertaken the publication of geological guidebooks to various areas of the province, in the hope that these guidebooks will help to satisfy the needs of amateur geologists and, at the same time, stimulate similar interests amongst the public generally.

This guidebook is the second of the series. It was prepared at the request of the Atikokan Chamber of Commerce, following the completion of Highway 11 between the Canadian Lakehead and Fort Frances.

The first part of the guidebook is a resumé of the general geology of the region and is intended to provide general information concerning the relationships between the principal groups of rocks, and to give the reader a simplified account of the geological history. While written primarily for the novice, it is nevertheless presumed that the reader has some knowledge of rocks and minerals. In case of difficulty, however, there are many excellent textbooks on elementary geology and mineralogy available in most libraries and book stores.

The second part of the guidebook lists various points of geological interest along or close to the principal highways in the region. The locations and means of access are indicated, and descriptions and explanations of the salient features are given. Although only easily-reached sites, with safe parking facilities nearby, have been included, the reader is advised to use every precaution against possible traffic hazards.

Completing the guidebook are: (1) an appendix for amateur mineralogists, lapidaries, and collectors, giving information on localities where specimens may be obtained, lapidary clubs and shops, and public displays of rocks, minerals and ores; and (2) a brief and simplified glossary of the technical terms used in this book.

ACKNOWLEDGMENTS

During the course of the field work, the author received much valuable assistance from the officials of the various operating mines in the district. He is also indebted to: (1) the geological staff, Caland Ore Company Limited, for the report on the company's operations near Atikokan; (2) H.L. Bell, Mining Recorder, Ont. Dept. Mines, Fort Frances, for the account of the colourful history of the Mine Centre area; and (3) W.J. Ransom, Public Relations Officer, Ontario Hydro, for much valuable information on the Silver Falls Generating Station near Port Arthur. The author is particularly grateful to M. Hupchuk and J. Hodgkinson for their kind assistance in the selection and examination of points of scenic and geological interest near Fort Frances and Shebandowan, respectively. Mr. J. Baillie, of the Geological Branch, Ont. Dept. Mines, assisted in the preparation of the maps and diagrams accompanying this report and provided much of the information given in the list of "Localities for Collectors" in the appendix.

REFERENCES

In the preparation of the guidebook, considerable use was made of the extensive literature available on the geology of the region. For those who wish to go beyond the scope of this publication, the reports and maps considered to be most pertinent are included in the following list of references. Publications of the Geological Survey of Canada are obtainable through the Office of the Queen's Printer, Ottawa, Ont.; those of the Ontario Department of Mines, through the Publications Office, Department of Mines, Queen's Park, Toronto 2, Ont. Publications marked with an asterisk (*) are out of print and are available only in libraries.

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General Geology of the Rainy Lake – Lake Superior Region

The rocks and rock materials in the region between Rainy Lake and Lake Superior were formed during two eras: the Precambrian, the oldest division of the Earth's chronology; and the Cenozoic, when mammals inherited the Earth and man made his appearance. All the consolidated rocks were formed during the Precambrian era.

The Precambrian era represents more than three-quarters of the entire history of the Earth. It began with the development of the first recognizable rocks; it ended about 600 millionyears ago, with the deposit of the Cambrian sediments, the oldest rocks in which fossils are found relatively abundant. The Cenozoic era is represented in the region by gravels, sands, and clays intermittently covering the Precambrian rocks. These unconsolidated materials were laid down within the last million years, chiefly in the Pleistocene epoch, when continental glaciers spread across the country.

The Precambrian Rocks

AGE RELATIONSHIPS

The Precambrian rocks in the region are difficult to classify according to relative age. This is particularly true in the case of the older rocks, because of: (1) the general absence of fossils; (2) the generally disturbed and metamorphosed condition of the formations; and (3) the interruption of recognizable and otherwise persistent rock units at closely spaced intervals by large masses of granite. No consensus exists among geologists on the classification of these rocks. Indeed, it seems the more detailed the geological work, the more complex are the relationships between the different formations. Yet, in a general way, a reasonably satisfactory classification, in which all the major rock groups are represented, has been accomplished. This classification is shown in the Table of Formations, in which the youngest formations appear at the top and the oldest at the bottom. See also the accompanying diagrammatic summary (Fig. 1).

TABLE OF PRECAMBRIAN FORMATIONS

PROTEROZOIC	
KEWEENAWAN:	*Diabase and related rocks.*
ANIMIKIE:	
ROVE FORMATION:	*Shale, greywacke.*
GUNFLINT FORMATION:	*Shale, carbonate rocks, chert-carbonate rocks, chert, taconite, volcanic tuff.*
KAKABEKA FORMATION:	*Conglomerate.*
ARCHEAN	
ALGOMAN:	*Granite, syenite, diorite, quartz diorite, quartz and feldspar porphyries, pegmatite, and related rocks.*
PRE-ALGOMAN:	*Gabbro, anorthosite, peridotite.*
WINDIGOKAN (Seine, Timiskaming, Steep Rock*):	*Slate, greywacke, mica schist and gneiss, conglomerate, iron formation.*
LAURENTIAN:	*Granite and related rocks.*
KEEWATIN:	*Acid and basic lavas, tuff, volcanic breccia, iron formation.*
COUCHICHING*:	*Slate, greywacke, mica schist and gneiss.*

*Position in table uncertain.

THE PRE-ALGOMAN BASEMENT COMPLEX

The oldest formations in the Rainy Lake - Lake Superior region have been found by radioactive age determinations to be older than 2,600 million years — in some cases probably older than 3,000 million years. They make up a group which, chiefly because of its highly disturbed character and its relationship to certain younger rocks, is commonly referred to as the pre-Algoman basement, or "schist", complex. They include volcanic, sedimentary, and some intrusive igneous rocks.

Volcanic Rocks

The volcanic rocks generally have been called Keewatin. This is because: (1) they can be followed across the region to Lake of the Woods, where they were first recognized and given this name; or (2) in some localities, from which a direct correlation is impossible, they closely resemble the volcanic rocks near Lake of the Woods in appearance and composition. Several varieties of volcanic rocks occur, acid and basic lavas, and associated volcanic fragmental products being the most abundant.

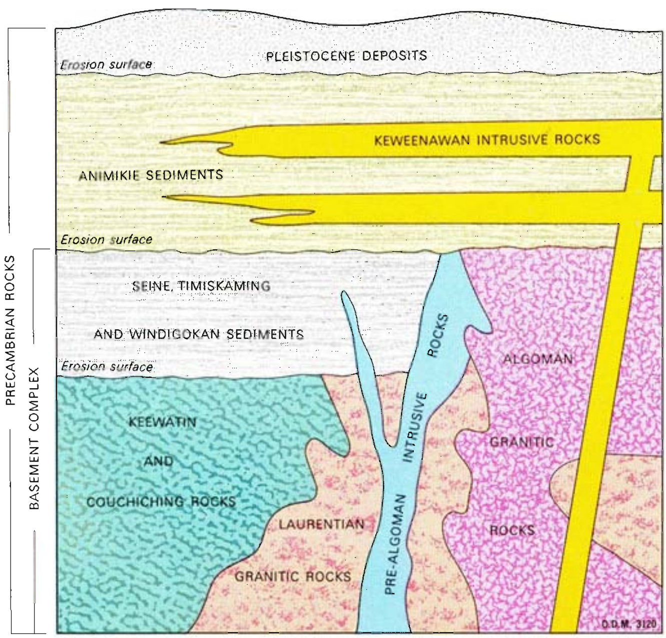


Figure 1 *Diagrammatic summary of the classification of Precambrian rocks in the Rainy Lake—Lake Superior region.*

Photo 2 *Rhyolite, west shore of Kabaigon Bay, Middle Shebandowan Lake, showing a primary layered structure resulting from laminar flowage of lava.*

Acid lavas, or rhyolites, are rich in silica and are similar in composition to common granite. They differ from granite in appearance, however, being made up of fine-grained, grey or greenish-grey materials. They are also hard and brittle. They have been found in several localities, mostly near Kashabowie and Shebandowan. One exceptionally large deposit, up to 4 miles wide, extends southwesterly from Upper Shebandowan Lake to Quetico Provincial Park, a distance of over 30 miles. Typical exposures can be examined along Highway 11, at a small lake 2.3 miles west of the intersection with Highway 802 (South). A particularly interesting outcrop occurs along the hydro-electric power transmission line, at the west shore, and near the north end, of Kabaigon Bay, Middle Shebandowan Lake. Here the rhyolite has a distinct thin-layered structure (Photo 2). This layered structure is believed to be an original feature of the rhyolite, formed as a result of laminar flowage of highly viscous lava upon eruption at the surface in early Precambrian time.

The basic lavas are far more widespread than the rhyolites which, in contrast, are relatively poor in silica. Originally the basic lavas were much the same in appearance and mineralogical composition as flow rocks which have erupted in recent times at numerous places around the margin of the Pacific Ocean. Since their formation, they have been highly altered (or metamorphosed) and original minerals have been converted, largely as a result of a recombination of chemical constituents, into new ones. Among the new minerals, chlorite, amphibole and often a little epidote may be found. These minerals impart a dark greenish colour to the lavas, earning them the common field term “greenstones”.

In addition to mineralogical changes, the basic lavas have also been modified in a structural sense. When first formed, most of them (except for certain properties indigenous to lavas generally) were more or less uniform in fabric. But as a result of disturbances in the Earth’s crust, they were tightly compressed, and some were transformed into strongly foliated rocks or schists. Such greenstone schists are abundant, and are found at intervals along Highway 11, between Fort Frances and McCauley Creek; along Highways 11 and 17-11 between Kashabowie and Kakabeka Falls; and along Highway 17A-11A, between Sistonen’s Corners and Port Arthur.

It is interesting to note that, despite the changes undergone by the basic lavas, their original features often have been preserved. Some greenstones, for example, exhibit an irregular flowage banding (Photo 21). Other greenstones are vesicular, i.e. they are full of tiny holes resulting from the escape of contained gases when the lavas were poured out on the Earth’s surface (Photo 50). Where these vesicular holes are filled with late-formed minerals, e.g., at the Port Arthur copper mine about 3 miles west of Mine Centre, they are described as being amygdaloidal. Still other greenstones have a distinctive pillow structure (Photo 53). They are made up of piles of balloon-like, lens-like, or irregularly-shaped masses thought to have been formed where the lavas erupted under, or flowed into, the sea.

The outpourings of the Keewatin lavas were interrupted at intervals by explosive volcanism, causing considerable quantities of ash and other rock materials to accumulate on the lava surface. Because of this, we commonly find, interbanded with the greenstones, deposits of consolidated volcanic dust called tuff, and deposits of coarse fragmental material called volcanic breccia or agglomerate. Such rocks, although not particularly abundant in the region, are widespread. They have been noted along Highway 11 near Fort Frances, at Upper Shebandowan Lake near Kashabowie, and between Sistonen’s Corners and Kakabeka Falls.

Both the tuffs and the agglomerates should be easily recognized by the novice. Most of the tuffs were laid down under water and, like some sedimentary rocks, they are characteristically thin-

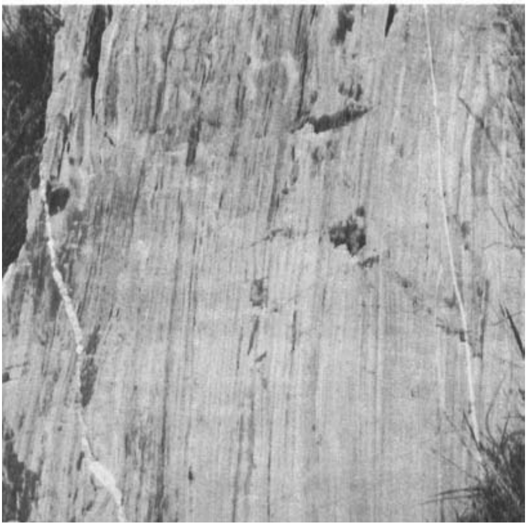


Photo 3 Laminated tuff, at the entrance to the Conmee Cemetery near Kakabeka Falls Provincial Park.

banded, with alternating light and dark layers commonly an inch or less in thickness (Photo 3). Often they contain small but visible pieces of broken rock (Photo 22). In this way, they are transitional to the genetically related agglomerates, which are characterized by the presence of rounded, lenticular, or irregularly-shaped fragments of volcanic rock material, sometimes several inches or even a foot or more in length, in a matrix not unlike the typical greenstone (Photo 58).

Sedimentary Rocks

The principal sedimentary rocks of the basement complex are slate and a sandstone, called greywacke, characterized by an abundance of tiny mineral and rock fragments resulting from the sudden deposit of detritus derived from the rapid erosion of older formations. Like the volcanic rocks, they too have been greatly altered or metamorphosed, and generally are represented by foliated materials (schists and gneisses) rich in mica.

The sedimentary rocks lie in very thick deposits rivalling the volcanic accumulations in prominence and are found in many areas between Rainy Lake and Lake Superior. They are exposed principally along Highway 11; at the east end of the Rainy Lake Causeway; at Bear's Passage, Rainy Lake; from Banning to a point 10 miles east of Atikokan; and west of Kashabowie, between 2 and 10 miles from the intersection with Highway 802 North.

The sedimentary rocks along the highway between Fort Frances and Atikokan, first investigated by A. C. Lawson at Rainy Lake, are called Couchiching. They extend continuously from Rainy Lake for about 130 miles eastward to Lac des Mille Lacs, and are found at intervals throughout most of Quetico Provincial Park. They are of particular interest because their position in the generalized geological column is unknown.

The reasons for this are twofold. First, the contact with the Keewatin volcanic rocks is mostly concealed and is therefore unavailable for study. Second, the Couchiching rocks appear to be separated in most places from the Keewatin volcanic rocks of the region by a major fault, although the displacement has not been established. The Couchiching sediments have often been suspected of being older than the volcanic rocks, and are considered by some geologists to be perhaps the oldest formations in the Canadian Shield. Despite many detailed investigations, this contention has not been proved and a major enigma in Precambrian geology remains.

Conglomerate is an interesting sedimentary rock found at intervals throughout the region. It is a very impressive rock, being essentially the hard, compacted equivalent of a gravel containing pebbles, cobbles, and boulders of older formations (Photo 4). As might be anticipated, many of the pebbles, cobbles or

Photo 4 *Seine conglomerate, north shore of Shoal Lake near Mine Centre, is made up chiefly of pebbles and cobbles of rhyolite in a matrix of greywacke.*

boulders in the conglomerates are made up of lava, tuff, slate, or greywacke. Pieces of granite are usually present also. Granite is an igneous rock, that is, one which has crystallized from a natural melt or magma generated at high temperatures deep below the Earth’s surface. From this, it has been speculated that at least some of the basement rocks were intruded by granite magma early in the Earth’s history, in what has been referred to as the Laurentian period, and that they were deeply eroded before the conglomerate was laid down in intermontane basins. Accordingly, where the conglomerates are found, the sediments are distinguished from the Couchiching rocks and have been classified variously as Seine, Timiskaming, and Windigokan. The relationships are represented in the Table of Formations on page 3 and are illustrated by the diagram reproduced in Fig. 2.

A conglomerate containing pieces of granitic rock is found at the iron mines north of Atikokan. Here, however, it is associated not with slate or greywacke but with economically valuable iron ores, an ancient residual soil called “Paint Rock” and with limestone and dolomite. As in the case of the Couchiching sediments described previously, the position in the generalised geological column of these sediments, called “Steep Rock”, is also unknown. The Steep Rock sediments appear to be younger than, and to lie directly on, a granite body separating the property of Steep Rock Iron Mines Limited from that of Caland Ore Company Limited. The age of this granite has not been determined. Some geologists consider the Steep Rock sediments to have been formed at roughly the same time as the Seine, Timiskaming, or Windigokan formations found elsewhere. Other geologists, pointing to the presence of peculiar fossil-like structures and the comparatively unaltered condition of the rocks, suggest that they may be much younger.

One of the most recognizable, and also one of the potentially most important, rocks in the region is a sedimentary material called iron formation. The iron formation consists largely of very fine-grained quartz or chert associated with such iron-bearing minerals as magnetite, hematite and, less commonly, siderite. The chert may be grey or red, whereas magnetite and most hematite is black, and siderite is pale grey or brown. Because the fine-grained quartz or chert tends to be free of the iron minerals, the normal layered structure of the sediment is accentuated and the rock is conspicuously banded (Photo 22).

The iron content of the typical iron formation in the region is 30 percent or less. In some deposits, much of this iron is present as magnetite. Magnetite is magnetic, and when found in sufficient quantity and quality, can be concentrated by magnetic separation to yield a high grade product suitable for blast-furnace feed. Several deposits of magnetite-bearing iron formation are found in the region.

At the time of writing, none of these were being worked, largely because they are not competitive with iron ores found elsewhere, e.g. at the Steep Rock and Caland mines near Atikokan. But they are of large dimensions, and with an expanding economy and depletion of known reserves generally, they could become of considerable significance in the future. The largest, and perhaps the most notable, occurrences are in Duckworth and Laurie townships near Shebandowan, and in Conmee Township near Kaministiquia on Highway 17A-11A.

Intrusive Igneous Rocks

Small bodies of igneous rocks are associated with the volcanic and sedimentary rocks of the basement complex, which they interrupt. Like granite, these rocks crystallized from melts injected into the crust from below. One of these bodies is a crescent-shaped mass extending across Watten and Halkirk townships from Rocky Islet Bay to Red Gut Bay, Rainy Lake. A second is exposed along the shores of Bad Vermilion Lake near Mine Centre. Others occur at widely-spaced intervals between Atikokan and Lac des Mille Lacs, and outcrops of these rocks are to be seen in the vicinity of the Shebandowan lakes. The rocks making up these bodies are chiefly gabbro, anorthosite, and peridotite. The gabbro is similar to granite in texture, but is dark green in colour and is made up of roughly equal amounts of the minerals feldspar and hornblende or pyroxene. The anorthosite is usually pale grey or pale greenish in colour, and is made up largely of feldspar with small amounts of hornblende or pyroxene. Peridotite differs again, being dark green in colour like gabbro but made up chiefly of the mineral olivine or, because of severe alteration, serpentine and usually some magnetite. Typical gabbro is exposed along Highway 11 about 1 mile west of Bear's Passage, Rainy Lake; anorthosite may be seen along the shores of Bad Vermilion Lake; and peridotite, at Discovery Point on the west shore of Southwest Bay, Lower Shebandowan Lake.

The basic igneous rocks are of special interest because deposits containing copper, nickel and, in some cases, platinum group metals are closely associated with them. Such deposits are fairly common in the region. The most accessible, and possibly the richest, of these deposits were found in 1913 by W. W. Renner of Port Arthur on Discovery Point, Lower Shebandowan Lake. They were later acquired by J. G. Cross (best known for his discovery of iron ore at Steeprock "Lake"), and subsequently purchased by The International Nickel Company of Canada Limited.

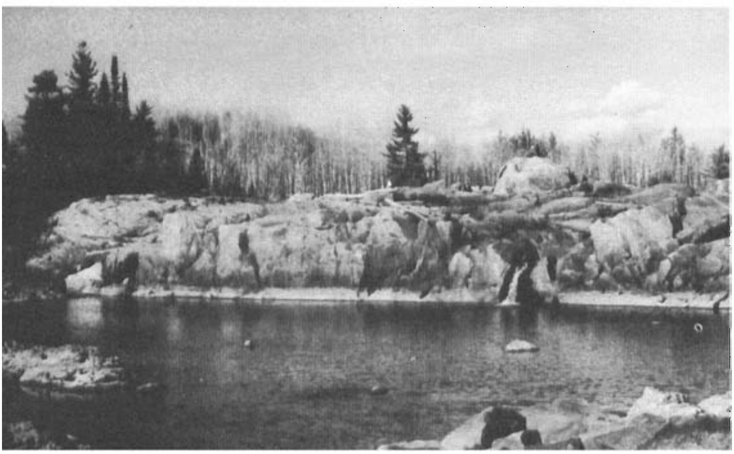
ALGOMAN ROCKS

The term Algoman is used to refer to a group of igneous rocks that are younger than, and have invaded, the igneous and sedimentary rocks of the basement complex just described. These igneous rocks include such diverse materials as granite, syenite, diorite and quartz diorite, and quartz and feldspar porphyries (see Glossary, pp. 110-114). Examples of all these are common.

Granites are abundant and very widespread in the region and make up extremely large masses, hundreds of square miles in extent, called batholiths. They are found along Highway 11 between Atikokan and Kashabowie, along Highway 622 north of Atikokan, and (except for a few miles west from Upsala) everywhere along Highway 17, from the intersection with Highway 11 to Ignace.

All of these granites are made up chiefly of the minerals quartz, feldspar, and mica or hornblende. They are mostly pale grey or

Photo 5 *Escarpment of massive Algoman granite at north end of Kakabeka Falls Provincial Park. The rocks in the river bed below the escarpment are flat-lying Animikie sediments.*



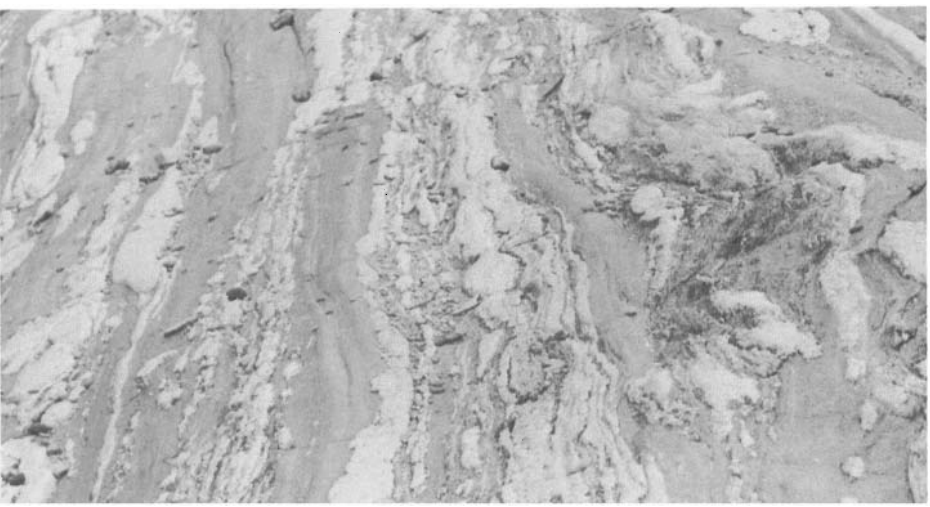
pale pink equigranular rocks with crystals measuring 1/8 to 1/2 inch across. Otherwise, they are quite variable in character.

Some are massive and structureless, others are gneissic due to the parallel or nearly parallel alignment of the dark minerals present. Some granites are free of foreign materials; other granites contain abundant inclusions of highly altered rocks of earlier age, and are called migmatites.

The migmatites are of two types. In one, the inclusions are irregular in size, shape, and distribution. In the second type, which is best observed near Kawene, at Lake Windigoostigwan and Pilcher's Service Station east of Atikokan, and at the United Church at Upsala, the inclusions are roughly tabular-shaped and are present as numerous, thin, closely-spaced parallel units giving the rock a distinctive banded appearance (Photo 6).

The older volcanic and sedimentary rocks bordering the granites in the region originally had horizontal or near-horizontal attitudes, much like their equivalents being formed at the present time elsewhere on the Earth's surface. But, where they are exposed in rockcuts along the highways between Rainy Lake and Lake Superior, they are found to stand vertically or to be inclined at very steep angles. Because of this, it has been assumed that the formation of the granite batholiths was attended by intense deformation of the Earth's crust, and that mountainous ridges,

Photo 6 *Migmatite exposed along Highway 633 near the Quetico Conference and Training Centre. The rock is made up of layers of mica schist (dark grey) alternating with layers of granite and pegmatite (pale grey).*



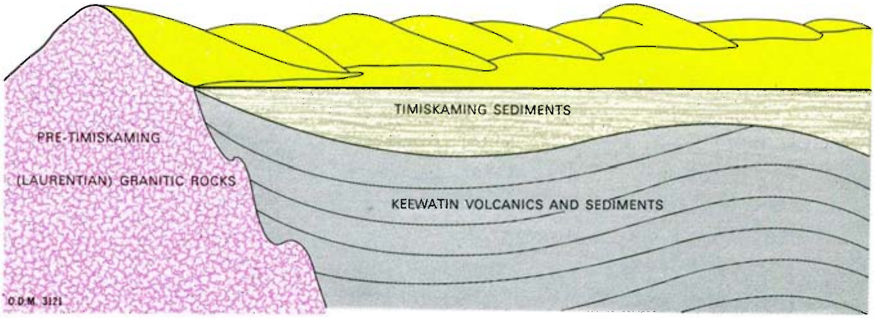
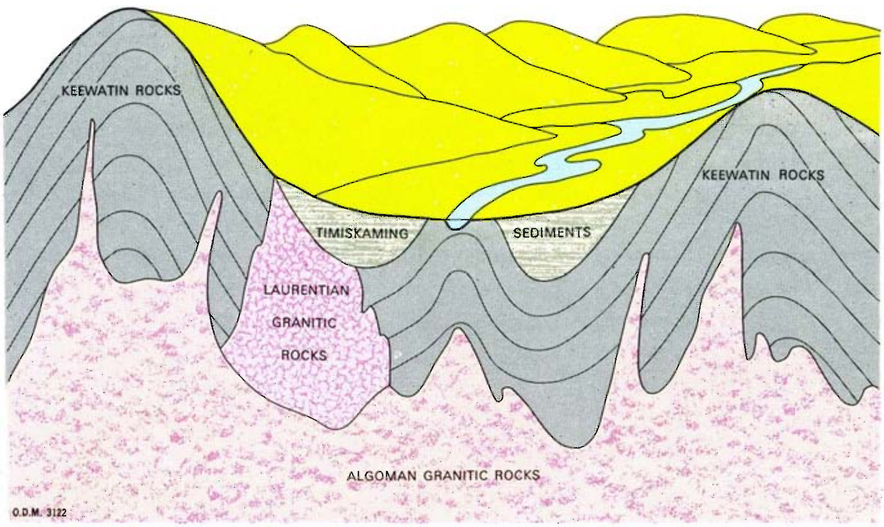


Figure 2. *Schematic vertical section illustrating supposed relationships between Couchiching and Keewatin rocks and overlying younger Seine, Timiskaming, or Windigokan sediments.*

Figure 3. *Schematic vertical section illustrating supposed relationships between the various Archean rock groups at the close of the Algoman period.*



perhaps in many ways similar to those found today in the western part of the North American continent, were created.

This period of great crustal disturbance is spoken of as the Algoman or Kenoran revolution. The approximate ages of many granites in the region have been determined by recently-developed radioactive dating techniques. These ages indicate that this revolution may have lasted about 200 million years and occurred roughly 2,500 million years ago.

The Algoman revolution was of great economic importance to the region, for during this period many valuable mineral deposits were formed. Base metal, pegmatite and quartz vein deposits genetically related to the granites and associated igneous rocks are usually found in the basement formations. The base metal deposits contain copper, which is often associated with one or more of zinc, lead, and gold and silver. One deposit, at the north end of Burchell Lake near Kashabowie, is being worked by North Coldstream Mines Limited. Between 1959 and the end of 1965, this deposit yielded 84,576,853 pounds of copper, 19,803 ounces of gold, and 368,561 ounces of silver, having a gross value of $28,087,539.[1] Pegmatite deposits also are important. Pegmatite is an igneous rock similar to granite in composition, but very coarse-textured with crystals commonly several inches, and often a foot or more, across. It is a host for certain valuable minerals. In the region, it has been found in small, crudely tabular or lens-like bodies containing one of beryllium, lithium, and molybdenum. Beryllium-bearing pegmatite bodies outcrop near Mine Centre and English River; lithium-bearing pegmatite has been found at the east end of Lac la Croix in Quetico Provincial Park; and molybdenum-bearing bodies are present at Bear's Passage east of Fort Frances and near Ignace. Although none of these deposits are being worked, one lithium deposit at Lac la Croix has been estimated by International Lithium Mining Corporation Limited to contain 1⅓ million tons of material grading 1.20 percent lithium oxide (Mulligan, 1957, p. 17), between the surface and a depth of 500 feet, and may therefore have future economic potential. The quartz-vein deposits in the region are noted principally for their content of gold and silver. They are found mainly near Mine Centre and in the vicinity of Atikokan and Sapawe. From 1893, when the first discovery was made near Mine Centre, to the end of 1965, quartz-vein deposits

1. Figures supplied by the Statistician, Ont. Dept. Mines. Earlier figures are not available.

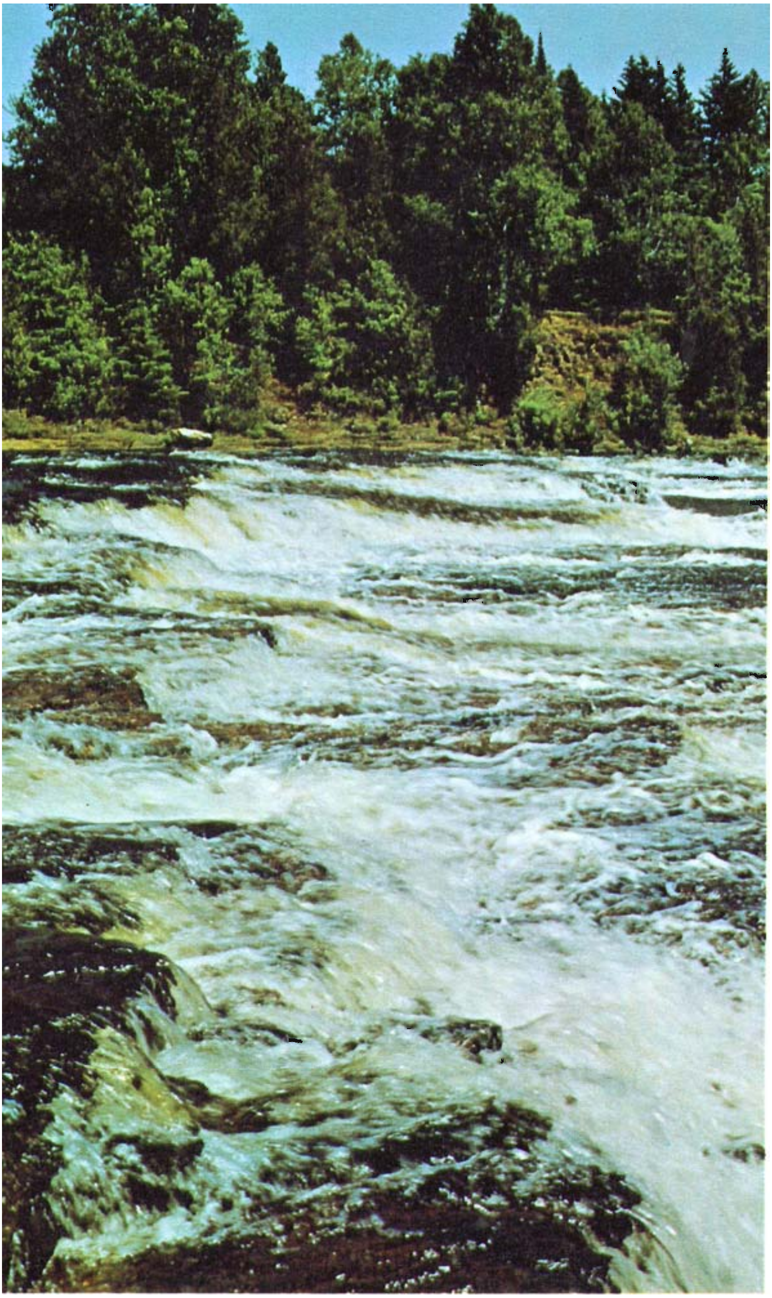


Photo 7 *Falls, Current River, Port Arthur. (Courtesy Ont. Dept. Tourism and Information)*

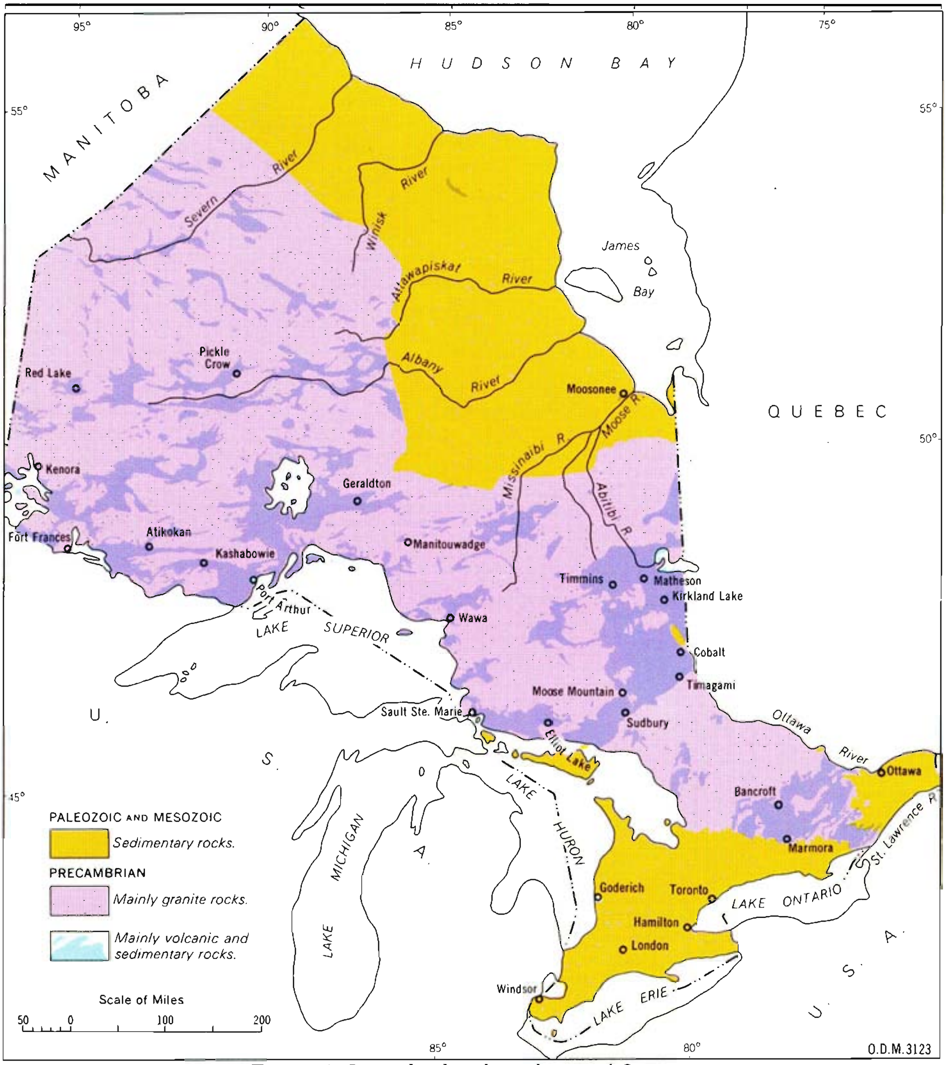


Figure 4 *Generalized geological map of Ontario*

from these camps yielded 51,414 ounces of gold, and 173,827 ounces of silver recovered as a byproduct, having a gross value of $1,441,117.[1]

1. Figures supplied by the Statistician, Ont. Dept. Mines

THE EPARCHEAN INTERVAL

After their formation, the Algoman mountains were subjected to weathering and rapid erosion. They were gradually worn down, until the countryside was reduced to a vast plain, perhaps similar to that found throughout much of northern Ontario at the present time (Photo 8). The great Algoman granite batholiths were formed at considerable depths below the surface. Because of the removal of a great thickness of basement rocks, these batholiths, originally at the roots of the Algoman mountains, became exposed. As a result, most of the rocks found in the region are granitic, and the older formations of the basement complex occur merely as relatively small, irregularly-shaped, and widely separated remnants (Fig. 4).

The erosion interval, called the Eparchean, had a duration of at least 200 million years. It separates the two major divisions of Precambrian time: the Archean, when the Algoman and pre-Algoman rocks were formed; and the Proterozoic, when the Animikie and Keweenawan rocks were formed (see the Table of Formations, p. 3, and the diagrammatic summary, Fig. 1).

Photo 8 *Aerial view, Quetico Provincial Park, showing the impressive overall evenness of the terrain. (Courtesy Ont. Dept. Tourism and Information)*

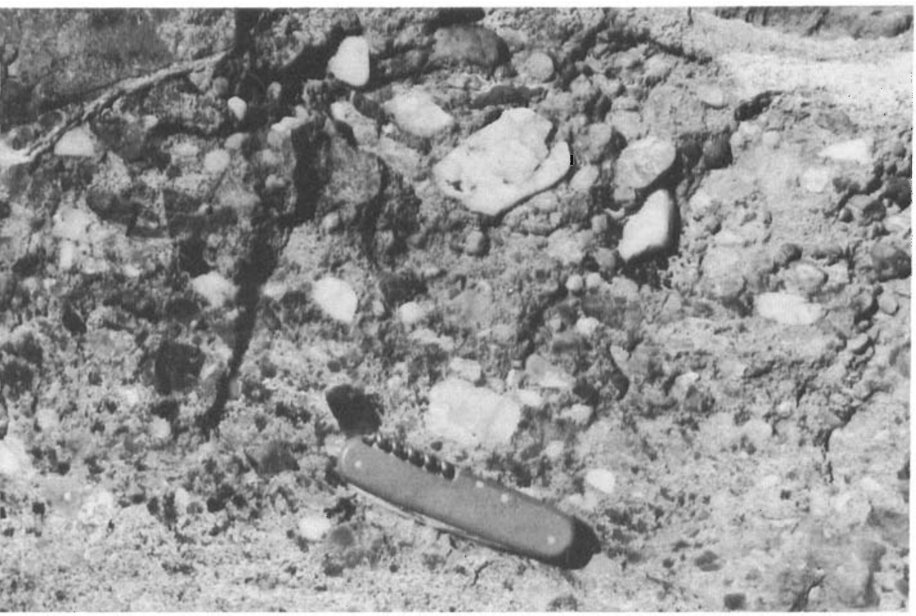
ANIMIKIE ROCKS

After the Eparchean interval of erosion, the eastern portion of the Rainy Lake — Lake Superior region was partly covered by an inland sea. A considerable thickness of sediments, classified as Animikie, was deposited upon the eroded Algoman and pre-Algoman rocks. These sediments are exposed in various localities near the Canadian Lakehead, extending northeastward for about 25 miles and southwestward across the international boundary into Minnesota. Radioactive age determinations indicate that they were deposited between 1,700 million and 2,100 million years ago. They have been divided into three distinct parts, which are referred to (from oldest to youngest) as the Kakabeka, Gunflint, and Rove formations.

Kakabeka Formation

The Kakabeka Formation is a consolidated gravel or conglomerate. It is made up of small pebbles of quartz, chert, jasper, granite, and greenstone, generally embedded in a coarse sandy matrix (Photo 9). It appears to be a fairly persistent sedimentary unit, although varying from only a few inches to 4 feet in thickness. It is everywhere horizontal or nearly horizontal, and lies

Photo 9 *Kakabeka conglomerate from Kakabeka Falls Provincial Park, showing pebbles of quartz, chert, jasper and other materials in a sandy matrix.*



directly on either granite or greenstone. Typical exposures may be observed: at the base, and near the south end, of an outcrop located at the junction of Highways 17-11 and 590 near Kakabeka Falls; in the bed of the Kaministiquia River at the north end of Kakabeka Falls Provincial Park; and in the bed of the Whitefish River, near the bridge 1.8 miles west of Nolalu along Highway 588.

Gunflint Formation

The Gunflint sedimentary rocks exposed at and near the Lakehead vary greatly, and include shale, tuff, carbonate rocks, chert-carbonates, and taconite. Black, thin-bedded shale is exposed in the gorge of the Kaministiquia River below Kakabeka Falls and here attains a thickness of 125 feet or more. Consolidated volcanic debris, or tuff, resulting from explosive volcanism, is interbedded with these shales near the bottom of the gorge, and one prominent bed is found upstream beneath the highway bridge (Photo 59). The carbonate rocks are layered sediments in which the beds consist of such carbonate minerals as calcite, dolomite, and siderite. Siderite is an iron-bearing substance. On exposure to the atmosphere, it weathers to form hydrous iron oxide, a brown mineral called limonite, and, where this is present, the surface of the rock is distinctly rusty. Typical carbonate rocks are exposed in Port Arthur at Hillcrest Park, and at Boulevard Lake Park. At Boulevard Lake Park, they contain lenses and occasional thin layers of chert. In places, such chert layers are numerous and closely spaced, and the carbonate rocks become strongly banded in appearance, forming chert-carbonates (Photo 10). Chert-carbonates are found at Kakabeka Falls, where they lie upon the shales, and at Trowbridge Falls Park in Port Arthur.

Taconite is found along the bed of the McIntyre River in Port Arthur, and at Boulevard Lake Park. This is a peculiar sedimentary rock made up not of sand grains but of tiny rounded bodies or granules of iron-bearing minerals and some chert. Because certain occurrences have a high iron content, it is potentially the most important member of the Gunflint Formation. Taconite provides an economic source of iron on the Mesabi range in Minnesota.

Here and there, lenses and layers of oölitic and algal cherts are associated with the taconite. Both cherts are found in Boulevard Lake Park, and particularly fine exposures can be examined in the bed of the Whitefish River 1.8 miles west of Nolalu. Oölitic cherts contain small, rounded bodies called oölites. Oölites are much like the granules of the taconite, but are characterized by radial or concentric structures, or both. They are generally less than 1/8 inch in diameter, and collectively resemble the roe of fish. Algal cherts are made up of cabbage-like, biscuit-like, and irregular bodies having peculiar concentric markings (Photo 13). They are thought by most geologists to have been formed through the action of primitive plants in Proterozoic time.

Rove Formation

The Rove Formation overlies the Gunflint rocks, and because of a general regional dip or slope of 5° to 10° toward Lake Superior, flanks the major portion of the Gunflint on the east and southeast. At Squaw Bay on Lake Superior, about 3 miles from Fort William, the Rove Formation was cut by a vertical bore-hole and found to have a thickness of at least 1,280 feet (Tanton, 1931, p. 36). It thins to the northeast and, near Loon Lake, about 25 miles from Port Arthur, it has a thickness of only about 20 feet. The rocks of the Rove Formation can be studied most conveniently at the Riverdale Road quarry, in the valley of the Slate River, and at Mount McKay at Fort William. The rocks are principally shales — for the most part thin-bedded, dark-coloured, fissile sediments similar to the shales of the older Gunflint Formation — and

Photo 10 *Bedded chert-carbonate rock, Trowbridge Falls Park, Port Arthur. The carbonate layers are light-coloured; the chert layers are dark.*

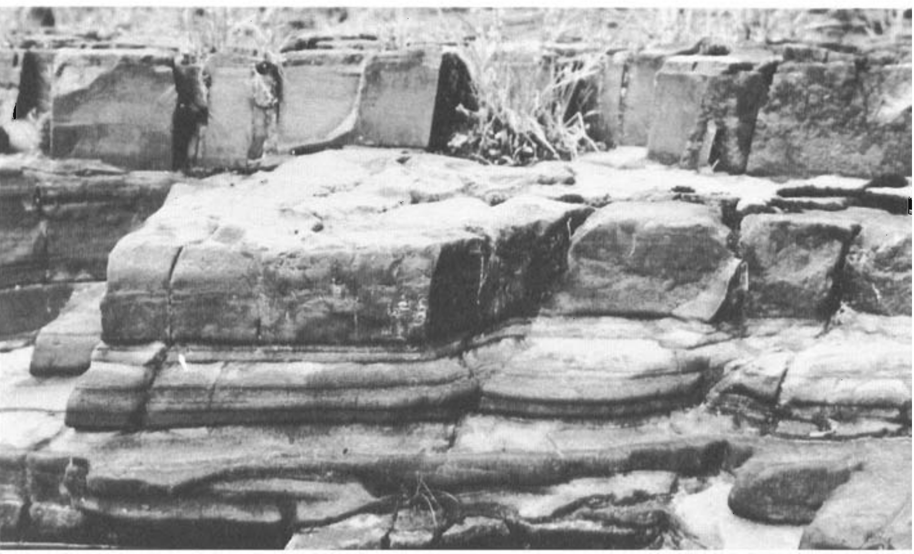


Photo 11 *Diabase dike cutting granite along Highway 11, about 10 miles east of the Rainy Lake causeway.*

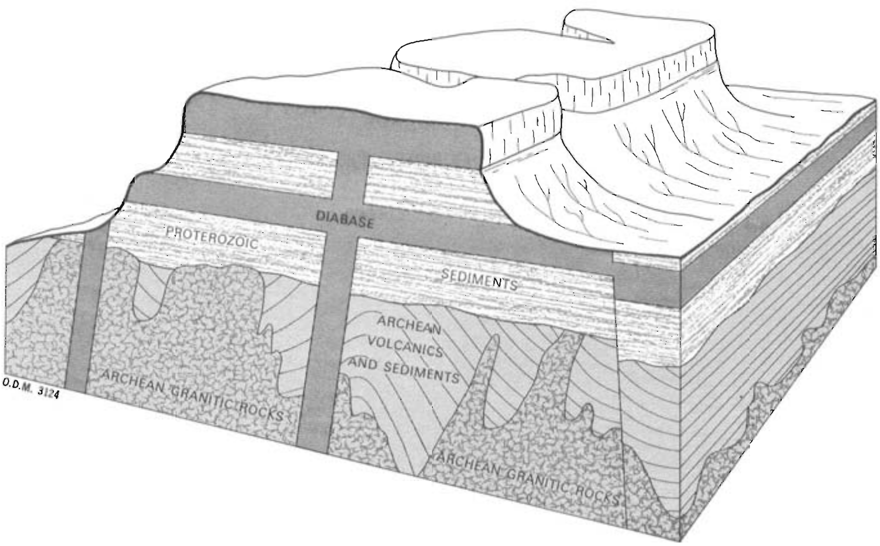
siltstone and greywacke, which make up uniformly-thick and persistent layers interrupting the more abundant shales at close intervals. One of the features of the Rove Formation is that, in places, it exhibits large concretions (Photo 14).
oblate-spheroidal, disc-like, or spherical bodies, up to several feet across, made up largely of the same materials as the enclosing rock. They are perhaps most numerous and best developed in the Slate River valley. Good examples can be observed in the Riverdale Road quarry and in some of the shale pits along Highway 130 (Oliver Road) just west of Port Arthur.

KEWEENAWAN ROCKS

The Keweenawan is represented in the region principally by a dark coloured, almost black igneous rock called diabase. The diabase crystallized from a natural melt or magma injected into the crustal rocks from below at about the same time as the original Lake Superior basin was being formed. It makes up two types of bodies, dikes and sills. The dikes cut obliquely or transversely across the older rocks and, in general, stand vertically or at steep angles. The sills were injected parallel to the older Animikie formations and, in most places, are flat or slope gently. The dikes are abundant in the region southwest of Fort William, along or close to Highway 61 (Pye, 1962, pp. 19-21), but elsewhere they are quite rare. The diabase sills, called Logan sills after Sir William Logan who first described them, occur only close to Lake Superior. They are more resistant to erosion than the sedimentary rocks they have intruded, and form the dark cappings on many of the high hills, such as Mount McKay, Pie Island, and the Sleeping Giant, near the Lakehead cities. The diabase cappings were once continuous across the whole region. They were subsequently fractured and faulted, and erosion by streams and atmospheric agencies has resulted in the development of isolated flat-topped mesas or gently-sloping cuestas in which only small remnants of the original sills remain.

As in the Algoman period of igneous activity, many valuable mineral deposits were formed in the region in Keweenawan time. Lead-zinc deposits of supposed Keweenawan age occur north of the Lakehead cities in Dorion and McTavish townships. A large barite deposit is exposed on South McKellar Island in Lake Superior. Important silver orebodies have been mined at Silver Islet at the foot of Thunder Cape; in or near Port Arthur; and at Rabbit Mountain and Silver Mountain near Kakabeka Falls. The total production of the silver mines from 1869 to 1922 has been valued at $4,780,000.

Figure 5. *Block diagram illustrating relationships between Proterozoic and Archean Precambrian rocks.*



THE LIPALEAN INTERVAL

After the large-scale intrusion of the crustal rocks by diabase, the Keweenawan period came to an end. Then began a long interval of erosion, called the Lipalean interval. Like the Eparchean interval that preceded it at the close of the Algoman period, the Lipalean interval lasted for hundreds of millions of years. It marked the close of the Precambrian era.

The Lipalean interval was terminated in other regions by the deposition of the oldest rocks of the Paleozoic era — the era of "old life", when invertebrate creatures dominated the scene, primitive fishes were evolved, and amphibians emerged from the sea. In the Rainy Lake — Lake Superior region, however, there are no Paleozoic rocks. It may be assumed that the long period of erosion, which started with the close of the Precambrian era, continued until the advent of continental glaciation in the Pleistocene epoch, about 1 million years ago. This period of erosion probably lasted over 1,000 million years.

Pleistocene Deposits

The continental ice sheets which extended across the region in the Pleistocene epoch advanced at different times and from different directions. The dominant direction was toward the the southwest; a second direction was more southerly; a third direction, evidence of which is found only in widely separated localities, was toward the south-southeast. The effect of these ice advances was a general stripping from the bedrock of the weathered mantle that had been accumulating on the surface since Precambrian time. The rock surface was grooved and scratched (Photo 12), and in places was smoothed and polished. Elevated areas were abraded. Valleys which were parallel to the direction of ice flow were gouged and deepened.

Eventually the climate warmed. The ice wasted away by melting, and the loose debris, largely a mixture of boulders, sand and clay, which had been picked up by the ice sheet, was dumped haphazardly as glacial till. This completely disorganized the pre-glacial drainage pattern, and the new landscape came to be characterized by an intricate pattern of lakes connected by short rapid rivers and spillways.

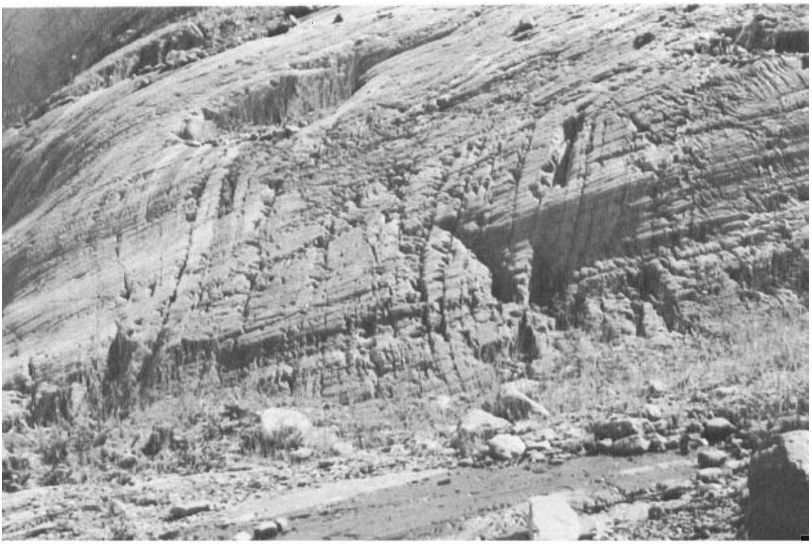


Photo 12 *Outcrop of greywacke near the Errington pit, Steep Rock Iron Mines Limited, showing well-developed glacial grooves and striae.*

During the retreat or wasting away of the ice sheets, glacial meltwaters were ponded in the Superior basin at the east end of the region and in the Rainy Lake basin at the west end. The original lakes occupying these basins were much larger and deeper than the present lakes, and were drained by rivers flowing southward to the Mississippi River valley. The lake water was held in by glacial ice. As the ice melted away and the glacial fronts receded, the land surface was exposed and new drainage patterns were developed. Water levels were changed. With the lowering of water levels, old shorelines were abandoned, more recent lake deposits became progressively exposed, and new shorelines were established. This produced a succession of terraces and abandoned beaches, separated from one another by fairly abrupt escarpments or shore cliffs created by wave erosion. Such terraces and beaches are found at and west of Fort Frances, where they attain elevations up to about 100 feet above Rainy Lake, and in and near Port Arthur and Fort William, where they occur as much as 235 feet above Lake Superior. The most prominent ones in the region are in Port Arthur, and one of the best examples can be observed in Current River Park (Photo 16).

Photo 13 *Plan view of an erosional remnant of a thin layer of chert at the north end of Boulevard Lake, Port Arthur. The concentric structure has been attributed to the action of algae primitive plant life.*

Photo 14 *Oblate spheroidal concretion in flat-lying shales The concretion is about 3 feet in diameter.*

Photo 15 *View looking east along Highway 17A-11A from Sistonen's Corners. The rolling hills are made up of consolidated clay, sand and gravel of Pleistocene age.*

Photo 16 *Current River Park, Port Arthur. The playground is an abandoned beach. The steep embankment separating the playground from the upper terrace marks the position of a pre-existing shoreline when the waters in the Lake Superior basin stood higher.*

Photo 17 *Aerial view of the causeway across Rainy Lake near Fort Frances. The rock till of the embankments is made up of three rock types: syenite, hornblendite and ancient sediments. (Courtesy Ont. Dept. Tourism and Information)*

PART 2

Points of Interest

Fort Frances and Vicinity

FORT FRANCES

The town of Fort Frances lies in an area characterized by the flatness of the land. This feature is all the more striking because of its marked contrast with the rocky, rugged terrain of the Canadian Shield immediately to the east. Indeed, it marks the eastern limit of the prairie plains of Manitoba and Minnesota, and as such reflects the deposit of gravel, sand, and silty clay laid down in a large lake that once covered the region.

When the Pleistocene continental ice sheets (see pp. 23-24) that once extended across the region began to retreat, the melt waters were ponded between the front of the ice sheet and the height-of-land south of the Canadian border, thus forming Lake Agassiz. At its maximum development, Lake Agassiz occupied an area greater than that taken up today by all the Great Lakes. It extended from south of the border northwest to the upper end of the present Lake Winnipeg, and from the site of Rainy Lake westward to Saskatchewan. At first, water levels were maintained by the Minnesota River, through which Lake Agassiz drained into the Mississippi River valley at St. Paul. With the eventual withdrawal of the ice from the Hudson Bay basin, however, new outlets to the northeast were opened. Lake Agassiz contracted in size and almost disappeared, leaving behind, as one of its remnants, beautiful Rainy Lake.

RAINY LAKE (NODEN) CAUSEWAY

One of the principal tourist attractions in the vicinity of Fort Frances is the causeway extending along Highway 11 across Rainy Lake. This causeway, completed in 1962 at a cost of $6,035,000, has a total length of 2.8 miles. Its construction required the building of a high-level bridge, with a length of 2,014 feet and a clearance of 36 feet above lake level, to facilitate marine navigation; a straight low-level bridge with a length of 1,811 feet; a curved, low-level bridge with a length of 453 feet; and, near the east end of the causeway, the "Seven Mile" low-level bridge with a length of 138 feet. Embankments defining the approaches to, and alternating with, the bridges have an aggregate length of about 2 miles.[1]

The embankments are made up of 260,000 cubic yards of rock fill. This fill was obtained from roadcuts and quarries located about a mile west of the high-level bridge, on the islands between the curved and the "Seven Mile" low-level bridges, and on the mainland near the east end of the causeway. Three radically different rock types are exposed in the road cuts and quarries: syenite, hornblendite, and ancient, altered sediments.

The rock in the quarry west of the causeway has been classified as a syenite, a rock that, except for the scarcity of the mineral quartz, is similar to granite in composition. It is a dark grey rock, rich in black mica or biotite. It is distinctive in being made up of large rectangular-shaped crystals of white feldspar in a relatively fine-grained groundmass of biotite and other minerals (Photo 18). Because of this, the rock is said to be porphyritic.

Assuming the rock to be of igneous origin, that is, to have crystallized from a natural melt or magma, the porphyritic texture is easily explained. When a melt is slowly cooled, very few crystal nuclei are formed, and these develop into a small number of large crystals. When a melt is rapidly cooled, many crystal nuclei are formed, and these develop into a large number of small crystals. We can, therefore, assume that a porphyritic rock may have crystallized in two stages. The large feldspar individuals resulted from slow cooling of the magma at depth where the temperature was high, the small groundmass crystals resulted from rapid chilling after the magma had worked its way upwards toward the surface where the temperature was much lower.

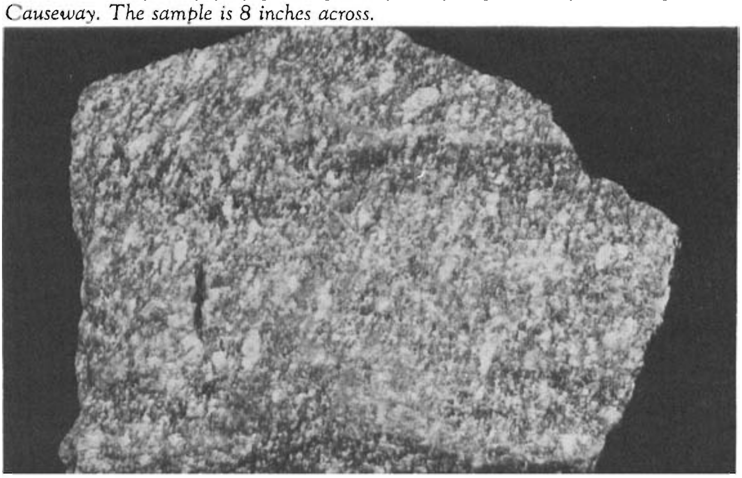
1. Bonner, D. H., Engineering Office Supervisor, Ont. Dept. Highways, Kenora, Ont., personal communication.

A second feature of the quarry southwest of the causeway is the vertical fault cutting through the bedrock. This fault strikes or trends east-northeast, and can be seen in both the north and the east walls of the quarry. It is represented by a zone, varying between 2 and 4 feet in thickness, of soft, dark green chlorite, interrupted by several small lenses and veins of quartz and calcite. As a result of the movements along the fault, the chlorite is fissile or schistose, with a tendency to flake and split into thin parallel sheets.

About 800 feet east of the curved low-level bridge, the rock quarried is a porphyritic syenite, similar to that just described. However, on the island immediately east of the quarry, a strikingly different rock is exposed. This is dark grey and of uniform texture, made up largely of black hornblende forming an interlocking network of crystals, some up to 1/2 inch across. The occurrence within this peculiar rock of large blocks of highly altered and locally distorted volcanic material indicates that, like the syenite, it may also be of igneous origin.

Ancient (Archean) sedimentary rocks can be seen in the large quarry on the mainland, at the east end of the causeway. They trend east-northeast, roughly parallel to the highway, and, as indicated by their stratification or layered structure, they stand more or less vertically. Because they represent water-laid deposits that formed originally with horizontal or nearly horizontal attitudes, it is apparent that they have been tilted.

Photo 18 *Sample of porphyritic syenite from quarry west of the Rainy Lake Causeway. The sample is 8 inches across.*



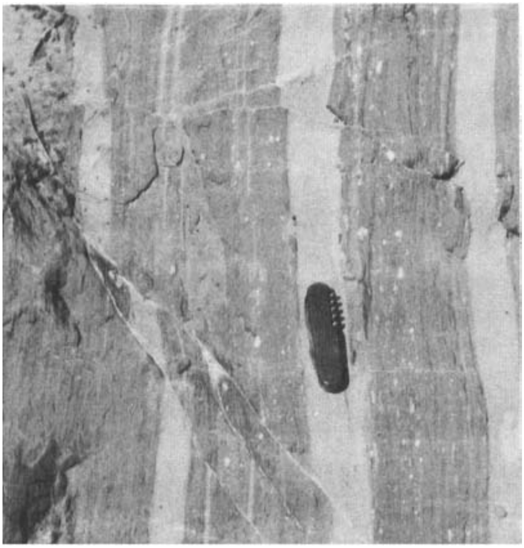


Photo 19 ***Interbanded tuff (dark grey) and mica schist (light grey) along Highway 11 east of the Rainy Lake Causeway. Note the offsets caused by faults.***

It is believed that, during the Algoman period, when the Earth's crust was invaded by large masses of granite, these ancient sedimentary rocks were tightly compressed into great folds. High mountainous ridges, now largely eroded away, undoubtedly characterized the landscape. The sedimentary rocks also were greatly changed at this time, and original minerals were made over into new ones. One of these minerals, which probably appeared at the expense of clays, is black mica or biotite. This mica was formed as numerous small platy crystals in a parallel or subparallel arrangement. This imparted a distinct foliation to the rocks, which now tend to split easily along closely spaced planes. The ancient rocks, presumably varieties of sandstones and shales, have thus been transformed into mica schist.

The mica schist at this locality forms a part of the Couchiching Group of sedimentary rocks (p. 7). About ¼ mile east of the quarry, it is found in contact with relatively dark coloured, highly altered volcanic rocks (tuffs) of the Keewatin Group. The transition from mica schist to volcanic rocks is not sharp. Along the south side of the highway, the rock exposed is chiefly mica schist interrupted by thin, parallel layers of volcanic rocks. To the north, the volcanic rock layers become more closely spaced and thicker, and along the north side of the highway, the outcrop is made up largely of volcanic rocks interrupted by a few thin layers of mica schists (Photo 19).

COMMISSIONER'S BAY, RAINY LAKE

A prominent outcrop is found where Highway 11 passes Commissioner's Bay, approximately 3½ miles east of the causeway. Here, volcanic rocks of the Keewatin Group enclose a thick deposit of sedimentary rocks. As before, these ancient rocks have been altered — volcanics are represented by foliated (schistose) materials rich in hornblende; and sediments, by materials rich in black mica or biotite. Because of folding, these rocks have been tilted so that, whereas initially they lay flat, today they stand vertically. They are interrupted by several thin bodies of a rock made strikingly conspicuous because of its contrasting white appearance (Photo 20).

Photo 20 *Intrusive bodies of granite and pegmatite (pale grey) in mica schist, Commissioner's Bay, Rainy Lake.*

The bodies of white rock pinch and swell somewhat, but in general are crudely tabular-shaped. Several of the smaller bodies parallel the bedding or layered structure of the sedimentary rocks, but the larger bodies extend diagonally across the sedimentary rocks cutting sharply through them. For this reason, and because nearby sedimentary rocks obviously have been distorted, it is evident that these bodies have intrusive relationships. Indeed, they are of igneous origin, and are believed to have crystallized from an introduced natural melt or magma. They consist mainly of quartz, feldspar, and black mica. Some of them are typical granites; others, which are coarse-grained due to relatively slow crystallization, are pegmatites.

REEF POINT IRON FORMATION

Reef Point is a picturesque peninsula which extends into Rainy Lake and affords an excellent site for summer cottages. It is readily accessible by a motor road that branches north from Highway 11 about 1/3 mile east of Commissioner's Bay and 1.8 miles west of the bridge at Rocky Inlet. It is underlain chiefly by ancient volcanic rocks of the Keewatin Group. A thick deposit of the unusual sedimentary rock called iron formation exposed at one place is of particular interest.

The Reef Point iron formation is found along the right-hand (north) side of the road ½ mile from the highway intersection. It is thought to have been laid down originally as a chemical precipitate in shallow Precambrian seas adjoining volcanic highlands. The formation is a strikingly banded or stratified rock (Photo 22) comprised of thin, pale grey layers, made up of fine-grained quartz, alternating with equally thin or thinner layers, made up largely of iron-bearing minerals, chiefly magnetite. Like the other sedimentary rocks in the area, e.g. at Commissioner's Bay, the iron formation has been tilted and now stands vertically; as an expression of this compression and folding, the stratification is severely distorted locally (Photo 22).

In 1957, the Reef Point iron formation was investigated as a source of iron ore by Stanol Minerals Limited. It was found to have a width (thickness) of up to 200 feet, and was traced in an east to northeast direction for about 1 mile. Considerable coarse-grained magnetite was exposed in a 200-foot long, 30-foot wide trench located north of the motor road 0.65 miles from the highway. Some diamond-drilling was also done. There is no record, however, that anything of commercial importance was indicated.

ROCKY INLET, RAINY LAKE

Volcanic rocks are exposed where Highway 11 crosses the mouth of Rocky Inlet. These rocks stand almost on edge, and trend easterly, dipping or sloping about 80°N. They also have been changed in form, and are schistose materials composed largely of dark green to black hornblende. Two types are distinguishable. In one, an irregular flow structure, visible on smooth outcrop surfaces, indicates that the rock originally was a lava flow (Photo 21). In the second type, a thin-bedded or layered structure shows that the rock may have been a water-laid deposit of ash or tuff resulting from explosive volcanism between the lava outpourings. A particularly interesting feature of these hornblende schists is that the hornblende present occurs as innumerable, tiny prismatic crystals, so arranged that their long dimensions are parallel or nearly parallel. This imparts to the schists a distinct lineation such that, when viewed from the highway, they are seen to extend downward at an angle of 60°W. (Photo 24).

Photo 21 *Irregular flowage structure in basic lava along Highway 11 at Rocky Inlet, Rainy Lake.*

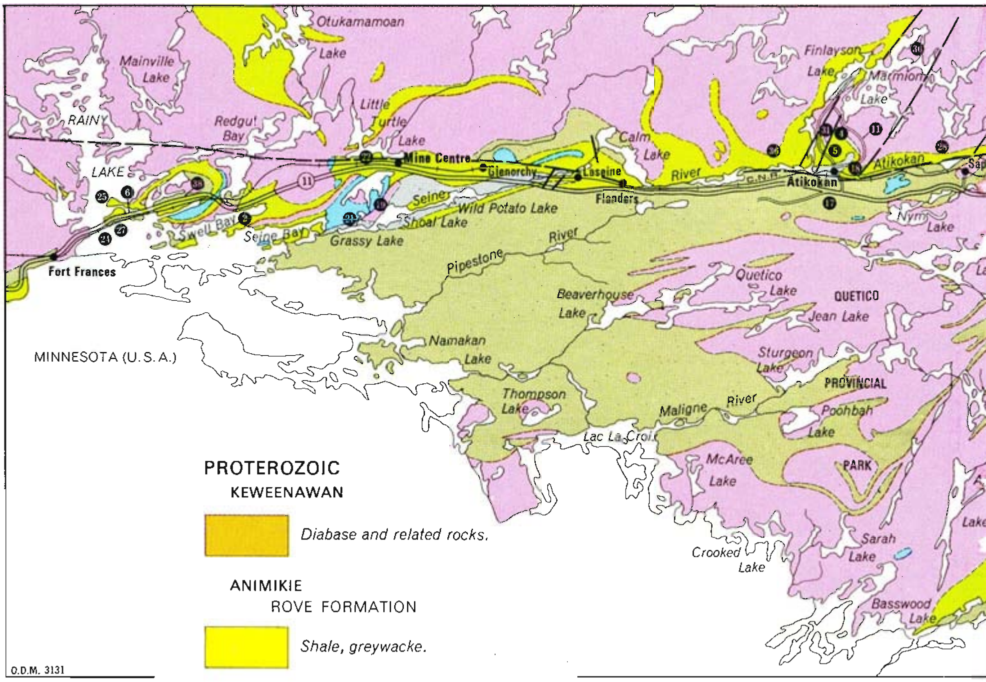
Photo 22 *Banded iron formation on Reef Point, Rainy Lake, made up of layers of chert (pale grey) alternating with layers of iron-bearing mineral.*

West of the Rocky Inlet bridge, the volcanic rocks contain abundant iron-bearing sulphide minerals, pyrite and pyrrhotite. Exposure to the atmosphere has broken down these sulphides to form hydrous iron oxide in the form of the brown mineral limonite, giving the outcrops a distinctly rusty appearance. These rusty, deeply weathered volcanic rocks, called “gossan”, extend along the highway for ¼ mile, forming one of the most conspicuous geological landmarks in the Rainy Lake area. As far as is known, the gossan does not indicate the presence of any mineral of economic significance, but some gossans found in other regions mark valuable deposits of base or precious metals. They thus serve as important guides in prospecting, and, whenever found, are carefully examined for ore minerals.

WINDY POINT

Along the highway 1 mile east of the side road to Windy Point (1.3 miles west of the road to Nickel Lake) occur prominent outcrops of hornblende schist similar to the metamorphosed volcanic rocks at Rocky Inlet. Here, the schists trend east-northeast and dip or slope 75°NW. They exhibit a pronounced lineation, due to the parallel or subparallel alignment of prismatic hornblende crystals, in this case pitching, or extending downward, to the west at 25°.

Geological Map of Rainy Lake—Lake Superior Region.



PROTEROZOIC

KEWEENAWAN

Diabase and related rocks.

ANIMIKIE

ROVE FORMATION

Shale, greywacke.

GUNFLINT FORMATION

Shale, carbonate rocks, chert-carbonate rocks, chert, taconite, volcanic tuff.

KAKABEKA FORMATION

Conglomerate.

ARCHEAN

ACID IGNEOUS ROCKS [1]

Granite, syenite, diorite, quartz diorite, quartz and feldspar porphyries, pegmatite, and related rocks.

BASIC AND ULTRABASIC IGNEOUS ROCKS

Anorthosite, gabbro, peridotite, hornblendite, and related rocks (includes some diorite).

WINDIGOKAN [2]

Conglomerate, greywacke, slate, mica schist and gneiss, limestone-dolomite, "paint rock," chert, iron formation.

KEEWATIN

Acid and basic lavas, tuff, volcanic breccia, iron formation, minor sedimentary rocks.

COUTCHICHING [3]

Greywacke, slate, mica schist and gneiss.

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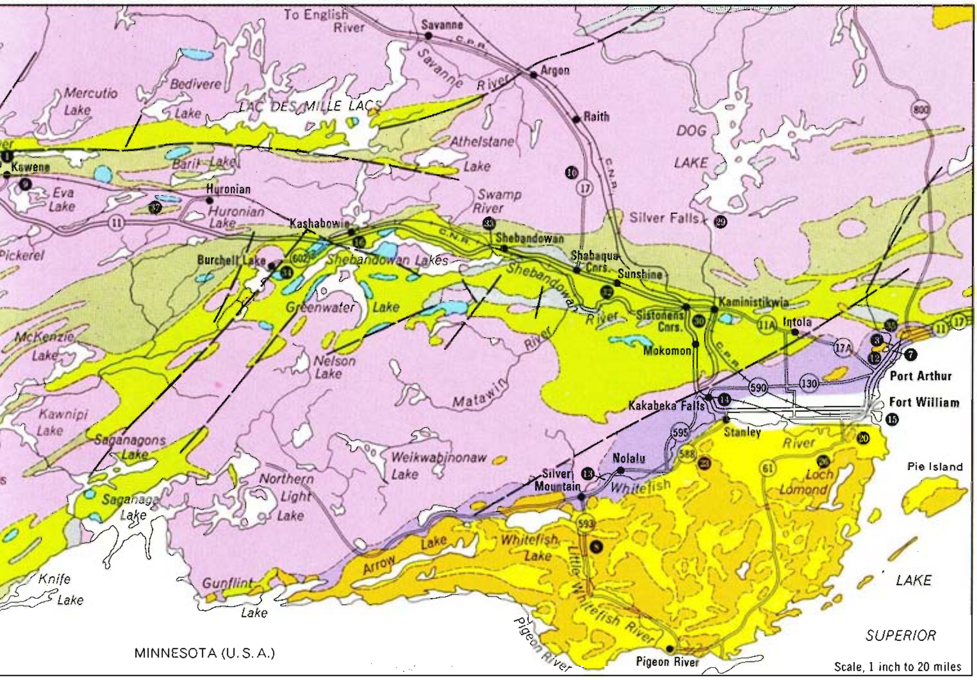
1. *Includes rocks classified as both Algoman and Laurentian.*
2. *Includes rocks classified as Seine, Timiskaming, and Steep Rock.*
3. *Age relative to that of Keewatin and Windigokan rocks not established.*



POINTS OF INTEREST

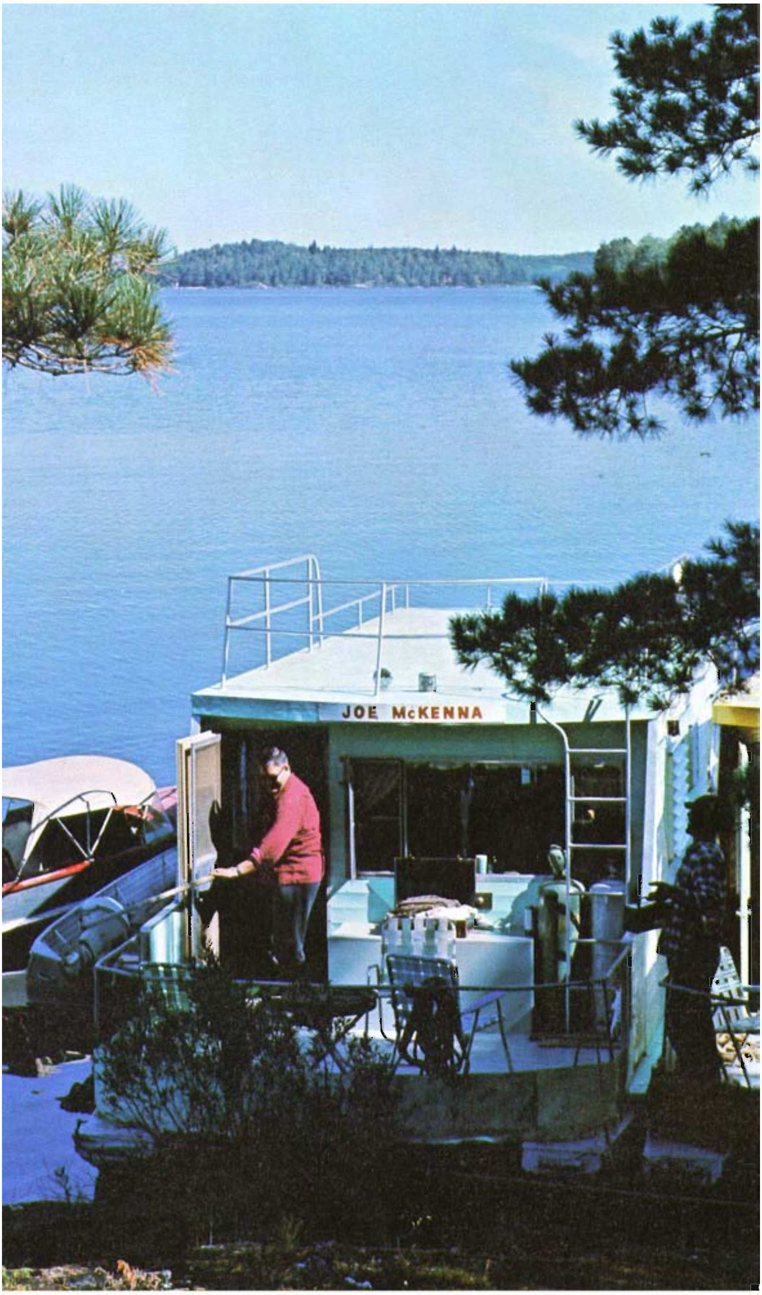


Photo 23 *Holiday-makers, Rainy Lake (Courtesy Ont. Dept. Tourism and Information)*

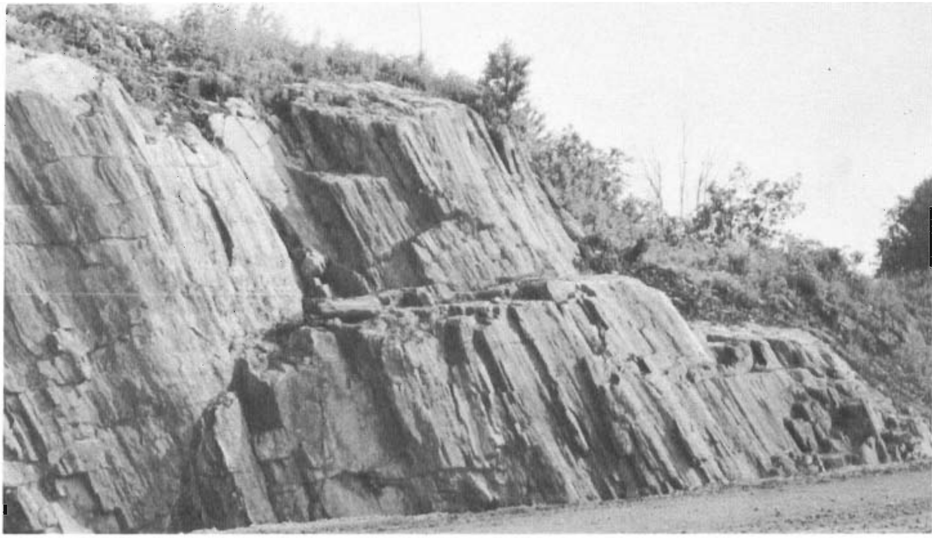


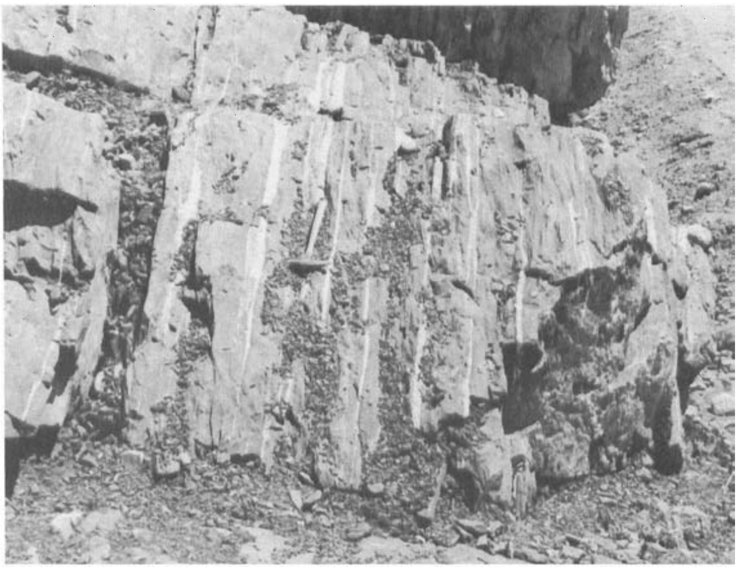
Photo 24 *Outcrop of hornblende schist along Highway 11 at Rocky Inlet, Rainy Lake, showing well-developed lineation.*

Two features are of interest. The schists are intersected by numerous joints or cracks, which extend across the outcrops at right angles to the east-northeast strike, and approximately perpendicular to the west-pitching lineation. It is probable that these joints or cracks resulted from the extension of the rock in the direction of the lineation, in response to lateral compression during folding. Also prominent are numerous thin veins and lenses of calcite. These are closely spaced and are oriented with their long dimensions parallel to the foliation or schistosity of the rock. The lenses are conspicuous, their whiteness contrasting sharply with the enclosing, nearly black schist. (Photo 26).

The calcite veins are not primary constituents of the metamorphic volcanic rocks, but are late-formed units believed to have been deposited from solutions that originated externally. Such solutions may be generated when a magma crystallizes to form igneous rocks within the Earth's crust. A magma is a complex solution of rock-making constituents, water and other volatile substances. As the magma solidifies, the volatiles, some carrying calcium carbonate in solution, become concentrated and may be forced out of the crystallizing mass. The volatiles migrate away under high pressure along fractures in the crustal rocks and, in so doing, often precipitate mineral matter, such as calcium carbonate, to form veins, like the calcite veins here.

Photo 25 *Outcrop of hornblende schist along Highway 11 near Windy Point, Rainy Lake, showing closely-spaced cracks or joints at right angles to a prominent west-pitching lineation.*

Photo 26 *Outcrop of hornblende schist along Highway 11 near Windy Point, Rainy Lake, showing closely-spaced, parallel veins and lenses of white calcite.*



BEAR'S PASSAGE

Bear's Passage is a very picturesque channel connecting Red Gut Bay of Rainy Lake and Swell Bay. Along the west side of the channel, where it is crossed by Highway 11, the bedrock is pink granite. This granite is made up largely of quartz and feldspar with a little black mica or biotite. It is an igneous rock crystallized from a natural melt or magma at considerable depth below the surface, and has been exposed to view only through the removal, by erosion, of a great thickness of ancient cover rocks. The granite forms a fairly small body only about 1 mile across. It probably widens downward and is, therefore, an upward projection of a much larger mass or batholith of granitic rocks below.

East of the bridge over Bear's Passage, the bedrock consists mainly of highly altered sediments of the Couchiching Group (see p. 7). These sedimentary rocks strike or trend north, and dip or slope to the east at angles of 40° to 60°. North of the bridge, however, they change in attitude. About ½ mile up the Passage, they strike northwest and dip northeast; after another ½ mile, they strike west and dip north; still farther up the Passage, 1.3 miles from the bridge, they strike southwest and dip 25° to 30° to the northwest.

The sedimentary rocks are also found along the highway, about 1 mile west of the bridge. Here again they are found to strike southwest and to dip flatly northwest. It is at once apparent that they are bent in a large fold about the extremity of the small granite body at this locality. Although now largely removed by erosion, at one time the sedimentary rocks no doubt were arched up over the granite like a curved roof, thus forming an anticline or an upfold having limbs that diverged sharply downward.

Mine Centre and Vicinity

By H. L. Bell[1]

LOWER SEINE GOLD MINES

The Mine Centre area has long been noted for its gold deposits, and is one of the oldest gold-mining camps in Ontario. The construction of the Canadian Pacific railway between Fort William and Winnipeg, completed in 1882, was one of the principal factors leading to prospecting and mining activity near Mine Centre. The railway afforded ready access to the Lake of the Woods area, and in a short time a number of gold deposits were discovered near Rat Portage (Kenora). These attracted considerable attention.

Prospectors, once having entered the region, gradually worked southward to Rainy Lake and from there eastward along the Lower Seine River. About this time, a "gold rush", precipitated by the finding of quartz veins by a timber cruiser in the Vermilion Lake area of northern Minnesota, brought other prospectors into the Lower Seine River area from the south. By 1892, the ground about Little Turtle, Bad Vermilion, and Shoal lakes was undergoing intensive examination.

Another factor of considerable importance was the completion of Niven's baseline. In 1891 Alexander Niven started to cut and survey a baseline along north latitude 48°45' for 109.5 miles, from the boundary of the Rainy River district westward to Fort Frances. Wooden pegs, set at 1 mile intervals along the baseline and iron posts set at 3 mile intervals, provided important reference points for tying in any land surveys. At that time a survey by a Provincial land surveyor was a prerequisite to obtaining title to a "mining location". Niven's baseline therefore greatly facilitated the acquisition of titles to mining lands and, in this way, promoted early exploration work.

The first gold discovery in the Lower Seine River area occurred on Little American Island at the entrance to Black Bay, Rainy Lake, in Minnesota. It was made in July 1893 by an American named George Davis. About two months later, the reward for perseverance came to a man named Campbell, who found a gold-bearing quartz vein about one mile east of Island Bay in Vermilion Lake. Title to the discovery was obtained with the surveying of locations AD2, AD3, and AD4 by A. Davis. Later

1. Mining Recorder, Ont. Dept. Mines, Fort Frances, Ont.

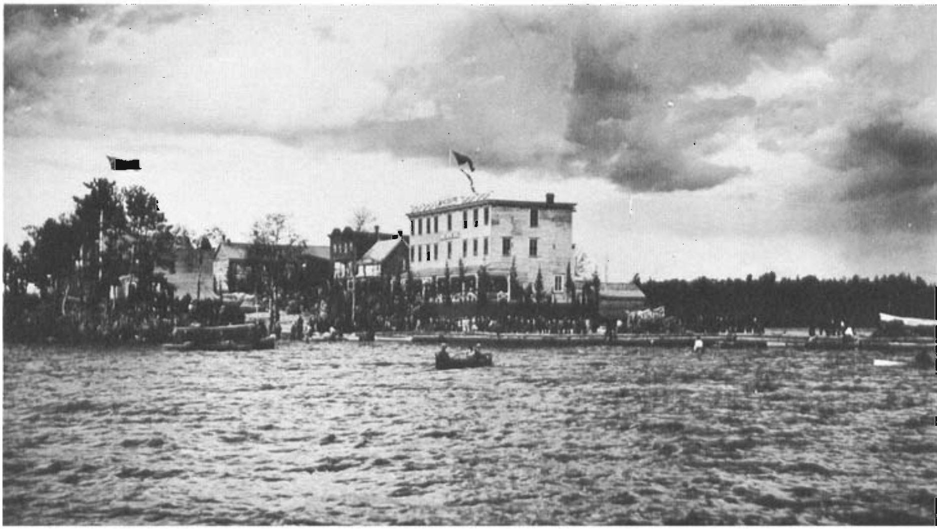


Photo 27 *A First of July celebration at Mine Centre on Shoal Lake about 1897. (Courtesy A. C. Howarth, Fort Frances).*

named the Golden Crescent mine, the property was developed by four shafts and two level openings or adits cut into a high escarpment on location AD2. A 2-stamp mill was erected and, in 1897, 192 tons of ore yielded 75 ounces of gold worth $1,543.

Shortly after the discovery of the Golden Crescent, new finds were reported and excitement mounted. Two prospectors, E. Randolph and Neil Berger of Harding (Crane Lake), Minnesota, staked the Golden Star (mining locations AL-114 and AL-116), the Isabella (mining location AL-113), and the Randolph (AL-115) properties.[1] The Randolph failed to yield any gold, and a promising vein on the Isabella property, although it contained some gold-rich "pockets", was found to have a low average grade. The Golden Star, by contrast, proved to be the most productive property in the region. According to official records, the Golden Star produced 11,745 ounces of gold having a total value of $165,059.

The gold-bearing quartz vein at the Golden Star was opened up to a depth of 432 feet by a vertical shaft and six level openings cut at intervals of 80 feet to 90 feet. The ore, after having been mined and hoisted to the surface, was carried by aerial tramway to a 10-stamp mill on the shore of Bad Vermilion Lake about ½ mile away.

1. AL is the mark of the land surveyor, A. Lougheed.

At about the time of the discovery of the Golden Star, two other prospectors, Thomas Weigand and Alexander Lochart, found a promising gold-bearing quartz vein about 4 miles to the southwest along the shore of Shoal Lake. Their locations, AL-74 and AL-76, became the Foley Mine property. Here a 400-ft. shaft was sunk, five level openings were cut at various depths, and a 20-stamp mill was erected. The mine was operated in 1897 and 1898. According to records of the Ontario Department of Mines, it produced a total of 2,043 ounces of gold worth $39,225.

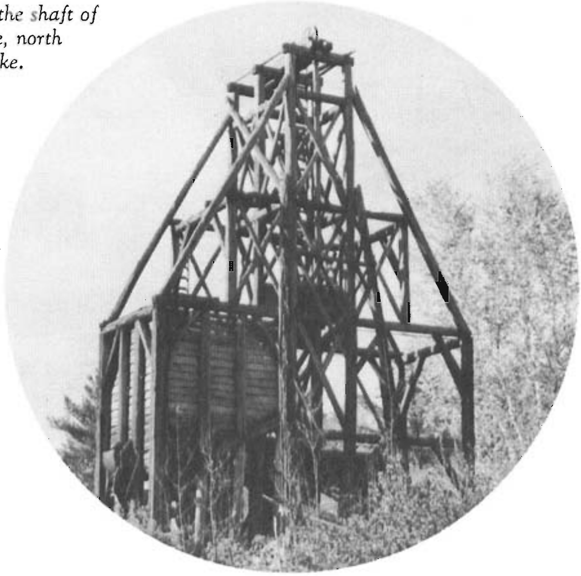
Another important discovery in the region was made along the south shore and near the west end of Little Turtle Lake. The property was made up of mining locations G-60, G-61, and G-69 surveyed by D.J. Gillon, and location HP-439 surveyed by Harold B. Proudfoot. It was first acquired by W. A. Preston, who at a later date was destined to become a Member of Parliament for the Rainy River district. The Preston Gold Mining Company was incorporated and, in 1897, mining was initiated. Work continued until 1900. During this period the mine is reported to have produced 6,925 tons of ore which yielded 2,699 ounces of gold worth $47,060. This production, however, did not save the company from financial difficulties. At one stage, refinancing becaine necessary and the company was reorganized as the Olive Gold Company, taking its name from Preston's daughter Olive. The mine was closed in 1900.

The Preston or Olive mine was developed by a shaft sunk to a depth of 251 feet with three level openings along the vein; and by a second shaft, at a point 150 yards from the first, sunk mainly to reach a small isolated "pocket" of rich ore. When mining started in 1897, the gold was recovered in a 2-stamp mill. Later the capacity of the mill was increased to 10 stamps and, subsequently, to 25 stamps. The ore was fed from the headframe at the main shaft to the mill by a 960-ft. long, gravity-operated tramway.

During a four month period beginning 1 March 1900, it is reported that the Olive mine yielded 1,930 tons of ore worth $9,400, and 75 tons of concentrate worth $24 per ton.[1] These figures make one wonder what may have happened to some of the reportedly rich mill feed. It is interesting to note that Billy McGee, an old Indian of unimpeachable honesty, later told how he had guided a discharged mine manager (not Preston) to Rat Portage (Kenora), via a little travelled canoe route, at the end of the four

1. Can. Mining Manual, 1901.

Photo 28 *Headframe at the shaft of the abandoned Verlac mine, north shore of Bad Vermilion Lake.*



month milling period. There is nothing remarkable about this alone, but the baggage included boxes so heavy that two men could lift them only with great difficulty. McGee's surmise that it was gold or rich concentrate may be correct!

Many properties in the area had colourful names such as the Decca, Alice A, Gold Bug, Mayflower, Fighting Chance, Independence, Gold Eagle, Lucky Coon, Swede Boy, Ferguson, Manhattan, Hidden Treasure and Emperor. Most of them had gold values but were lacking as mine-makers. With this tantalizing evidence, however, one cannot help but anticipate that someday new producing mines will be found to render full justice to the camp.

Mine Centre was sited originally on a point along the north shore of Shoal Lake. It was favoured with a sandy beach and had direct access to Fort Frances by way of Shoal Lake, the Seine River and Rainy Lake. It has been estimated to have had a population of over 500, with a school, hotels, customs house, post-office, assay office, and retail stores. Half a mile along the shore to the east of Mine Centre another settlement was established with the impressive name of Bell City. The outlook at this time was encouraging and for a time there were high hopes for the future. However, in 1903 and 1904, as if by common accord, one mine after another closed down.

The Canadian Northern Railway line reached the area in 1903. It passed about five miles to the north of Mine Centre, the new station being given the same name. The coming of the railway marked the beginning of a new era and the quick disappearance of the more exciting old.

Some people moved to new homes along the railway, others went back to the more settled farming areas west of Fort Frances or to the more distant cities. Buildings at old Mine Centre on Shoal Lake were torn down or moved. One notable event was the dismantling of the Mine Centre Hotel into sections, its transportation to Fort Frances on barges, and its reassembly there as the Monarch Hotel, now more familiarly known as the Irwin. The buildings remaining at old Mine Centre and Bell City have deteriorated to such an extent that today little or no evidence remains to remind us of past endeavours.

From 1903 to the present, exploration in the area has only come to life spasmodically. During the thirties, a little gold was produced at the principal mines. At the present time, the area is dormant, except for work being done by a lifetime resident, Russell C. Cone, who mines the odd vein and operates an antiquated but serviceable 2-stamp mill, "the potato masher". Cone's efforts portray fortitude under adverse conditions. They constitute a continuous link with the past.

PORT ARTHUR COPPER MINE

The Mine Centre area is known not only for its gold deposits but also because of the occurrence of base metals. One base-metal deposit that has received much attention for its copper-mining possibilities is found along the Olive wagon road, 200 feet north of the intersection with Highway 11 and approximately 3 miles west of Mine Centre. This deposit was opened up in 1916 by the Port Arthur Copper Company Limited. Initial mining was from an open-cut measuring 30 feet by 50 feet. Several carloads of ore, containing 3 percent to 3.5 percent copper, were shipped to the smelter at Trail, British Columbia.

Later, underground development was begun. A two-compartment vertical shaft was sunk and the copper deposit was investigated by a 200-foot-long opening driven 100 feet below the surface. This work apparently met with little success, for in 1918 operations were suspended. The property then lay idle until 1955. In that year, it was acquired by Stratmat Limited and an extensive program of diamond-drilling was carried out to test the mineral

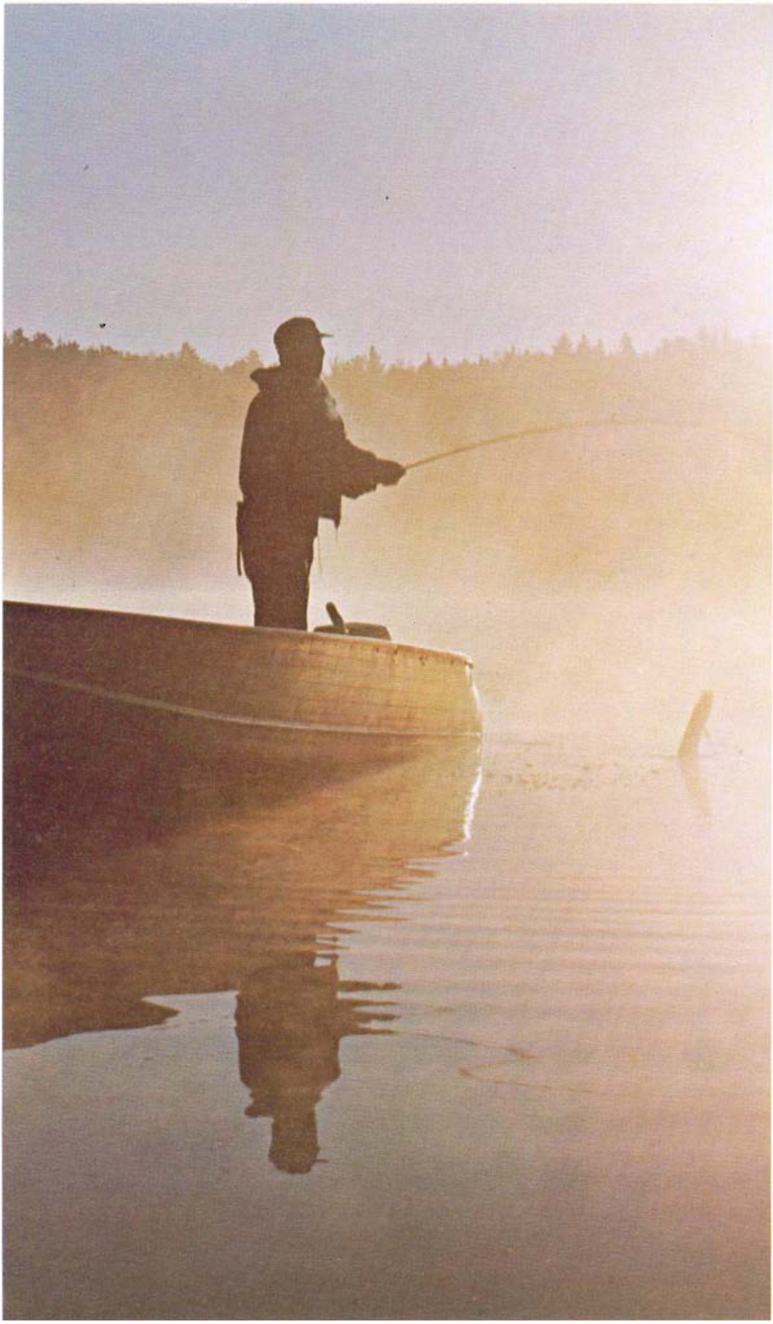


Photo 29 *Fishing, Rainy Lake. (Courtesy Ont. Dept. Tourism and Information).*

Photo 30 *Cascade along the Kemuel Riwer near Atikokan. The exposed rocks are ancient sediments of the Couchiching group.*

Photo 31 *Atikokan River. (Courtesy Ont. Dept. Tourism and Information).*

deposit beyond the limits of the old workings. The mineral deposit was traced for several hundred feet and, in places, was found to contain high grade copper. As so often happens in mine exploration, however, nothing was disclosed that could be mined profitably under existing economic conditions.

The old workings provide excellent exposures for detailed study. The bedrock is a highly foliated or schistose one, which trends east-northeast and, like other formations in the region, stands more or less vertically. It is distinctly spotted. When examined carefully, the rock is seen to contain numerous tiny inclusions, round to ovate in shape, with diameters up to 1 inch. Some of these inclusions consist entirely of quartz, others of quartz enclosing central fillings of a soft, rusty-weathering, iron-bearing carbonate mineral. They result from the quartz and carbonate filling the original cavities (vesicles) formed by the escape of gases when the rock, an extrusive lava, was in the molten state. The inclusions are called “amygdules”. The rock is known as amygdaloidal lava.

The amygdaloidal lava has been highly altered, and now consists largely of dark-green chlorite. This chlorite schist is well mineralized with both quartz and metallic sulphide minerals. The quartz occurs as numerous closely-spaced lenses and as thin veinlets. Most of these are oriented with their long dimensions parallel to the rock’s foliation. Because they are harder and more resistant to erosion than the schist, they tend to stand up in slight relief on outcrop surfaces.

The metallic sulphide minerals are pyrite, pyrrhotite, and chalcopyrite. These occur as tiny grains and crystals largely peppered or disseminated throughout the schist but, in places, also associated with the vein quartz. They are irregularly distributed, so that some portions of the schist are rich in sulphide minerals and, of course, also in copper, whereas other portions are nearly barren. The richest section of the deposit occurred at the site of the open-cut, and has been mined out.

Along the north side of the open-cut is a lens, up to six feet wide, of a pale pink to white material. It is made up of crystals of quartz and feldspar in a fine-grained groundmass, and is a porphyritic igneous rock that crystallized from a natural melt or magma injected into the lava long after the lava had formed. Like the lava, it is foliated or schistose, and has been so greatly altered that it is now made up largely of a fine, scaly, white mica or sericite. Surprisingly, it contains very little metallic sulphides.

Some of the bedrock surface at the Port Arthur copper mine has been smoothed by the action of the Pleistocene glacier which once advanced across the region. In places, the surface was also scratched by rock particles carried by the ice, and north of the open-cut a well developed system of parallel grooves or striae may be seen. These glacial striae trend west-southwest, and reflect the direction of the ice movement at this locality.

MUDGE CAMP

Mudge Camp is located on the north shore of Grassy Lake about 8 miles west-southwest of Mine Centre. It can be reached only by boat, either by way of Bad Vermilion and Obashinsing lakes or by way of Shoal Lake and the Seine River. Its principal attraction, scenically and geologically, is its situation at the mouth of the river draining Obashinsing Lake. Here a small but pretty waterfall has been formed where the river drops over a 5-foot-high rock wall. (Photo 32).

The bedrock here is metamorphosed basic lava or greenstone, interrupted by several small, irregularly shaped bodies of a pale-coloured porphyritic igneous rock. The greenstone and the porphyry are characterized by a distinct foliation or schistosity, which stands vertically and trends N55° to 80°E. Significantly, the schistosity is better developed in an outcrop at the lakeshore than in the exposure in the river bed. The waterfall marks the abrupt transition from fairly hard bedrock upstream to softer and more fissile bedrock downstream.

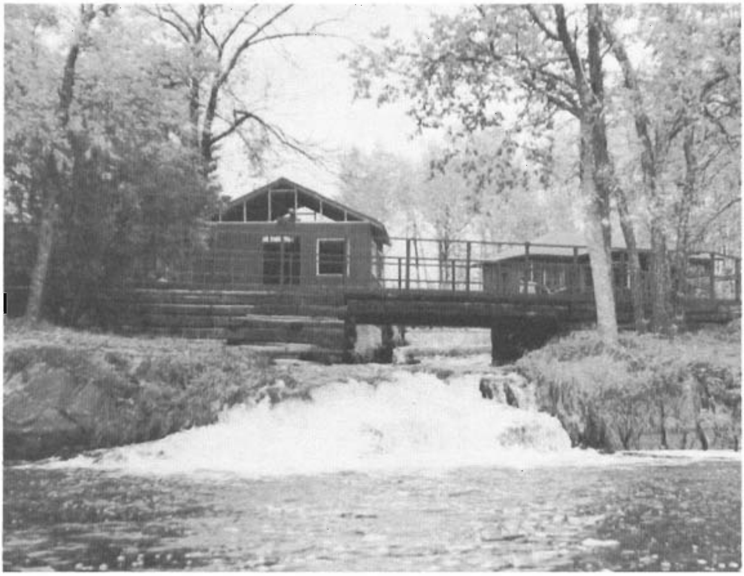


Photo 32 *Low waterfall at Mudge Camp, where the river draining Obashinsing Lake empties into Grassy Lake. The rocks here are greenstone and porphyry.*

Photo 33 *Little Falls on the Atikokan River, at the railway bridge 2 miles east of Atikokan station.*

Atikokan and Vicinity

KEMUEL FALLS

Highway 11 crosses Kemuel River 1 mile west of the Atikokan turn-off. The Kemuel River flows north; for the most part, it is wide but shallow and sluggish. Just south of the highway, however, it flows in a narrow channel through an outcrop of ancient sedimentary rocks of the Couchiching Group. The channel is defined on one side by a nearly vertical cliff, up to 15 feet high, and on the other side by an outcrop surface sloping gently inward toward the cliff.

The bedrock has a well-defined layered structure or stratification that stands vertically and trends easterly. It is also interrupted by several fractures or joints, which dip at angles of 20° to 30° to the northeast. The layered structure and the joints have influenced the shape of the profile of the river bed in the narrow channel. The river drops about 10 feet in a horizontal distance of 50 feet forming a pretty, step-like cascade (Photo 30).

LITTLE FALLS, ATIKOKAN RIVER

A picturesque waterfall, with a near-vertical drop of about 25 feet, is found where the Canadian National railway line crosses the Atikokan River about 2 miles east of the station (Photo 33). It provides a source of electrical power for Atikokan, and a small generating station has been constructed at the site. Both the falls and the station can be reached conveniently by a short (0.6 miles) motor road, which branches from Highway 622, about ¼ mile north of its intersection with Highway 11 (Atikokan turn-off).

The rocks exposed at Little Falls are basic volcanics. These have been altered to greenstones, and are distinctly foliated or schistose. Once horizontal or nearly horizontal in attitude, they were folded during the Algoman revolution (see p. 14) and now stand on edge. They trend east-northeast, nearly perpendicular to the river's course at the falls, and stand up to form the north-facing escarpment over which the river tumbles. This escarpment almost certainly marks the boundary between the greenstones and more easily eroded rocks downstream. The bedrock below the falls is not exposed, and it is not known whether the difference is compositional, in the occurrence of two different rock types, or structural, in the presence downstream (north of the escarpment) of more fissile or more highly fractured material.

Photo 34 *Low waterfall upstream from Little Falls on the Atikokan River, at the railway bridge east of Atikokan.*

A second waterfall, with a drop of about 6 feet, is found a short distance upstream from the main falls (Photo 34). As before, the rocks are altered and schistose volcanics. But here the escarpment is at a large angle to that of the main falls. The reason for this lies in the fact that the greenstones are intersected by a system of closely-spaced parallel fractures, extending northward across the original schistosity, thus greatly facilitating erosion of the river-bed.

STEEP ROCK IRON MINES

The presence of iron-bearing rocks in the Atikokan region was first recognized by H. L. Smyth[1], who described the formations about Steeprock Lake. In 1897, William McInnes of the Geological Survey of Canada observed that boulders of iron ore occur along the southwest but not along the northeast shores of the lake. Since the Pleistocene glaciers had advanced southwesterly across the region, he deduced that the source of the boulders (float) should be under the lake. This view was supported in 1903 by W. G. Miller of the Ontario Bureau of Mines, and again in 1925 by T. L. Tanton of the Geological Survey of Canada. On the strength of this reasoning, several attempts were made to find iron ore under the lake. But these were mostly unsuccessful and it was not until some forty years had passed that rich ore was finally discovered.

1. American Journal of Science (Volume 42, 3rd Series) 1891.

In the autumn and winter of 1930-1931, Julian Cross of Port Arthur, in response to an interest aroused through years of prospecting in the district, undertook a dip-needle survey of the lake from the ice. A dip needle is simply a compass needle suspended on a horizontal rather than a vertical axis, to indicate the presence below the surface of magnetic minerals. Cross's dip-needle survey indicated that a large body of highly magnetic material occurred beneath a part of the lake. Eventually, he interested two friends, Joseph Errington and Donald M. Hogarth, in the possibilities disclosed by his survey. As a result, the Steerola Exploration Company, Limited was organized in 1938 to undertake exploration by diamond-drilling. The first few diamond-drillholes proved disappointing. They intersected only metamorphosed volcanic rocks which proved to be the source of the magnetic attraction. Subsequent holes, however, cut high grade, non-magnetic iron ore, and in a short time rich orebodies had been located and outlined under the Middle Arm of the lake and under Falls Bay, on the property now being worked by Caland Ore Company Limited.

With the discovery of the rich orebodies came the problem of actual mining operations. It was at once apparent that to mine the ore economically, it would first be necessary to drain the lake and remove the millions of cubic yards of silt on the lake bottom. With financial assistance provided by the United States Government, at this time faced with a wartime shortage of high grade iron ore essential to armament manufacture, the huge project was commenced in 1942. The waters of the Seine River, which entered Steeprock Lake along the east shore of Falls Bay, were first diverted to flow around Steeprock Lake by way of Finlayson, Barr, Reed, and Modred lakes. Then, in December 1943, dewatering of the Middle Arm of the lake began. Ultimately, about 70,000 million gallons of water and over 100 million cubic yards of silt were removed, and in August 1944, after two years' work, rich ore was sighted for the first time at the south end of the lake. Full-scale mining operations commenced in May of the following year, and from that date production has been continuous. To the end of 1965, a total of 33,239,027 tons of ore, having a gross value of $266,342,391, have been shipped.[1]

The ore at the Steep Rock mine forms part of the Steep Rock Group of sedimentary and volcanic rocks (see pp. 9-10). These rocks lie along the west side, and rest directly on the eroded and

1. Figures supplied by the Statistician, Ont. Dept. Mines.

weathered surface of a large mass of granitic rocks forming the high land separating the Middle Arm from Falls Bay. The oldest member of the group occurs only as small scattered lenses, and is a lithified gravel, or conglomerate, containing pebbles and boulders of the granitic rocks. It is overlain, in turn, by ferruginous (iron-bearing) limestone and dolomite, by "Paint Rock", by the ore itself, and by a thick deposit of volcanic tuff called "Ash Rock" (see Fig. 8). Each of these formations has its own special characteristics and is quite distinctive. The limestone is a bluish grey or grey rock with a well-defined layered structure accentuated in places by thin parallel films or stringers of quartz (Photo 36). The "Paint Rock" is a soft, earthy, crudely banded material made up largely of iron oxides, quartz and chert, clays, and subordinate manganese-bearing minerals. It is believed to be an ancient residual soil formed by the deep weathering of the underlying limestone. It lies adjacent to the ore bodies, forming their footwall.

On the opposite side of the orebodies, making up the hanging wall, is a thick deposit of volcanic ash or tuff. This "Ash Rock" has been altered and is a foliated or schistose material with a fragmental texture due to the presence of innumerable tiny,

Photo 35 *Dredging silt from the bottom of Steeprock "Lake". (Courtesy Ont. Dept. Tourism and Information).*

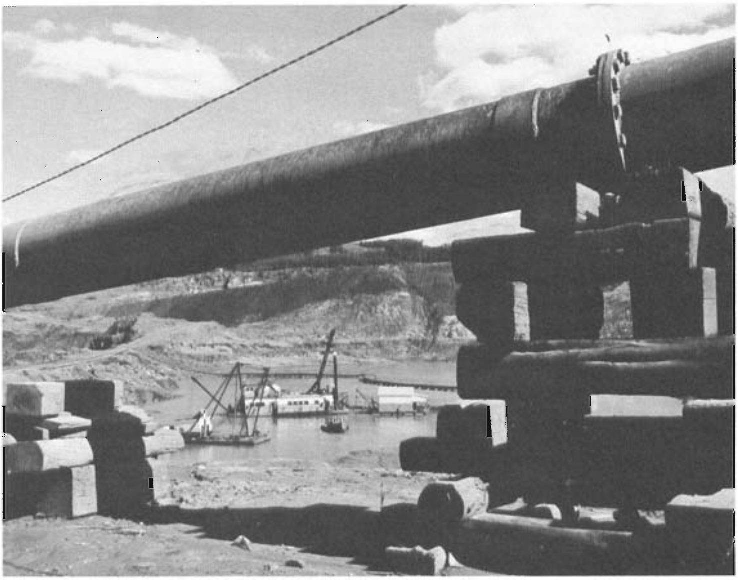



Photo 36 *Boulder of limestone at the entrance to the Errington lookout, Steep Rock Iron Mines Limited, showing typical layered structure.*

closely-packed rock particles, presumably representing the accumulated debris of explosive volcanism.

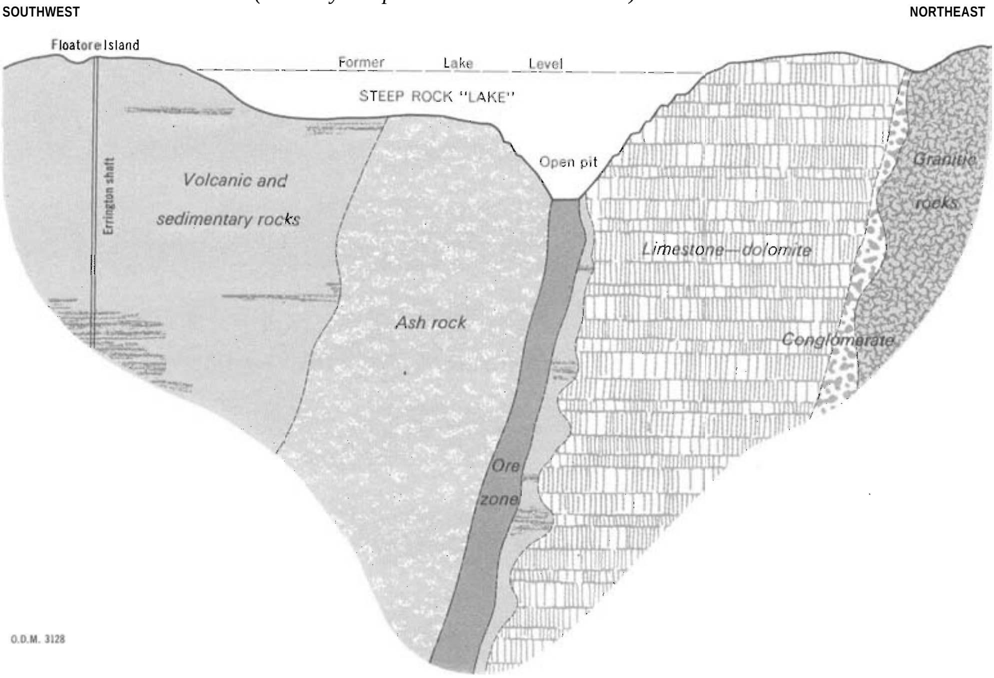
The orebody between the "Paint Rock" and the "Ash Rock" is made up of variable proportions of the minerals goethite and hematite, with a little quartz and clay. The goethite, a hydrous iron oxide containing about 63 percent metal by weight, ranges in character from hard, blue-black lumps to soft, brown material. The hematite, a more simple oxide containing about 70 percent iron, is similarly varied and includes both dense and earthy varieties. The two minerals are easily distinguished. Goethite has a brown streak or powder and hematite has a characteristic red streak. In most places, the goethite predominates, commonly occurring as angular fragments in a matrix of either goethite or hematite or both.

The orebody, because of the presence of quartz and clays, contains less metal than either of the two ore minerals, averaging about 58 percent metal by weight. It is a tabular mass with a mean thickness of about 200 feet, dipping or sloping steeply to the west or southwest (Fig. 6) and trending in a general northerly direction for over 2 miles.

This immense orebody, extending the length of the Middle Arm of the "lake", has been divided, for convenience in mining, into four working areas: (1) the Hogarth mine, at the north end of the Middle Arm; (2) the "G" zone, south of and adjoining the Hogarth mine; (3) the Errington mine, at the south end of the Middle Arm; and (4) the Roberts mine, between the "G" zone and the Errington mine (Fig. 8). In 1963, ore was being removed by open-pit methods from the Hogarth and Roberts mines. At the Errington mine, the economic limit of surface mining was reached several years ago, and the open pit has been abandoned. Here, current production is from underground workings serviced by a vertical shaft sunk from the crest of Floatore "Island."

Because of the interest shown by tourists in its operations, Steep Rock Iron Mines has established three lookouts for viewing the work areas. One lookout lies to the south of the Errington mine, just outside the mine gate; another along the west "shore" of the Middle Arm, above the Roberts mine; and a third at the north end of the Middle Arm overlooking the Hogarth mine. Conducted tours through the property also have been organized. These free tours are normally held twice daily throughout the week, except Sunday and Monday.

Figure 6 *Vertical section through the Errington mine workings, Steep Rock Iron Mines Limited. (Courtesy Steep Rock Iron Mines Limited).*



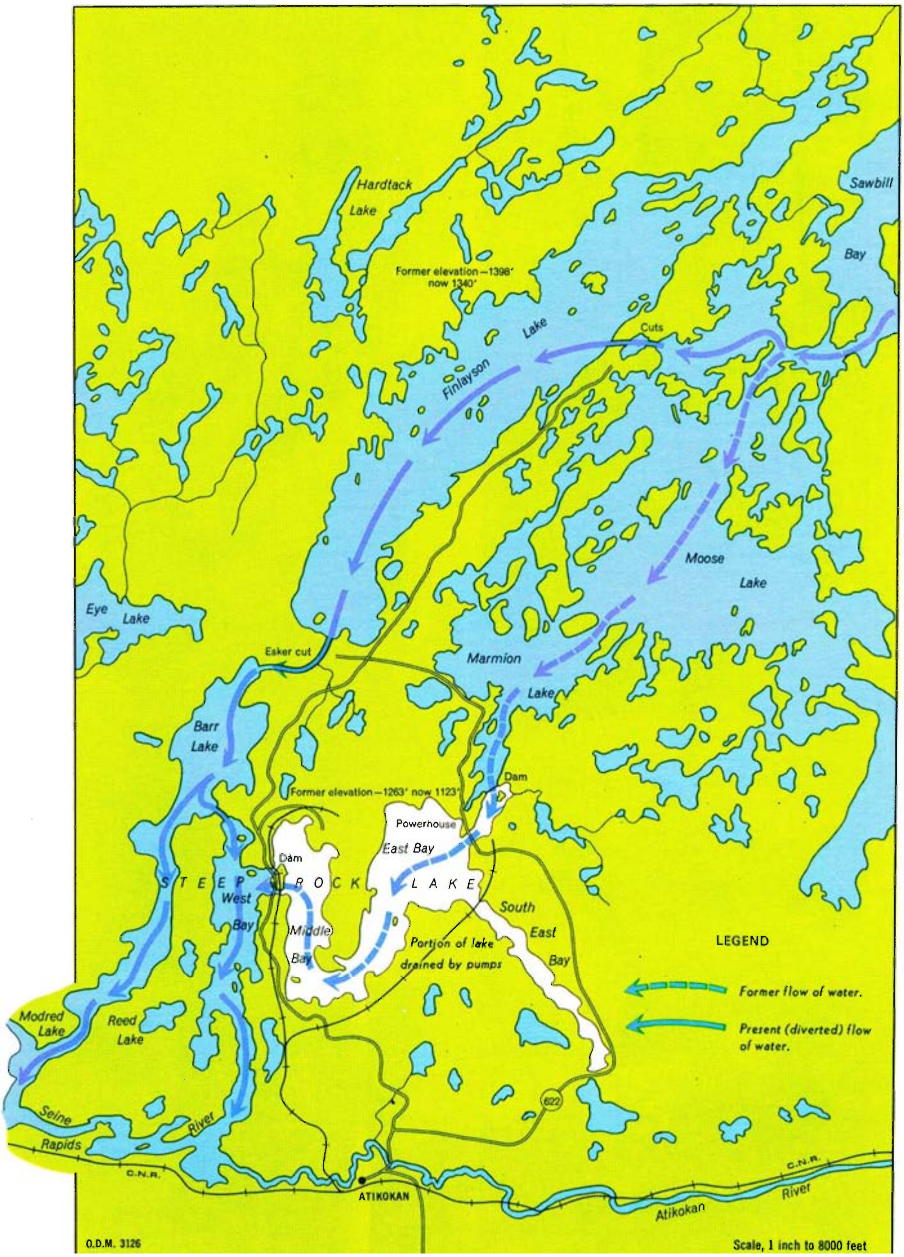
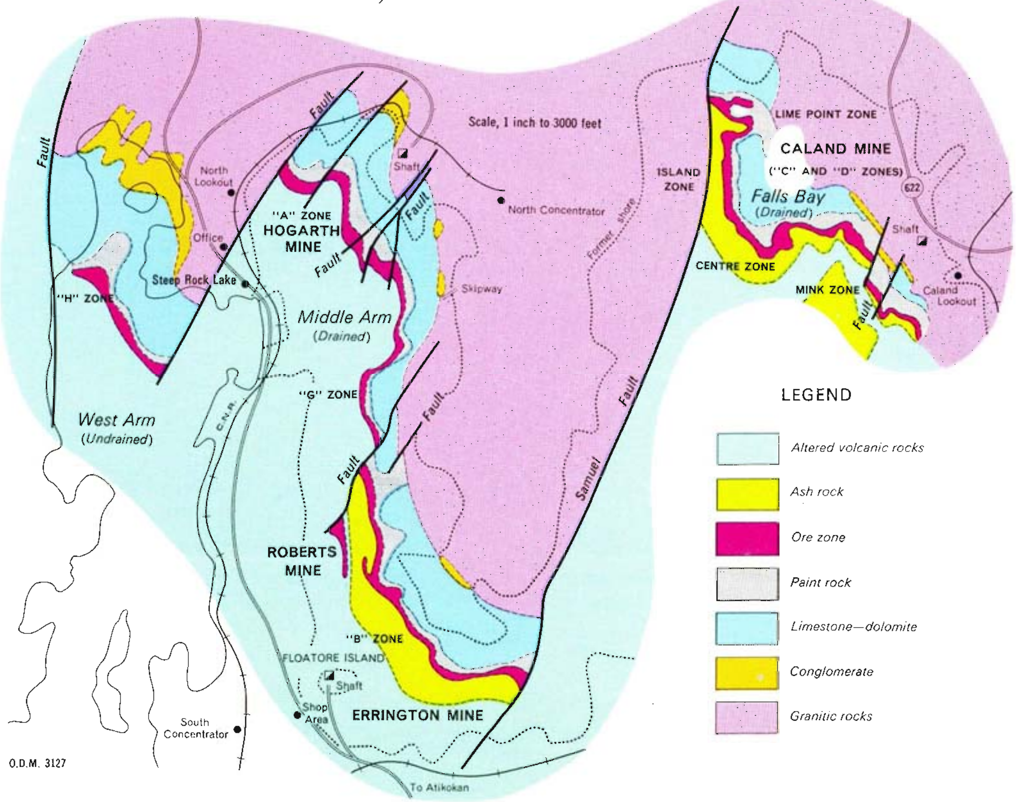


Figure 7 *Topographic map showing the change in the direction of water flow owing to the Seine River diversion around Steeprock Lake. (Courtesy Steep Rock Iron Mines Limited).*

Photo 37 *View of open-pit mining operations, Steep Rock Iron Mines Limited. (Courtesy Steep Rock Iron Mines Limited).*

Figure 8 *Simplified geological plan of the Steeprock "Lake" area. (Courtesy Steep Rock Iron Mines Limited).*



CALAND IRON MINES[1]

History and Development

Caland Ore Company Limited was formed in 1949 as a wholly-owned subsidiary of Inland Steel Company of Chicago. In that year, Caland obtained an option from Steep Rock Iron Mines, Limited to explore the orebody found under Falls Bay. On January 1, 1953, a 99-year lease was arranged to permit Caland to proceed with development and mining. The property leased was intended to provide high grade iron ore for the Inland Steel Company furnaces at Indiana Harbor, Ind. The lease called for Caland to produce 750,000 tons of ore in 1960, with a gradual increase to 3 million tons a year by 1969.

During the seven year period following the signing of the lease, and prior to the first ore shipments in 1960, a tremendous amount of development work had to be completed to maintain the

1. This section prepared by the staff, Caland Ore Company Limited.

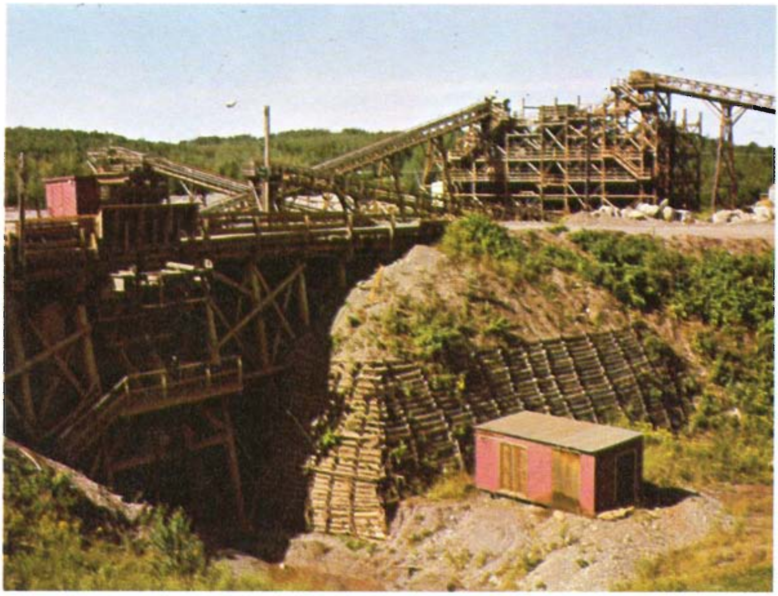


Photo 38 *Screening and concentration plant of Canadian Charkson Limited near Atikokan, prior to cessation of operations in 1965.*

Photo 39 *View from Highway 622 (Courtesy Ont. Dept. Tourism and Information).*

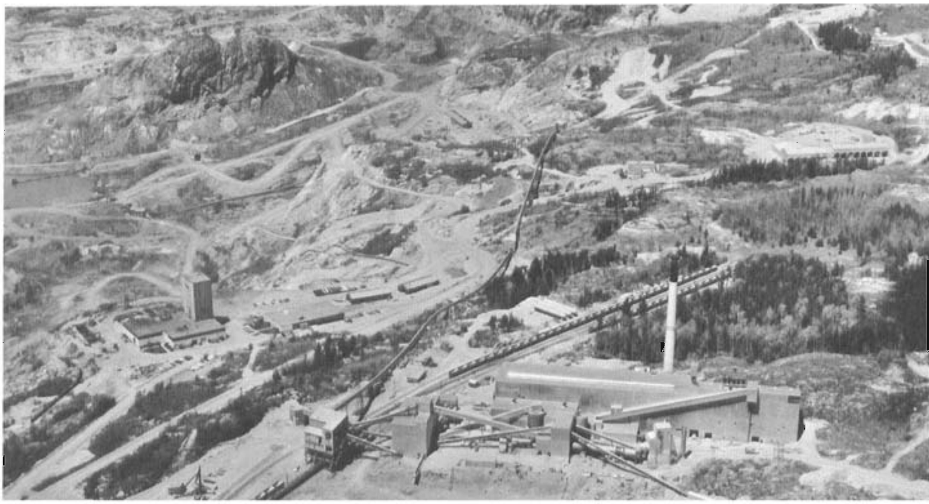


Photo 40 *View of Falls "Bay", Steeprock "Lake", showing the open-pit mining operations of Caland Ore Company Limited. (Photo by Lockwood Survey Corporation Ltd., courtesy Caland Ore Co. Ltd.).*

schedule. The orebody was overlain by silt to an average depth of 300 feet plus 100 feet of water. A dredging contract was let to Construction Aggregates Corporation (C.A.C.) of Chicago in 1953 for the removal of an estimated 160 million cubic yards of lake bottom material. Twenty-three dams were constructed around the perimeter of the original lake and a complex pumping system was installed to divert run-off water from the drainage area about the mine site. At the same time, two 36-inch suction dredges were assembled, along with pipelines, booster stations, and other shore facilities. Pumping began in March 1955 and was completed on 30 September 1960, by which time 162 million cubic yards of lake bottom material had been removed. Most of this material was pumped a distance of 4 miles to Marmion Lake.

As dredging lowered the water in Falls Bay, construction of ore handling facilities went ahead. A conveyor system was constructed running from the Lime Point mine, at the north end of the ore-body, to the railroad loading plant. This system consists of a 36-inch belt conveyor in four flights, totalling 5,000 feet in length, with a lift of 680 feet. A vertical shaft was sunk, to a depth of 1,330 feet, to permit development of the Mink Point mine at the south end of the orebody. The sinking was completed in 1958, and over 6,000 feet of underground openings have been driven from it, but underground mining operations have been deferred. The shaft is currently being used to assist in the handling of ore recovered from the Mink Point mine by surface or open pit mining methods.

Open pit mining was started in 1959 in the Lime Point area at the north end of the orebody. This part of the orebody was the first to be mined simply because it was the highest in elevation and consequently the first to be exposed by the dredging. From May 1960, when the first ore train left for the Lakehead, to the end of 1965, a total of 10,733,739 tons of ore were shipped, valued at $102,964,317.[1]

In late 1963, Caland Ore Company Limited announced plans to build an ore processing and pelletizing plant. This plant, completed in 1966, is designed to handle 2½ million tons of ore per year. The ore is divided into a coarse fraction, consisting of particles bigger than 3/16 inch, and a fine fraction, consisting of the smaller particles. The coarse material is shipped directly to the steel mill. The fine material, on the other hand, is subjected to a variety of processes, including drying, grinding, screening, and balling, before being pelletized. It emerges from the plant in the form of ½ inch pellets, at a rate of about one million tons per year. The ore processing and pelletizing plant, built at a cost in excess of $15 million, is an outgrowth of the steel mill's demand for ores with improved physical characteristics.

Geology

At the south end of the Middle Arm of Steeprock "Lake", and at the limit of the Errington mine, the orebody of Steep Rock Iron Mines, Limited, is truncated abruptly by a zone of sheared and broken rock. This zone reflects the occurrence of a major northeast-trending fault, called the Samuel fault, along which the rock formations have been displaced for about 2 miles. The relative horizontal movement along the Samuel fault was east-side-north, such that the dislocated extension of the orebody is found at Falls Bay, on the property now being worked by Caland Ore Company Limited.

The Caland orebody is the faulted extension of the Steep Rock orebody and occurs in much the same way. Except that it is sinuous in plan, forming a broad Z-shaped structure, this orebody is a steep, crudely tabular mass that makes up a distinct unit or formation of the Steep Rock Group of sedimentary rocks (see

1. Figures supplied by the Statistician, Ont. Dept. Mines.

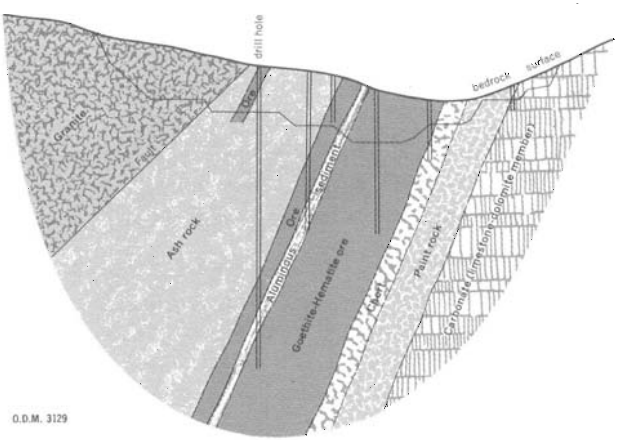


Figure 9 *Vertical section through the Island Zone, Caland Ore Company Limited. (Courtesy Caland Ore Co. Limited).*

Fig. 9). It is also similar to the Steep Rock orebody in composition and physical characteristics. It does not consist of a single iron-bearing mineral, but rather it is a mixture possessing a distinct rubbly texture due to the inclusion of fragments of goethite in a fine-grained matrix of hematite and limonite.

The average dry composition of the ore approximates 67 percent goethite and 21 percent hematite, with 5 percent each of silica and kaolin (clay) as waste constituents. The goethite varies from a hard, metallic, bluish-black lump to a soft, earthy, brown material. Hematite also is found in places as lump material. Most of it, however, is fine-grained and earthy.

The origin of the Steep Rock and Caland ores has been a matter of controversy among geologists. Several theories to explain the deposits have been proposed. Of these, only two seem to fit enough of the observed facts to warrant serious consideration.

One theory is that the ore is an exceptionally large bog iron deposit made up largely of limonite precipitated by surface waters on top of older sedimentary rocks. This bog-type deposit is visualized as having been buried under volcanic debris ("Ash Rock" and lava flows), and subsequently faulted, folded, and eroded until it attained its present outlines. The principal objection to this idea is that much of the ore has a loose, earthy texture despite the heavy compactive forces to which it must have been subjected during the faulting and folding.

The second theory attributes the ore to exceptionally thorough weathering (oxidation and hydration) of an original sedimentary rock containing large amounts of the iron-bearing carbonate mineral, siderite. This view agrees with the most widely held opinion of the origin of other similar ores found elsewhere in the Lake Superior region. The principal objection to it is that, contrary to what one would anticipate, no remnants of an older, siderite-bearing sediment have been found in the mine workings.

CANADIAN CHARLESON IRON MINE

Before its removal in 1965, one of the most conspicuous man-made structures to be seen in the Atikokan region was the concentrating plant of Canadian Charleson Limited. This plant began operations in 1959 and closed down six years later (Photo 38). The remains of the structure are located on the paved road leading to the Steep Rock mines, roughly midway between the latter and Atikokan. Here, the company, a subsidiary of Oglebay Norton Company of Cleveland, obtained valuable iron ore by mining and treating surface gravel containing small pebbles and particles of the minerals goethite and hematite. This type of operation, while well-known on the Mesabi iron range in Minnesota, was at the time unique in Canadian mining.

The iron-bearing gravel has been found only south of Steeprock "Lake", and it can be inferred that the goethite and hematite in it were derived from the Steep Rock ores by the action of the Pleistocene glaciers and their melt waters. The gravel, which contains 5 percent to 25 percent metal, underlies an area of over 1,000 acres. It averages about 70 feet thick, and makes up a deposit having a volume estimated to be in excess of 50 million cubic yards.[1] Except for trees and other vegetation, the gravels are exposed at the surface. The gravel was removed by self-loading, self-dumping, diesel-powered scrapers, each having a load capacity of 24 cubic yards. The crude gravel was first dumped into a hopper which fed the material to a screening plant. The screening served to remove coarse, worthless materials. Afterward the gravel was fed by a conveyor system to the concentration plant. At the concentration plant, a high grade product, containing about 58 percent iron, was produced through the use of jigs and spiral washers.

The plant was designed to treat two million tons of gravel annually and to yield about 250,000 tons of concentrate. Oper-

1. The Northern Miner, Aug. 16, 1959, p. 17.

Photo 41 *Margaret Lake Fault breccia along Highway 622 north of Atikokan. The breccia consists of fragments of rusty weathering greenstone cemented by white vein quartz.*

ations were started in July 1958, and continued intermittently until 1965. Total production during this period was 783,940 tons of concentrate, worth $6,430,977, from 4,674,286 tons of gravel.[1]

HIGHWAY 622 (FALLS BAY HIGHWAY)

Highway 622 branches from Highway 11 at the east end of Atikokan and leads to the Caland mine at Falls Bay in Steeprock "Lake". There are three points of geological interest along this highway: (1) the Margaret Lake fault, exposed 3 miles north of the intersection with Highway 11; (2) Steeprock "Lake", 3.1 to 3.4 miles north of the intersection; and (3) the Schwenger Township highlands, north of Steeprock "Lake".

Margaret Lake Fault

The Margaret Lake fault passes under a hydro-electric power line on the west side of the highway opposite a large open swamp. This near-vertical fault cuts and displaces altered volcanic rocks (greenstones) and appears to trend northeast across the area. Movement along the fault has severely fractured the rocks, which now occur as a jumble of angular fragments of all sizes, forming what is called a breccia, in a zone 25 to 35 feet wide.

1. Figures supplied by the Statistician, Ont. Dept. Mines.

Subsequent to its formation, the Margaret Lake fault or breccia zone provided a channelway for the upward migration of mineral-bearing solutions generated at high temperatures in the Earth's interior. These solutions introduced iron sulphide or pyrite into the dark green volcanic rocks making up the breccia fragments, and at the same time precipitated the mineral quartz between the fragments and along their fractures. The pyrite is peppered or disseminated throughout the broken rocks and the quartz cements the once-loose fragments into a coherent mass (Photo 41). The pyrite, an iron-bearing mineral, has weathered where exposed to the air to form the rusty mineral limonite; thus, at the surface, the breccia fragments have a uniform brown colour that stands out in marked contrast against the white vein quartz.

Steeprock "Lake"

As outlined previously, it was necessary to drain Steeprock Lake to permit removal of the rich iron ores under the lake bottom. In the Southeast Arm of the "lake", where mining operations have not been undertaken, original lake-bottom clays and silts still remain. These clays and silts are rich in plant nutrients and, where the highway passes the end of the old lake, they are seen to support a young but luxuriant forest growth. An excellent view of the old lake bottom and the new forest can be obtained from the top of the Hardy earth dam which, on the opposite side of the highway at this point, holds back the waters of the Rawn Reservoir.

Schwenger Township Highlands

The principal rock making up the Schwenger Township highlands is a granite. It was formed at high temperature in a large mass or batholith at a considerable depth below the surface, and has been exposed through the erosion and removal of once extensive cover rocks. Most of the granite in the Rainy Lake — Lake Superior region is of Algoman age, and was formed later than the sedimentary formations referred to as Seine or Windigokan, which it intrudes. The granite along Highway 622, however, is overlain by the ancient sedimentary rocks found at the Steep Rock and Caland mines. If, as is generally assumed, these sedimentary rocks are a part of the Seine or Windigokan Group, the granite along the highway must be older than that formed during the Algoman period and must be of Laurentian age (as outlined on page 9).

Photo 42 *Dike of diabase cutting granitic rocks, along Highway 622 near the Caland iron mines.*

The Laurentian granite of the highlands is interrupted by a number of black basic dikes. One of these dikes is found 0.8 miles south of the Caland mine entrance, 200 feet north of a small parking area along the west side of the highway. It is a tabular body, 20 feet wide, which strikes northeast and stands almost vertically. It is made up of the igneous rock known as diabase, crystallized from a magma injected into a fracture in the granite long after the latter had formed. Because of its colour, it is easily recognized (Photo 42). The novice must take care, however, not to confuse the diabase with bodies of altered volcanic rocks (greenstones) that occur as irregular fragments within the granite rather than as dikes cutting it.

UPPER SEINE GOLD MINES[1]

Harold Lake Mine

Long before the Atikokan region became famous for its iron mines, it was known for its gold deposits, and it has attracted prospectors since about 1890. The most significant discovery before the turn of the century was the Harold Lake mine in Baker Township, about 6 miles west-northwest of Atikokan. This mine was in operation in 1895 and 1896, producing 1,131

1. Production figures obtained from the records of the Statistician, Ont. Dept. Mines.

tons of ore which yielded gold worth $11,236. The ore came from several quartz veins associated with small inclusions of altered volcanic rocks (greenstones) in granite. In places, these veins are well mineralized with such sulphides as pyrite, chalcopyrite, galena, and sphalerite. But they are of limited size, and the gold generally is present only in small amounts irregularly distributed. The veins were carefully sampled in 1937 by the E. J. Longyear Company of Minneapolis, but were found to contain nothing of economic significance.

Elizabeth Mine

In 1900, gold was also discovered in quartz veins ½ mile northeast of Modred Lake in Freeborn Township, about 4 miles northwest of Atikokan. The occurrence was first acquired by the Anglo-Canadian Gold Estates, Limited, and in 1902 this company, through diamond-drilling and underground development work, found an estimated 20,000 tons of ore worth about $10 per ton. No production is recorded, however, and the mine remained idle until 1912, when additional development work was done and 50 tons of ore worth $400 were removed. In 1936 the Elizabeth Gold Mining Company, Limited revived operations at the property, but again nothing of commercial value was discovered.

Hammond Reef and Sawbill Mines

Two other mines, the Hammond Reef and Sawbill, attracted much attention about the turn of the century. Both lie near the northeast end of Sawbill Lake, an expansion of the Seine River about 18 miles northeast of Atikokan. A 10-stamp mill was installed at the Hammond Reef mine in 1897. In that year, 977 tons of ore were milled, and 222 ounces of gold worth $3,850 were produced. Later, this plant was expanded and a hydroelectric power plant was built. The mill motor burned out on 6 October 1900 during a thunderstorm, and since by this time development work at the property had proved discouraging, all work was suspended.

A somewhat more successful story was recorded at the neighbouring Sawbill mine. Here, a gold-bearing quartz vein in granite was mined intermittently for two years from October 1897, when a 10-stamp mill commenced operation. Work at the mine was suspended in the autumn of 1899. By then, 677 ounces of gold, worth $8,982, had been produced from 2,416 tons of ore, obtained from workings that reached a depth below the surface of 275 feet.

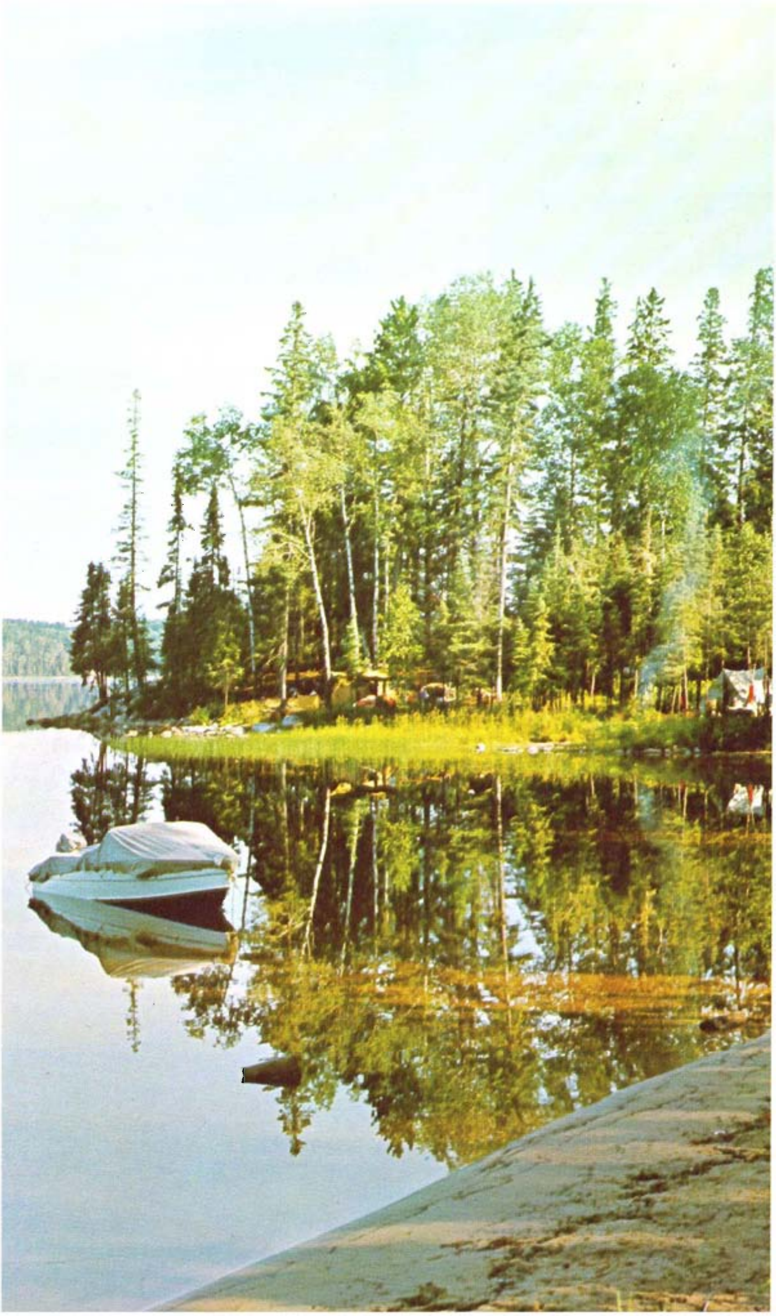
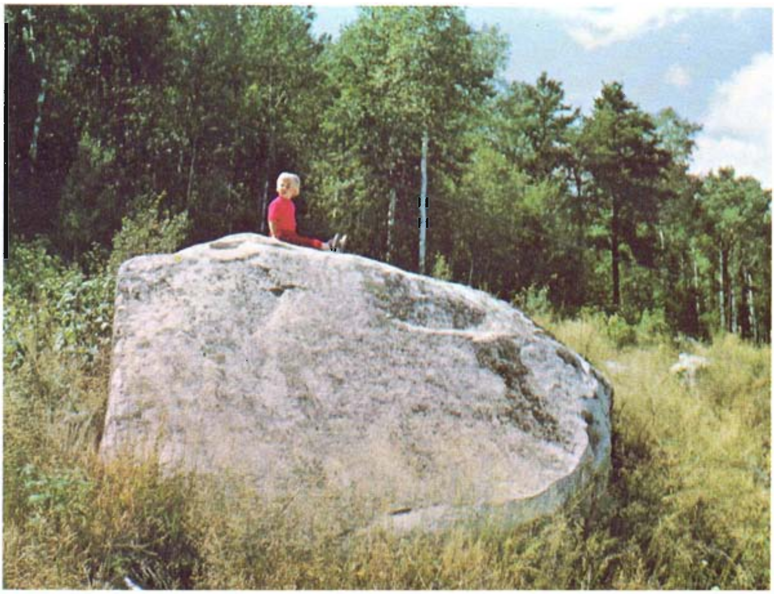


Photo 43 *Quetico Provincial Park. (Courtesy Ont. Dept. Tourism and Information).*

Photo 44 *Atikokan iron mine (abandoned).*

Photo 45 *Large boulder (glacial erratic) of granite, along Highway 11 near Eva Lake.*



The mine remained idle until 1938, when it was reopened by Upper Seine Gold Mines, Limited and some further underground work was carried out. In 1940, a mill with a capacity of 50 tons per day was put into operation. Between 1 October and 24 September of the following year, an additional 332 ounces of gold worth $12,777 were produced.

Atikokan to Shabaqua

SAPAWE GOLD MINE

The Sapawe gold mine is located in McCaul Township. It is accessible by a 5-mile motor road, which branches from Highway 623 at a point 1.5 miles north of the intersection with Highway 11 at Niobe Lake. The gold at the Sapawe mine was recovered from a steeply-dipping quartz vein averaging about 6 feet in thickness. This vein occurs along an east-west fault or sheared zone in a granitic host rock. Its location is shown on Map 38e, published by the Ontario Department of Mines in 1930. It is thought that the deposit was discovered sometime between 1895 and 1910, when the area was first actively prospected. However, the first serious exploration work was not carried out until 1950, when Elmer Corrigan and D. R. Young tested the vein by diamond-drilling. Further diamond-drilling was done in 1960 by Lindsay Explorations, Limited. A small, high grade orebody was indicated. Shaft sinking commenced early in 1961, and during this and the following year underground openings were driven 170 feet along the vein and 320 feet below the surface. The property was acquired by Sapawe Gold Mines, Limited in 1963, and a mill, with a capacity to treat 100 tons of ore per day, was built. Operations were started in December 1965. To the end of 1964, 2,960 ounces of gold and 752 ounces of silver, having a total value of $112,786, were recovered from 18,413 tons of ore milled.[1]

ATIKOKAN IRON MINE

The abandoned Atikokan iron mine near Sapawe is an interesting property which caused much excitement in northwestern Ontario prior to World War I.

The presence of iron ore at this locality was known as early as 1882, but little work was done at the property until 1905, when it was taken over by the Atikokan Iron Company Limited of Port Arthur. A blast furnace was built at Port Arthur, and

1. Figures supplied by the Statistician, Ont. Dept. Mines.

mining operations commenced in 1907. The mine was again operated in 1909, 1910, and 1911. During this period, 90,680 tons of ore, averaging 60 percent iron, were shipped to the Lakehead. Most of the ore contained considerable sulphur in the form of the minerals pyrite and pyrrhotite, and roasting was found necessary to prepare it for the blast furnace. The operation proved uneconomical and, in 1913, work at the mine was terminated.

The ore at the Atikokan iron mine consists largely of the magnetic iron oxide mineral magnetite. It occurs in several thin tabular and lenticular bodies exposed along the crest of a narrow but prominent ridge of sheared and altered rocks. These orebodies are vertical in attitude and, like the ridge, trend east-west. To test them, five tunnels have been driven into the ridge and three exploratory shafts sunk. Most of the production has come from a large open cut near the No. 2 shaft and the central or C tunnel, about midway along the ridge.

The Atikokan iron mine lies along the north bank of the Atikokan River. It is 3.2 miles by motor road east of the village of Sapawe, on the timber concession of J. A. Mathieu Limited.[1]

EVA LAKE

When the continental ice sheets advanced southwesterly across the region in the Pleistocene epoch, they plucked out large blocks from the bedrock and transported them to distant points. In transit, the boulders were held firmly in the glacial ice, first in one position, then in another. They were abraded by the bedrock over which they travelled, and their lower surfaces, in each position, were worn flat. In this way they became distinctly faceted, and, in most cases, crudely equidimensional. Innumerable glacial boulders of this type, made up chiefly of granitic rocks, are found along Highway 11 at Eva Lake, and between Eva Lake and the intersection with the road (Highway 633) leading to Kawene on the Canadian National railway line. A typical example, displaying well-developed facets, is shown in Photo 45.

WINDIGOOSTIGWAN AND HURONIAN LAKES

Surrounded by low rounded hills, Lake Windigoostigwan is one of the prettiest lakes along Highway 11 between Mine Centre and the Lakehead (Photo 46). It straddles the north

1. The motor road was built, and is maintained, by the company. Company permission to use it is required.

Photo 46 *Lake Windigoostigwan along Highway 11 east of Atikokan. The outcrops are made up of migmatite, a variety of granitic rock. (Courtesy Ont. Dept. Tourism and Information).*

boundary of Quetico Provincial Park about midway between Atikokan and the village of Kashabowie, and lies deep within the exposed portion of a large batholith of once deep-seated granitic rocks, that outcrops along the highway for 27 miles west and for 16 miles east.

The rocks making up the batholith are of Algoman age (see page 11). Some of them are pale pink or grey massive materials consisting of quartz and feldspar with a little mica, and are true granites. Excellent examples are found at the Hillcrest Resort and at Huronian Lake (Photo 47), 27 miles and 47 miles respectively east of the Atikokan turn-off. Most of the batholithic rocks are composed of much altered remnants of older sedimentary rocks (mica schist) mixed with variable amounts of granite or its coarse-grained equivalent, pegmatite. They are migmatites — crudely banded rocks with a lit par lit structure, in which layers and streaks of the dark grey sedimentary rocks alternate with layers of granite or pegmatite (Photo 51). Numerous fine examples can be seen along the highway. They can be studied safely and conveniently at three places: along the road to the Quetico Conference and Training Centre at Kawene; at Lake Windigoostigwan; and at a federal-provincial roadside park ½ mile east of Huronian Lake.

The granite and pegmatite of the batholith are igneous rocks crystallized from liquid magma that migrated toward the Earth's surface from a deep-seated source. In its upward migration, this magma was introduced into the older rocks along closely spaced planes parallel to the original bedding (and the foliation or schistosity), producing the extensive migmatites now seen in the region. The introduction of the liquid magma occurred at high temperatures, and in some places the older rocks were deformed by the moving magma into complex crenulations and dragfolds. A migmatite showing the results of such plastic distortion is exposed at Pilcher's Service Station, 1.7 miles east of Huronian Lake (Photo 52).

TIP TOP COPPER MINE

The Tip Top copper mine supports a village of about 80 families at Burchell Lake, approximately 8 miles southwest of Kashabowie. The mine is accessible by Highway 802, which branches from Highway 11 at a point 2.2 miles west of the Kashabowie River.

Photo 47 *Low rounded outcrops of massive granite, west shore of Huronian Lake.*

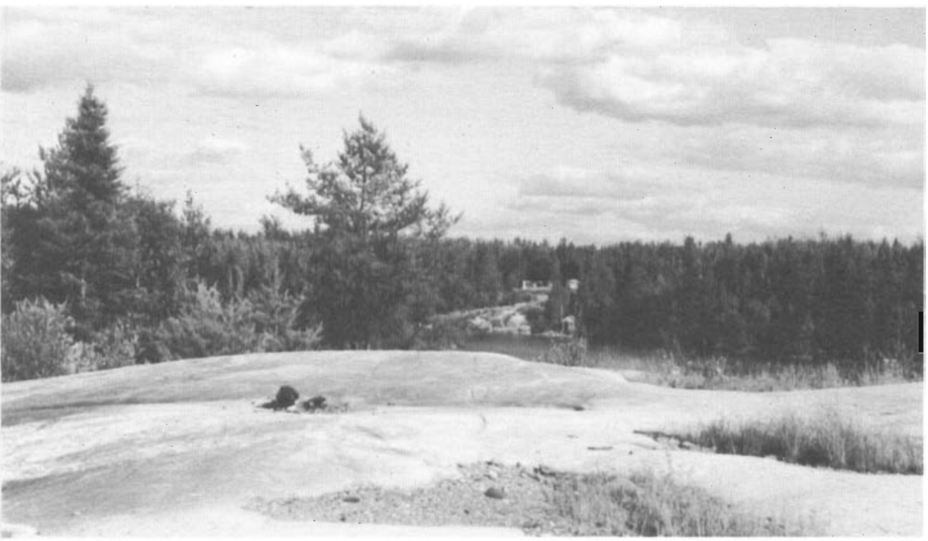


Photo 48 *Headframe at the Tip Top copper mine of North Coldstream Mines Limited, Burchell Lake.*

The ore at the Tip Top mine is found in a body of blue-grey, fine-grained quartz or chert interrupting a thick succession of altered volcanic rocks or greenstones. Although very irregular in detail, this chert body is, in a general way, lenticular or lens-like in shape, with a length up to about 1,000 feet and a maximum width of about 400 feet. It trends east and dips or slopes steeply north to vertically. The iron sulphide mineral pyrite and the copper-bearing mineral chalcopyrite are usually present in the chert. Both the pyrite and the chalcopyrite are either peppered or disseminated throughout the chert, or fill tiny irregular fractures in it. Generally, the minerals occur in such small amounts as to be of little or no value. In some places, however, they become abundant and form rich copper orebodies. These orebodies vary greatly in size and appear to occur at random within the chert. Like the enclosing chert, they strike east and dip to the north at 80° to 90°.

The Tip Top mine has had a long history. It was discovered in the 1870s, and was first worked by the New York and Canadian

Copper Company Limited in 1902-3, when 768,000 pounds of copper, worth $30,720, were produced. An additional 72,000 pounds of copper, worth $7,200, were produced in the period 1906-7, and 472,979 pounds, worth $94,508, in the years 1916 and 1917.[1]

The mine then lay idle, except for exploratory work by various mining companies, for over 35 years. Finally, in 1951, it was acquired by Coldstream Copper Mines Limited. The old workings were pumped out, a new shaft was sunk, and considerable underground development work was done. The presence of a large tonnage of copper ore was indicated. The mine was soon made ready for production and a mill to treat the ore was constructed. The mill was put into operation on 22 June 1957. It was operated only a short time, however, as the lack of funds caused a shutdown in February 1958. With an improvement in the price of copper, the company was reorganized as North Coldstream Mines Limited and production was resumed in 1960. From the start of milling in 1957, to the end of 1965, the mine yielded copper, gold and silver having a gross value of $28,087,539.[2]

KASHABOWIE FALLS

Where the Kashabowie River enters Upper Shebandowan Lake, it drops over a low ledge forming an attractive waterfall. The tourist may reach this pleasant spot quite easily over a well-used gravel road, branching south from Highway 11 on the west side of the bridge over the river, 1 mile west of the Kashabowie turn-off (Highway 802).

The rocks here are metamorphosed basic lavas or greenstones trending east-northeast across the river bed and dipping or sloping vertically to steeply south. The rocks above the falls appear to be identical to those below, and the cause of the low escarpment, over which the river flows, is not readily apparent. The face of the escarpment, however, reflects the attitude of the greenstones. It may be that the river, in cutting its channel, has been able to remove blocks of rock from its bed on the downstream sides of the boundaries between adjacent lava flows. An alternative explanation may be that the Pleistocene glaciers, which once advanced across the region, plucked out a block of rock on the downstream side of a vertical crack, and that despite headward erosion by the river, the steepness of the escarpment has since been maintained, possibly because of the tendency of the volcanic rocks to break or split parallel to their steeply tilted sides.

1. Figures obtained from Geol. Rept. No. 19, Ont. Dept. Mines, 1964, p. 28.
2. Figure obtained from Statistician, Ont. Dept. Mines.

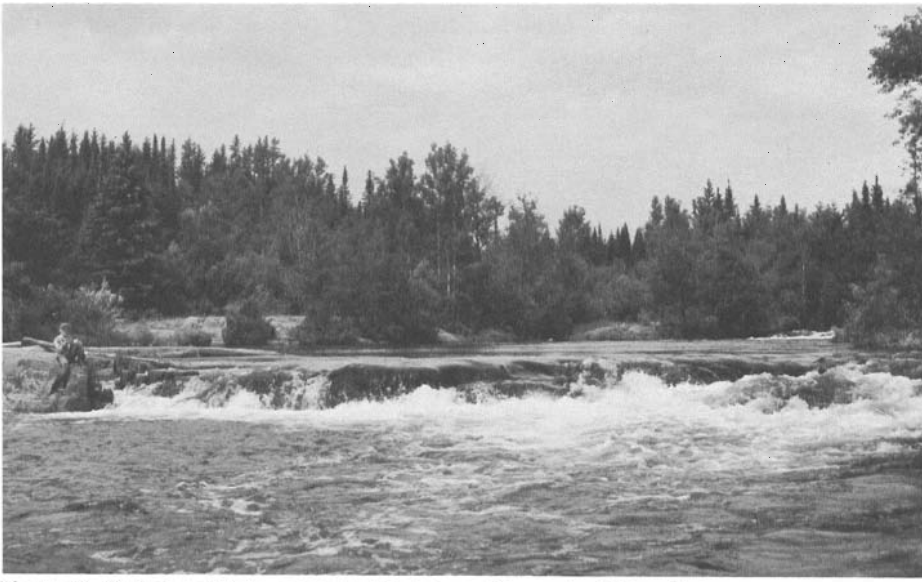


Photo 49 *Kashabowie Falls, where the Kashabowie River enters Upper Shebandowan Lake. The exposed rocks are metamorphosed basic lavas or greenstones. (Courtesy Ont. Dept. Tourism and Information).*

The waterfall has some historic interest, as it lies along the Dawson trail — the route followed by a part of the expedition, led by Col. Garnet Joseph Wolseley, sent to Manitoba in 1870 to quell the Riel rebellion.

SWAMP RIVER

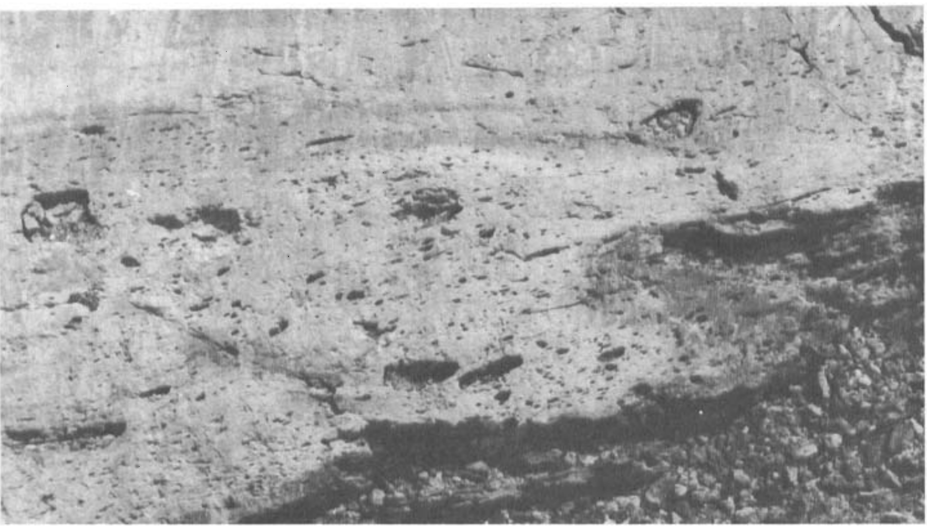
A very interesting outcrop is found along the north side of Highway 11, where the road crosses the Swamp River 18 miles east of Kashabowie (about 1 mile west of the turn-off to Shebandowan Station on the Canadian National railway line).[1] The outcrop is of basic lava which, like others of Archean age found in the region, has been changed to greenstone. The greenstone here is distinctive, in that it exhibits a remarkably well-developed pillow structure (Photo 53). This pillow structure is an original feature of the lava flow. It is thought to have been formed under water. Presumably, as the lava erupted at the surface and flowed into the sea, it was chilled and became viscous, thus forming large globules (pillows), which accumulated one on top of the other.

1. There are no parking facilities at this outcrop, which occurs east of the Swamp River bridge. The tourist may park along a side road at the railway line on the west side of the bridge and walk to the exposure. The distance from the side road to the outcrop is less than 1,000 feet.

The pillows at Swamp River are elongated and, in places, reach 12 feet in length. The direction of elongation originally was horizontal and the lava resembled an accumulation of bun-like bodies. Due to folding, the lava was upended and the pillows now stand with their long dimensions almost vertical. Careful study of the pillows shows that they tend to be convex toward the north, and their south sides, in places, conform to the convex surfaces of adjoining pillows (Photo 54). In the development of the lava, newly formed pillows, because of their plasticity, would naturally adjust themselves to the shapes of older ones. Because of this, it is reasonable to assume that the original upper surface of the once horizontal lava now faces to the north.

In addition to the pillow structure, the greenstone at Swamp River is riddled with tiny, rounded and irregularly-shaped holes (Photo 50). These holes are vacuoles or vesicles caused by the escape of contained gases when the molten lava was poured out at the surface. They are found distributed throughout the pillows, but significantly, they are concentrated along the north sides of the individual pillows. Since the escape of gases from a lava would be upward, this substantiates the conclusion, based on the shapes of the pillows, that the upper surface of the flow now faces north.

Photo 50 *Close-up view of pillow lava at Swamp River near Shebandowan, showing tiny holes or vacuoles resulting from the escape of gases when the lava was poured out on the surface. The vacuoles are up to about 1 inch in length (Photos 53 and 54).*



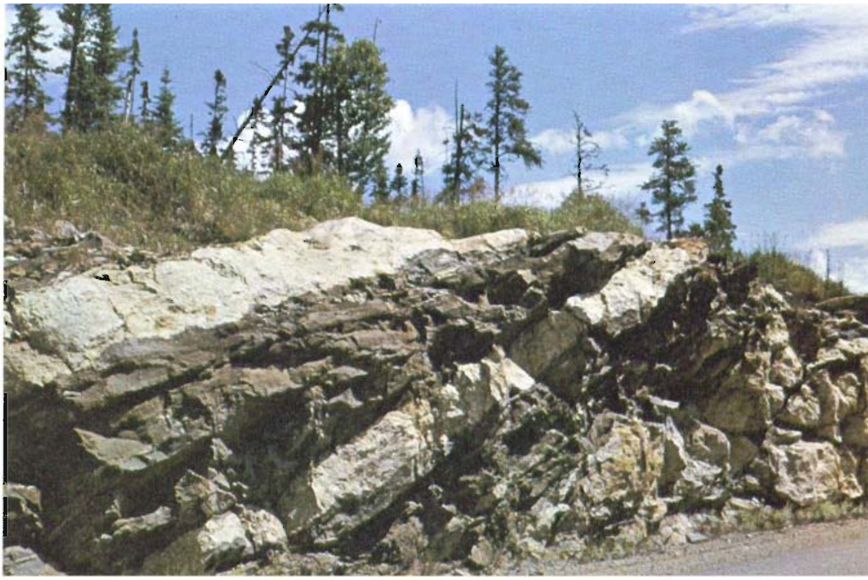


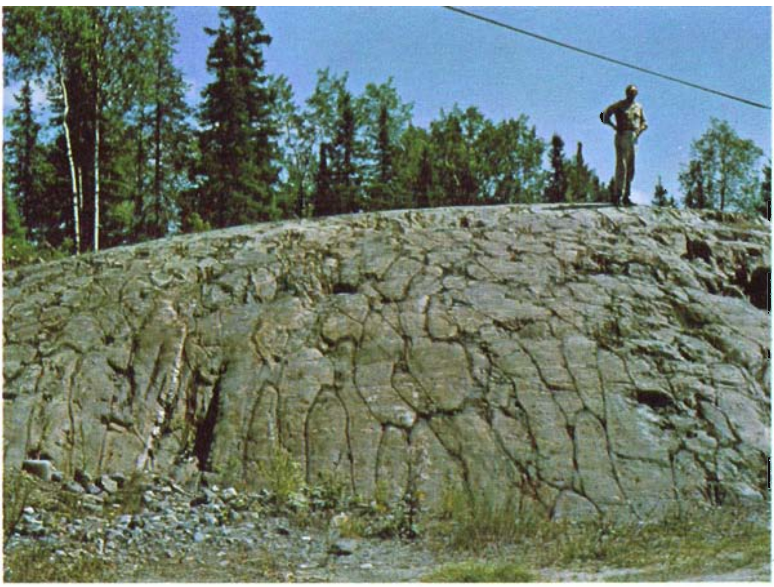
Photo 51 *Outcrop of migmatite, along Highway 11, showing banded appearance due to the alternation of layers of mica schist (dark grey) and granitic rocks (light grey).*

Photo 52 *Migmatite at Pilcher's Service Station near Huronian Lake, showing complex crenulations and drag folds.*

Except for a small body of ancient volcanics (greenstones) exposed for 9 miles along Highway 17 west of Upsala, the region between Shabaqua Corners and English River is underlain almost entirely by granitic rocks. The granitic rocks reflect the occurrence of a huge mass or batholith, which resulted from the crystallization of natural melt or magma deep within the Earth, and came to view only after prolonged erosion had removed a great thickness of older cover rocks. Most batholiths are associated with intensely folded volcanic and sedimentary rocks in mountain ranges. It is thus tempting to speculate that, in Precambrian time, the granitic rocks that outcrop along the highway may have formed in the roots of great fold mountains, perhaps similar to those found today along the western side of the North American continent.

Most of the granitic rocks exposed along the highway are not true granites of approximately uniform composition, but are "mixed rocks" or migmatites. They are made up of thin layers, lenses, and streaks of dark grey materials (metamorphosed sediments or volcanics) which alternate with layers of granite or pegmatite. Presumably, as the magma, from which the granite and pegmatite crystallized, worked its way into the older rocks,

Photo 53 *Outcrop of greenstone showing well-developed pillow structure, along Highway 11 at Swamp River near Shebandowan.*



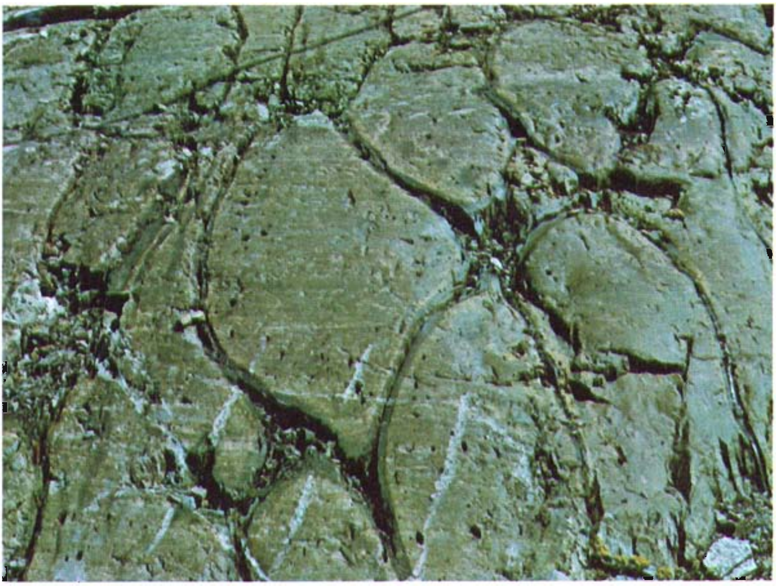


Photo 54 *Close-up view of pillow lava at Swamp River near Shebandowan (Photo 53). The largest pillow is convex toward the left (north), and its right side conforms to the convex surfaces of the two adjoining pillows.*

it embedded itself along closely-spaced planes parallel to the original foliation or schistosity, producing a lit par lit structure, in many ways resembling the stratification of sedimentary rocks. An excellent example of a migmatite, derived from the introduction of granitic magma into ancient schistose volcanic rocks (greenstones), is found at the Upsala United Church.

One of the striking features of the region, northwest of the height of land at Raith, is the overall evenness of much of the landscape. The area was deeply eroded during and after Precambrian time, and the region in consequence is a vast plain. Continental glaciers advanced across this plain in the Pleistocene epoch (p. 23) and, upon their retreat, melt-waters were ponded in the region. Lake sediments (gravel, sand, silt, and clay) accumulated in depressions and today the evenness of the ancient plain is accentuated by large level areas between low rocky ridges. At a roadside park established by the Ontario Department of Highways about 7 miles northwest of Raith (on the Savanne River), there occurs a low waterfall (Photo 57). This waterfall drops in a cascade formed where the river falls about 10 to 15

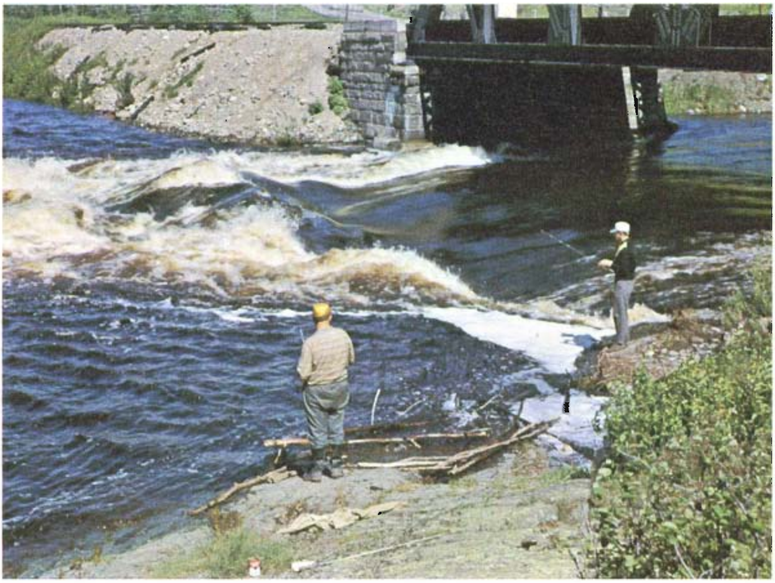


Photo 55 *Low waterfall where the Matawin River flows over a ledge of greenstone, under the railway bridge at Sunshine.*

Photo 56 *Close-up of cap-rock, Kakabeka Falls.*

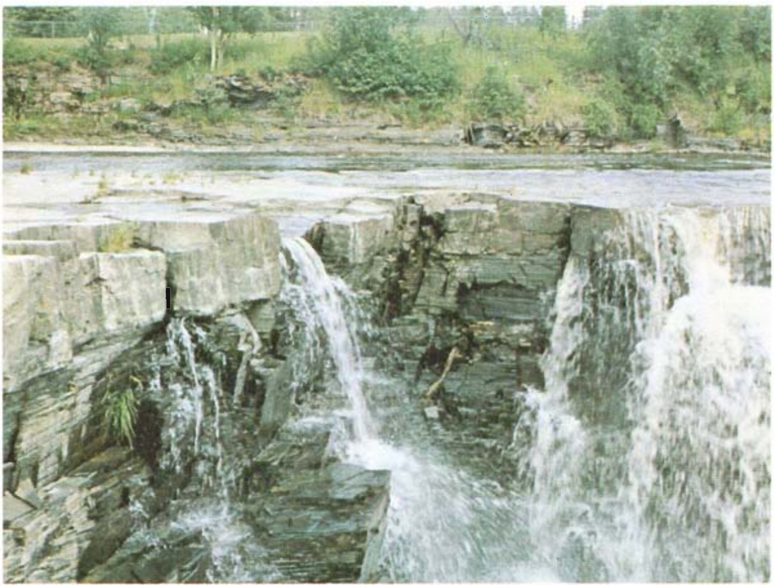


Photo 57 Waterfall along the Savanne River, at a roadside park near Raith. The waterfall is a cascade where the rlver drops over an accumulation of boulders along the side of a granite ridge.

feet, in a horizontal distance of 50 feet, over an accumulation of boulders along the side of a granite ridge.

The river is of much historic interest, being the canoe route to western Canada used in early times by the Indians and travelled by Jacques de Noyon in 1688. It was abandoned in 1731 in favour of the Grand Portage route to the south. However, the route was re-opened by Roderic Mackenzie of the North-West Company in 1799, and was used extensively from that year until the opening of the Dawson road, through the Shebandowan Lakes area to the south, in 1870-1871.

Kakabeka Falls and Vicinity

SUNSHINE

Highway 17-11 crosses the Matawin River at Sunshine, 1.7 miles west of the junction with Highway 17A-11A. Here is a low waterfall where the river flows under the railway bridge. The rocks are greatly altered basic lavas (greenstones) of Archean age. These lavas strike N 70°E, obliquely across the river bed, and dip vertically. The 3-foot-high falls occurs where the Matawin River, flowing west, drops over the end of a ledge of massive lava bordered downstream by relatively soft, highly foliated schistose lava.

SISTONEN'S CORNERS

A short distance south of its junction with Highway 17A-11A at Sistonen's Corners, Highway 17-11 winds for about ¼ mile through a deep cut across a large prominent outcrop. The rocks making up this outcrop are greenstones, which, because of intense folding due to lateral compression in the Earth's crust, now stand vertically such that their eroded upturned edges are exposed to view. Some of these greenstones are ancient basic lava flows. Others are fragmental materials, resulting from explosive volcanism, which have accumulated as thick deposits between the lava outpourings.

The fragmental rocks are agglomerates. One of them is well exposed at the south end of the rockcut, where the entrance to a side road to the west permits safe parking. This is a very distinctive rock, made up of round to ellipsoidal fragments of pale pink to greenish grey acid lava or rhyolite in a matrix of dark greenstone (Photo 58). It is similar to a conglomerate in appearance (Photo 4), but differs in that the fragments consist of a single rock type and the matrix is a metamorphosed basic lava or volcanic ash.

Similar agglomerates have been formed in historic times. In volcanic regions, effusions of rhyolite sometimes interrupt those of more basic lavas. The rhyolite flows, because of their high silica contents, are very viscous. On occasion, they form hot, fairly rigid plugs in the conduits of volcanoes. These plugs resist the upward migration of newly formed more basic lava; and if, as is often the case, the fresh lava is charged with abundant steam and other gases, the pressure rises. Eventually the plug is disrupted, and the fluid, gas-charged lava, along with fragments

Photo 58 *Agglomerate near Sistonen's Corners is made up of fragments of rhyolite (pale grey) in a matrix of greenstone (dark grey).*

of perhaps still-incandescent and plastic rhyolite, is discharged in an explosion. The resulting mixture may be ejected laterally or vertically, accumulating on the flanks of the volcano as agglomerate.

KAKABEKA FALLS PROVINCIAL PARK

A park with facilities for camping, picnicking, and swimming has been established by the Ontario Department of Lands and Forests at Kakabeka Falls, where the Kaministiquia River is crossed by Highway 17-11, about 18 miles west of Fort William. This park contains two points of geological interest: an outcrop in the river bed below the highway bridge and the falls themselves.

The rocks exposed under the highway bridge are dark shales overlain by a 3-foot thick bed of tuff. Tuff is the compacted and consolidated equivalent of ash (fine-grained debris) resulting from explosive volcanic discharge. Here, the tuff bed was compressed and folded, so that it forms a low structural ridge, one limb of which slopes gently upstream, the other limb, gently downstream (Photo 59). The bed forms a gentle upwarp called an anticline.

With a crest-width of over 200 feet, and a near vertical drop of 128 feet, there is no doubt that Kakabeka Falls, aptly termed the "Niagara of the North", is the most spectacular physiographic feature in northwestern Ontario. It is a typical example of a waterfall that has developed where, along a river's course, easily eroded rocks are overlain by a capping of hard resistant material. The rocks here are flat-lying sediments, a thick sequence of soft black shale protected by a 2-foot thick layer of Gunflint chert-carbonate (Photos 56, 60). Had the shales been the only rock present, any original waterfalls would have been destroyed early in the river's history, for the running water would eventually have scoured out the river bottom to produce a bed sloping gradually towards Lake Superior. However, the chert-carbonate above the shales has prevented the scouring. Because the underlying shales wear away at a faster rate than the chert-carbonate, the latter tends to be preserved as a projecting lip, thereby maintaining the sheerness of the escarpment.

This escarpment was originally much closer to Lake Superior, but, through the gradual erosion of the shales and the attendant undercutting and piecemeal collapse and foundering of the caprock, the escarpment has receded slowly upstream, leaving a deep gorge downstream to mark the watercourse.

Photo 59 *Folded bed of volcanic tuff in shales, below the highway bridge, Kakabeka Falls Provincial Park.*

Photo 60 *Chert-carbonate cap-rock overlying soft shales above Kakabeka Falls. The cap-rock is about 2 feet thick.*

HILLSIDE

A low waterfall is found about 200 feet downstream from the bridge, along Highway 588, over the Whitefish River about 1.8 miles west of the village of Nolalu. The river here flows eastward, and tumbles over the face of a 5-foot high escarpment bounding an outcrop made up mostly of chert.

The chert is a member of the Gunflint Formation of Animikie age (see page 18). It is a peculiar rock. Unlike most sediments, it does not display a well-developed layered structure. On the contrary, it is made up of cauliflower-shaped and biscuit-shaped bodies, up to several feet across, in a groundmass of granular-textured material. The cauliflower-like and biscuit-like bodies exhibit concentric and irregular wavy markings due to the alternation of light and dark laminae. They are thought to represent concretions or reef-like mounds resulting from the action of primitive plants (algae) in Proterozoic time. The granular-textured chert enclosing the concretions or mounds is best studied under a hand lens. It is seen to consist largely of tiny rounded bodies or granules. Some of these, like the larger algal concretions, have a concentric structure and are oölites.

The body of chert in the river bed slopes gently, at about 10 degrees, to the southeast. It rests on a layer of lithified gravel or conglomerate of the Kakabeka Formation. This conglomerate is exposed at low-water level along the north side of the river bed, below the falls. It is about 2 feet thick and is made up of pebbles of quartz distributed irregularly throughout a groundmass of sandy quartz grains with considerable admixed dark green mineral (chlorite). Presumably, it was derived from the weathering and erosion of underlying ancient (Archean) greenstones, and is the basal unit of the great Proterozoic sequence of sedimentary and volcanic rocks found in the eastern part of the Rainy Lake — Lake Superior region.

The waterfall was created here by the gently-sloping mass of hard, resistant chert. The face of the fall marks the position of a prominent, vertical crack or joint. No doubt the river, in its descent, worked its way into this crack, gradually removing blocks of the rock and leaving behind a straight vertical escarpment extending obliquely (southwest) across the river bed.

Photo 61 *Low waterfall along the Whitefish River at Hillside near Nolalu. The river flows over a ledge of Gunflint chert, noted for the presence of algal structures.*

Photo 62 *Waterfall along the Little Whitefish River, at Devon Park, Highway 593, occurs where the river flows over a step-like escarpment of diabase.*

DEVON PARK

A small but pretty waterfall (Photo 62) occurs along the Little Whitefish River at a small park established along Highway 593 through federal-provincial co-operation. It is reached from Nolalu by following Highway 588 past Hillside to Highway 593, and then by travelling south via the latter for 6.2 miles. The fall occurs where the river flows east-northeast over a steep escarpment at the edge of a large outcrop of the igneous rock called diabase. The fall is only a little more than 10 feet wide, but makes a beautiful cascade dropping about 25 feet over a number of flat ledges, in a horizontal distance of 150 feet. The step-like character of the escarpment is due simply to the fact that the diabase is intersected by two sets of closely-spaced cracks or joints, one horizontal or nearly horizontal, the other vertical. The horizontal joints in the rock along the river's course provide flat ledges, and the vertical joints, the risers between the ledges.

RABBIT MOUNTAIN AREA

The Rabbit Mountain area along the south side of Highway 588, 2 to 6 miles southwest of the village of Stanley, is a group of flat-topped, diabase-capped hills or mesas. Late in the last century, the hills became famous for their silver deposits. Silver was first discovered here in 1882 by a trapper and explorer named Oliver Daunais. According to one story, Oliver Daunais, while trapping in the Black Sturgeon Lake region, met and fell in love with, and married an Ojibway Indian girl, Helene L'Avocat, daughter of the Chief of the Lake Nipigon Band, Joseph L'Avocat. Joseph L'Avocat knewof the presence of silver at Rabbit Mountain. He was also aware of the legend that an Indian who showed a valuable mineral deposit to a white man would die within a year. To overcome this difficulty, and yet help his new son-in-law, the Chief is reported to have taken Oliver Daunais to a place near Rabbit Mountain and then, rather than actually showing him the silver location, simply explained how he might find it.

The silver find made by Oliver Daunais became the Rabbit Mountain mine. It initiated a rush of prospectors to the area. Several additional discoveries resulted, notably the orebodies of the Badger, Beaver, and Porcupine mines. The silver at these mines was found to be present as argentite and native silver. These occur in thin, roughly tabular-shaped veins, made up largely of quartz and calcite, with small but variable amounts of such diverse minerals as barite, chalcopyrite, fluorite, galena, pyrite, pyrrhotite, and sphalerite. The silver-bearing veins at the principal properties were worked until about 1891, when the known ore was exhausted. They yielded silver having a total value of $900,000 (Tanton 1931, p. 89).

The silver-bearing quartz-calcite veins in the Rabbit Mountain area are characterized in places by open cavities or vugs. The walls of these cavities are usually lined with well-developed pyramidal and prismatic crystals of ordinary quartz and of the purple-coloured variety, amethyst. The old mine workings, and the nearby dumps, are thus of great interest to collectors. The locations of the mines are shown on the Atikokan-Lakehead Sheet (Map 2065), published by the Ontario Department of Mines; and also on the Kakabeka Sheet (Map 213A) published by the Geological Survey of Canada.

SILVER FALLS

Silver Falls is located at the north end of a two-lane motor road, 10 miles from the intersection with Highway 17A-11A, and ⅓ mile east of Kaministiquia. The waterfall occurs where the Kaministiquia River drains Dog Lake, dropping 347 feet in a winding stretch about 4 miles long. Because of this difference in

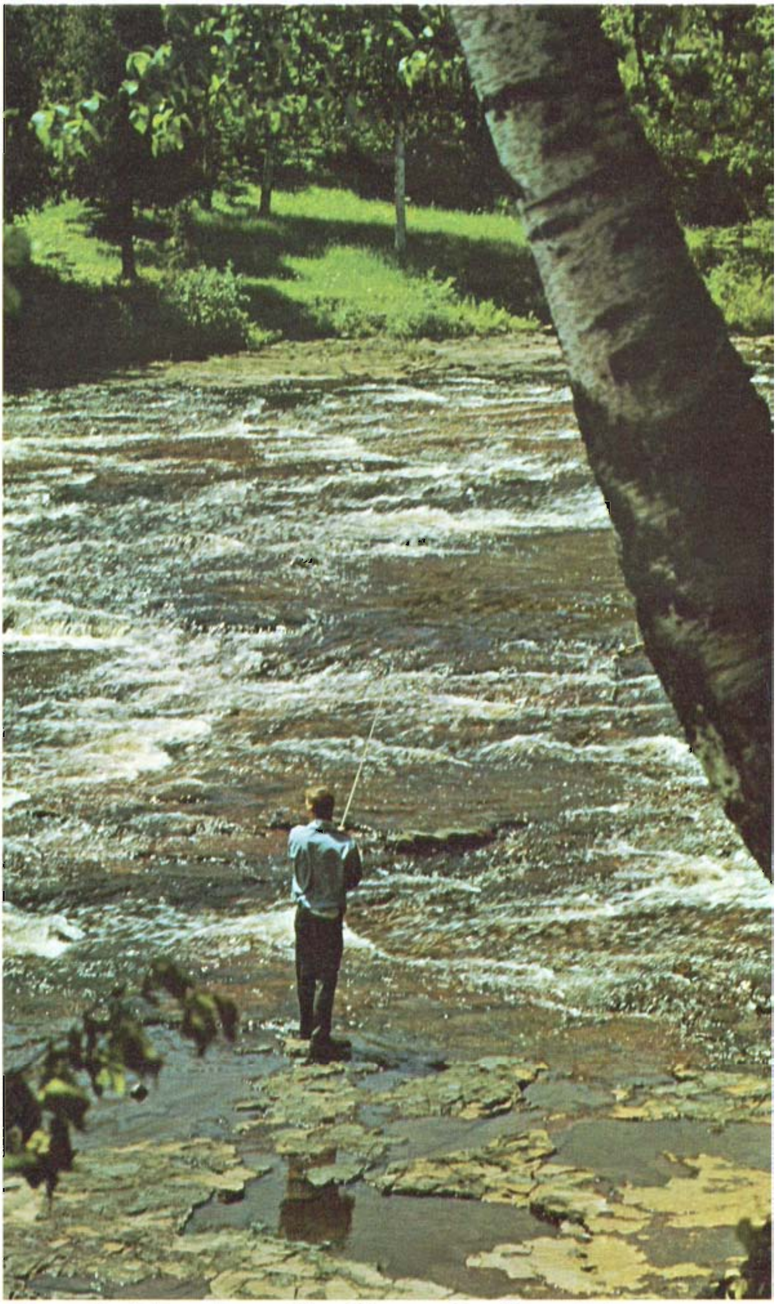


Photo 63 *Fishing, Current River (Courtesy Ont. Dept. of Tourism and Information).*

Photo 64 *View of Mount McKay across the flat Kaministikwia delta.*

elevation, and because of the great volume of water discharged annually from Dog Lake by way of the Kaministiquia River, this site has long been considered as a source of hydro-electric power.

Prior to World War II, all the electrical power needed in the region was supplied from other sources. But these sources could not meet the new power requirements resulting from rapid expansion in Port Arthur and Fort William during and after the war. The decision was reached in 1957 to develop the site, and on 1 September 1959 the Silver Falls Generating Station, with a capacity of 45,500 kilowatts per annum, was placed in service by Ontario Hydro.

As in the case of the Little Whitefish River at Devon Park (see p. 89), the Kaministiquia River at Silver Falls does not flow over a single escarpment, but rather tumbles over a number of low ledges and forms a series of rapids and cascades. The most scenic of these cascades, and one of the most spectacular waterfalls in the region, is shown in Photo 65.[1] The bedrock here is granite. Like the diabase at Devon Park, it has a step-like outcrop because of the presence of flat joints or cracks intersected by

1. Because of the necessity of maintaining a high water level in Dog Lake for hydro-electric power generation, it is only during periods of moderate to heavy rainfall that water is spilled from the lake into the river bed and the falls are most attractive.

Photo 65 *Upper waterfall along the Kaministiquia River above the Silver Falls Generating Station. The step-like character of the waterfall reflects flat and vertical joints in the bedrock (Courtesy Ontario Hydro).*

vertical or steeply dipping joints extending transversely or obliquely across the river bed.

To reach the cascade shown in Photo 65, the tourist must go upstream on foot. For the less venturesome, a low waterfall, with a steep drop of 25 feet, occurs where the Kaministiquia River enters Little Dog Lake at the generating station. This waterfall was caused by a change of rock type. At its top, and upstream from it, the rock is a mica schist, with a distinct foliation trending northeast obliquely across the river bed, dipping or sloping at an angle of 80° to the southeast. Below the falls, at the shore of Little Dog Lake, the rock is pink granite.

Canadian Lakehead and Vicinity

KAMINISTIQUIA DELTA

Where a river laden with sediment flows into a body of standing water, such as a lake, the rate of flow is checked and the materials being transported are rapidly dropped from suspension. The debris settles near the river's mouth, forming a triangular-shaped piece of land called a delta because of its resemblance to the Greek letter delta.

Photo 66 *Lower waterfall, along the Kaministiquia River, at the Silver Falls Generating Station. The waterfall occurs where granite is in contact with mica schist.*

Fort William is noted for the extreme evenness of the land upon which the city has been built. Fort William and a part of Port Arthur are on the forefront of a huge delta. This delta occupies the lowlands drained by the Kaministiquia River and its tributaries. It extends inland to and beyond the village of Stanley, a distance of over 16 miles, and is the largest and most impressive delta found along the north shore of Lake Superior.

The delta deposits are chiefly sand, silt, and clay. They are believed to have been laid down at the mouth of the ancestral Kaministiquia River when, thousands of years ago, the level of Lake Superior was much higher. With the lake lowered to its present level, the Kaministiquia River now cuts deeply into these old deposits, forming an entrenched channel that is contributing material to help build up a new delta (Island 1 and Island 2) on the Fort William waterfront.

MOUNT McKAY

South of Fort William, on the Ojibway Indian reserve, and towering above the Kaministiquia delta, is Mount McKay (Photo 1). Mount McKay rises to a height of 1,600 feet above sea-level and 1,000 feet above Lake Superior. It is a large mesa made up of shales and greywackes of the Rove Formation overlain by a hard, protective capping, about 200 feet thick, of diabase.

The diabase capping is the erosional remnant of a flat sheet or sill that once extended without interruption across the entire area. A second sill, about 15 feet thick, also an erosional remnant, is found in the Rove sedimentary rocks about 200 feet below the first sill and 400 feet below the top of the hill. Like the upper sill, it is also very hard, much more so than the enclosing shales and greywackes. It forms the base of a wide and prominent terrace on to which the tourist may drive for a magnificent view of the Lakehead cities.

RIVERDALE ROAD QUARRY

An excellent exposure of the Rove Formation of the Animikie Series is found in the quarry along the Riverdale Road. This quarry is located about ½ mile west of the intersection along Highway 61, at a point midway between the Neebing Hotel and Uncle Frank's Tavern, approximately 3 miles southwest of the Fort William city limits.

The rock exposed in the quarry is a flat-lying, thin-bedded, dark, fissile shale. Its chief claim to geological prominence is the fact that it contains numerous large, well-developed concretions.

A fine example of one of these bodies is illustrated in Photo 14. The concretions are much like curling stones in shape; they are oblate spheroids with diameters up to 6 feet and thicknesses up to 1½ feet. They are harder and more massive (less fissile) than the enclosing rock, and contain abundant finely crystalline calcite, thus differing somewhat in composition from the surrounding rock. They have a distinctly layered structure. When viewed from above, as in the floor of the quarry, the boundaries of the layers appear as concentric circles. In the quarry face, where the concretions can be examined in section, their internal layered structure is found to be coincident with, and their long dimensions parallel to, the bedding or stratification of the shales. Significantly, the layers thicken slightly from the margins of the concretions inward, and the shale strata immediately above and below the concretions are distinctly bulged. These features — the continuity of the bedding of the shale through the concretions and the distortion of the enclosing strata — indicate that the concretions are not simply inclusions of foreign material in the enclosing rock. On the contrary, they must have been formed in place, and in their development they must have partly incorporated, and partly displaced, original rock material. Although the mechanism of the process has not been satisfactorily explained, it is generally conceded that concretions, like those found at this locality, are the result of a spontaneous migration of a minor rock constituent (calcite) toward some nucleus such as a pebble or a grain of sand near, and around which, precipitation took place.

HILLCREST PARK

Hillcrest Park, along the Scenic Drive in Port Arthur, stands about 160 feet above the level of Lake Superior. Because it is at the top of a steep embankment — as its name implies — it affords a splendid panoramic view of Thunder Bay and the Lakehead harbours. Directly in front of the park lookout, and 3 miles offshore, are the Welcome Islands. To the left of the Welcome Islands, commanding the entrance to the bay, is the Sleeping Giant, so-named because of a resemblance to a huge reclining human figure. To the right, some 12 miles away, is Pie Island, with a roughly circular, pie-like hill at its west end. On the extreme right, at the south end of Fort William, is Mount McKay and the range of hills stretching toward Pigeon River and the International Boundary.

The Welcome Islands are made up of Rove sedimentary rocks.

Photo 67 *Pie Island; near Port Arthur.*

These slope gently to the southeast and form cuesta ridges attaining elevations of almost 100 feet above the lake. Similar rocks are found in the Sleeping Giant, Pie Island and, as we have already noted, Mount McKay. In these localities, however, the sedimentary rocks are overlain and protected by flat diabase cappings. The ridges occur as large mountainous hills rising hundreds of feet above the lake. The Sleeping Giant is of particular interest (Photo 70); it comprises four flat-topped mesas known, (from north to south) as the Head, Adam's Apple, Breast, and Triangle. A fifth mesa, Thunder Mountain, lies east of the Breast and the Triangle, but is not visible from the park. On the west side of the Giant, facing the Lakehead, is a sheer cliff 800 feet high. This cliff is the highest in Ontario.

Along the escarpment at Hillcrest Park, at the flagpole and in the mound 250 feet south of the flagpole, are outcrops of limestone. This limestone is a peculiar fragmental rock made up of numerous, small, rounded and angular pieces of chert in a matrix of coarsely crystalline iron-bearing carbonate. Interrupting it at close intervals are thin layers of chert. These layers, in places, separate and join in an irregular manner, enclosing lenticular masses of the limestone. When traced for any distance, however, the layers are found to be persistent and crudely parallel bands, and it is quite possible that they represent an original sedimentary stratification. The fragmented character of the limestone and the irregular chert layers are best observed at the base of the escarpment, in the lane near the stairway 150 feet south of the flagpole.

Because the limestone is exposed along the escarpment, it might be assumed that it controls the nature and height of the latter. However, this is not the case. The limestone trends northeast at a slight angle to the escarpment and dips about 20° southeast, opposite to the direction one might anticipate. The most notable feature of the escarpment is that it separates two terraces. The upper terrace is made up of water-laid sand. The lower terrace is an old beach. They are thought to have been formed when, after the melting of the glaciers that once covered the area, the waters of the Lake Superior basin stood higher than they do now. The escarpment is a cliff formed largely by wave action along an old shoreline after the lake level had dropped to the elevation of the lower terrace.

CURRENT RIVER PARK

Current River Park is located along Cumberland Street (Highway 17), where the road crosses the Current River near the north end of Port Arthur. This park contains two features of geological interest; the southeast-facing embankment behind the nursery and the playground; and the falls in the river below the dam.

The southeast-facing embankment is an old shore cliff similar to that at Hillcrest Park. There are, in fact, several such shore cliffs in the Lakehead cities. These separate old abandoned beaches, the highest of which has an elevation of about 235 feet above the present lake level. The shore cliff in Current River Park (Photo 16) is perhaps the most prominent. It separates terraces having elevations of 85 and 60 feet, and it can be traced across the city of Port Arthur from the Canadian Pacific railway on Strathcona Avenue (Highway 17) southwest to the Oliver Road (Highway 130), a distance of more than 5 miles.

Below the dam, the Current River drops about 40 feet in a horizontal distance of 600 feet. The bedrock here is diabase. The diabase is interrupted by a large number of cracks or joints which cause the rock to break into rectangular shaped blocks. The most prominent joints are vertical, others are flat-lying. Because of these joints, the surface of the bedrock is step-like rather than a uniform slope, and the river water tumbles over a series of flat ledges to forrn a beautiful cascade (Photo 68).

Photo 68 *At Current River Park, Port Arthur, the river flows over diabase and, because the diabase is broken by flat and vertical joints, the falls are step-like in character.*

BOULEVARD LAKE PARK

(Black Bay Bridge and Lookout)

Exposures of Gunflint Formation are found along the east bank of the Current River below and near the Black Bay bridge at the upper end of Boulevard Lake. The sedimentary rocks here slope gently south at the south end of the outcrop, and slope north at the north end near the bridge. Downstream, towards Boulevard Lake, the river cuts deeper and deeper into them, so that rocks occurring progressively lower in the stratigraphic section (geological column) can be seen.

At the bottom of the section is dark green, thick-bedded taconite. It is found along the river bank below the low falls that terminate the rapids about 500 feet south of the bridge. Taconite makes up a very large part of the Gunflint Formation. Its principal distinguishing feature is its granular texture, best seen when the rock is examined through a hand lens. This granular texture is due to the presence of innumerable tiny rounded bodies or granules made up largely of iron-bearing minerals, chiefly greenalite.

About 20 feet of limestone overlies the taconite and this in turn is covered by about 5 feet of dark-coloured shales. The limestone also is iron-bearing. On exposure to the atmosphere, it breaks down to form hydrous iron oxide in the form of the brown-coloured mineral limonite. This has characteristic rusty weathered surfaces that are in sharp contrast to the grey freshly-broken rock. The limestone is interrupted closely by small lenses and thin layers of taconite and chert, particularly in the lower portions. These stand up in relief on exposed surfaces and occur as conspicuous irregular-shaped patches (Photo 13). More notable, though, is the contact between the limestone and the overlying shales. The upper surface of the limestone, where it can be seen on the north side of the bridge, is hummocky. The shales resting upon it tend to conform to the irregularities and, as a consequence, are gently undulating. The hummocky surface is called a surface of unconformity. It represents an interruption in the development of the sedimentary rocks in this locality and indicates uplift and a period of erosion after the formation of the limestone but prior to the laying down of the mud which ultimately gave rise to the shales.

North of the Black Bay bridge, across the river, a vertical cliff rises about 90 feet out of the valley. This cliff, when examined closely, is found to be made up of shales overlain and protected by a 25-foot thick capping of diabase. The diabase is flat-lying, and forms a prominent ledge from which the tourist can obtain a superb view of Boulevard Lake and Thunder Bay to the east. The Lookout provides Port Arthur with one of its most outstanding scenic attractions.

TROWBRIDGE FALLS PARK

Two small but scenic waterfalls occur along the Current River, about 2 miles upstream from Boulevard Lake, at Trowbridge Falls Park. This park was established in 1957 by the Kinsmen Club of Port Arthur as a community recreational site. It is readily accessible by motor road. The entrance is found on Hodder Avenue, 1⅓ miles north of Arundel Street where Highway 17 turns east to skirt the Strathcona Golf Links.

At Trowbridge Falls Park, the bedrock is mainly gently dipping shale of the Gunflint Formation. The shale is typical of the area. It is dark coloured, fine-grained, and thin-bedded. In it, at widely spaced and irregular intervals, are thin beds of iron-bearing carbonate. Upstream, these carbonate beds increase

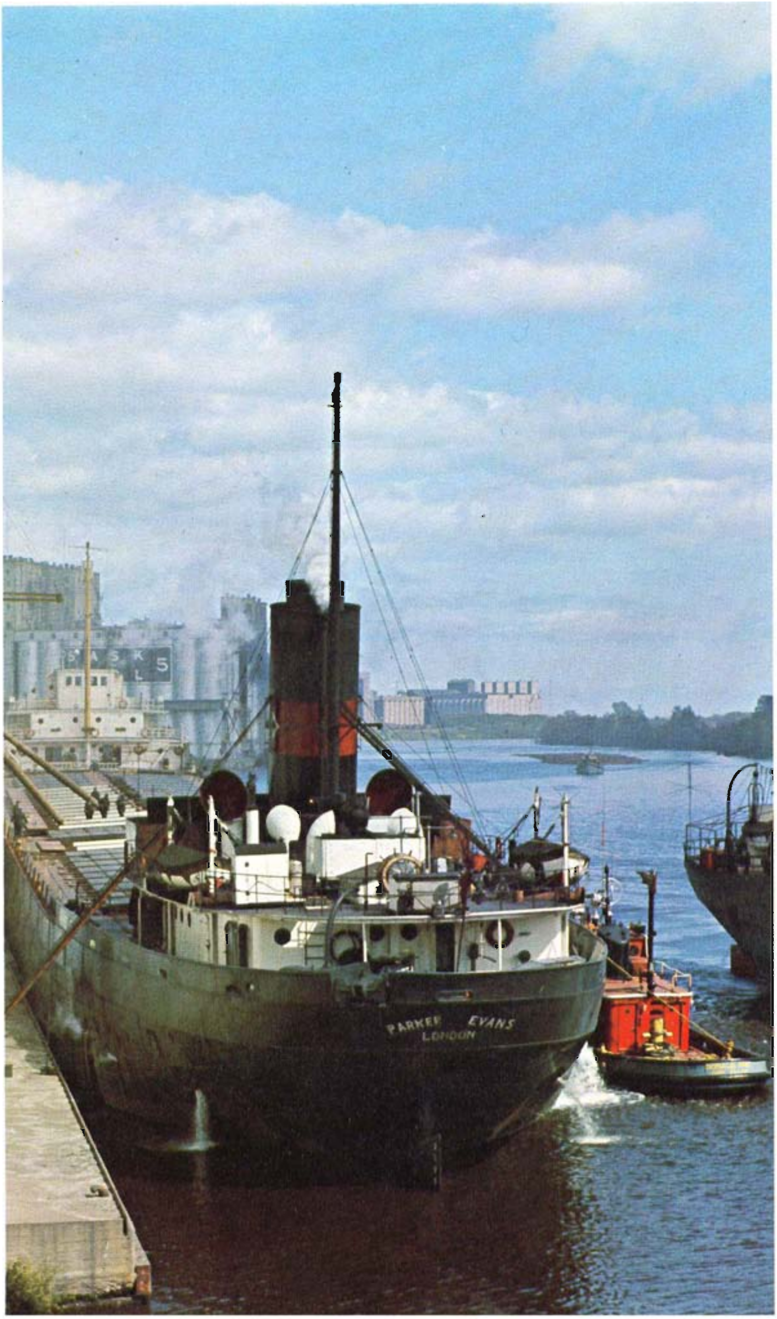


Photo 69 *Docks, Fort William (Courtesy Ont. Dept. Tourism and Information).*

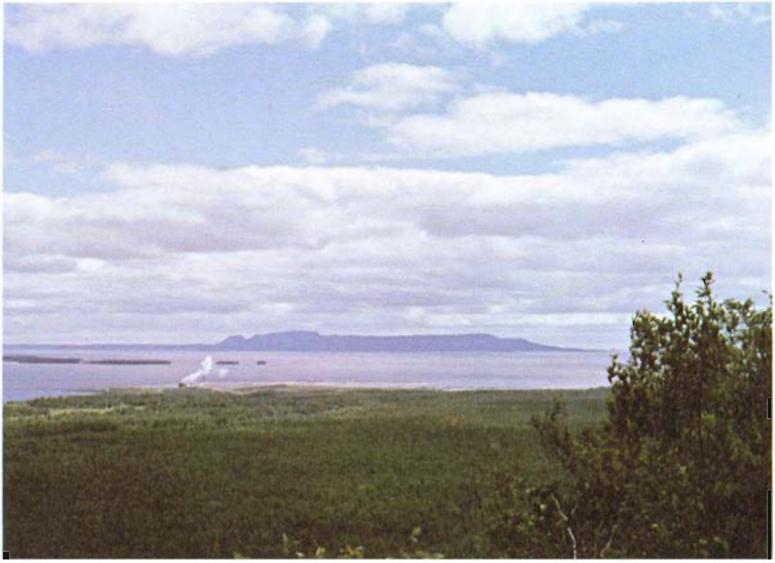
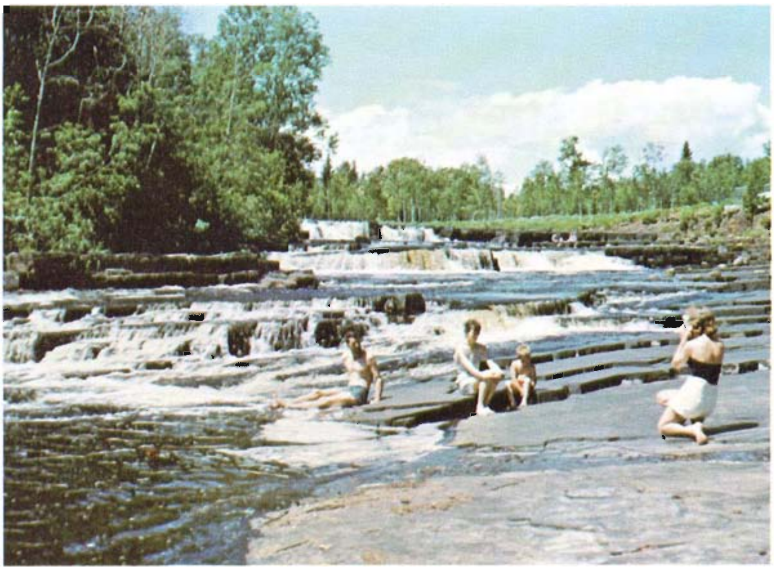


Photo 70 *View of the Sleeping Giant from Mount McKay. The Sleeping Giant is made up of Proterozoic sedimentary rocks capped by erosional remnants of a thick diabase sill. Four mesas, the Head, Adam's Apple, Breast, and Triangle, are visible.*

Photo 71 *Lower waterfall along the Current River at Trowbridge Falls Park, Port Arthur, showing the step-like cascade caused by vertical joints interrupting flat-lying sedimentary rocks of the Gunflint Formation.*



in number and thickness so that, at the lower falls, they make up about one-third of the rock exposed. They are rusty-weathering and, because their brown surfaces contrast sharply with the dark shales, they are easily recognized in outcrops. The rusty carbonate beds can be traced upstream about 1,000 feet to the upper falls. Here, however, they do not alternate with thin layers of shale, but rather with thin layers of chert. Accordingly, they mark a transition between the shales and the overlying chert-carbonate member of the formation.

At each of the two falls, the Current River does not tumble over one escarpment but drops over the edges of a number of flat ledges, varying between 2 and 5 feet in height (Photo 71). Unlike most waterfalls, they are not caused by the protection of soft, easily-eroded rocks by overlying, more resistant ones. Some ledges are capped by thin layers of carbonate, and others are capped by beds of shale or chert. However, the bedrock here splits easily along the flat bedding and is interrupted in places by vertical cracks or joints that extend across the outcrop. The river water readily works itself into these cracks and widens them, removing blocks of rock from the stream bed. As the blocks are removed, a vertical cliff is developed, giving rise to a low waterfall. In the step-like cascade produced, the treads of the individual steps are due to the flat-layered structure of the rock formation, the risers being the cracks or joints.

Photo 72 *Fall colours (Courtesy Ont. Dept. Tourism and Information).*

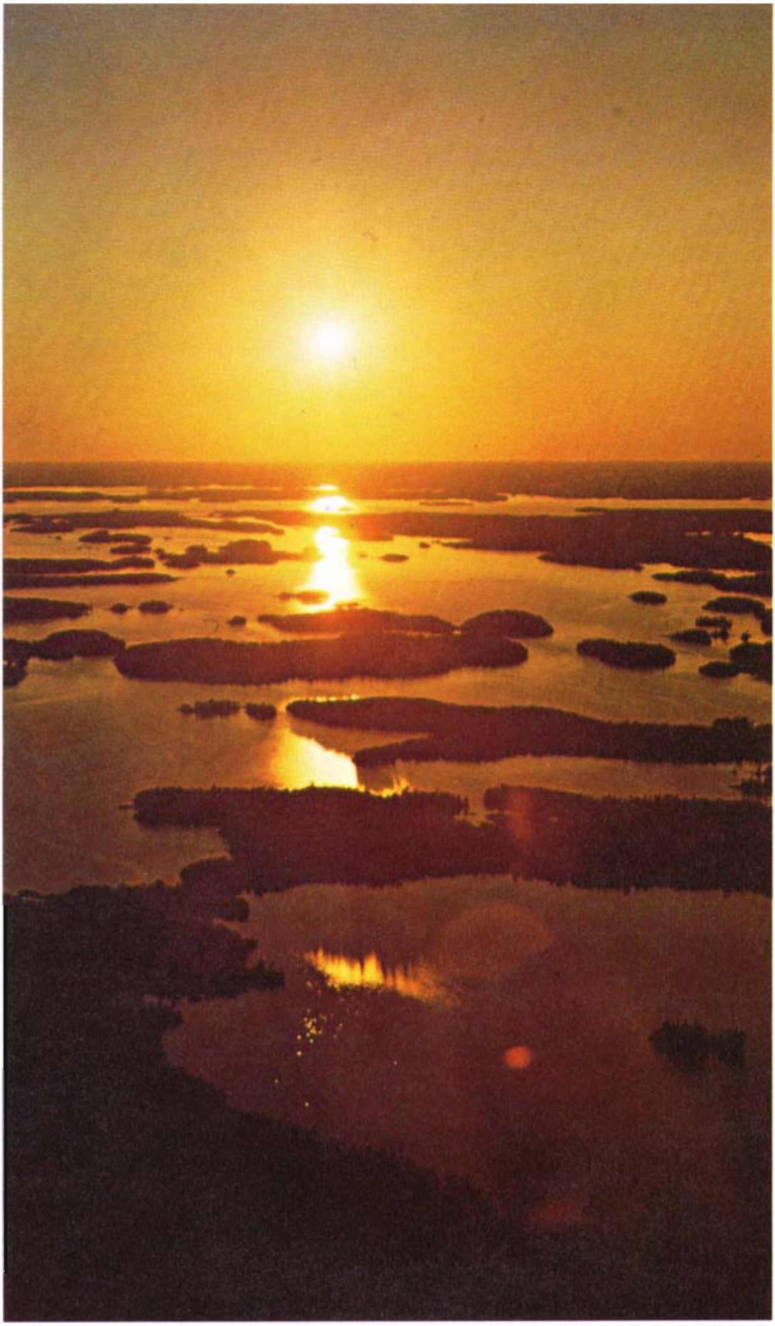


Photo 73 *Sunset, Rainy Lake (Courtesy Ont. Dept. Tourism and Information).*

APPENDIX

1. Localities for Collectors

A large number of minerals and rocks, some of them suitable for lapidary work (cutting and polishing) are obtainable along or close to Highways 17-11 and 11. Names and descriptions are set out below.

Amethyst

Amethyst is a purple coloured variety of quartz. It occurs in veins and, where these have open cavities or vugs, it commonly forms beautiful clusters of pyramidal crystals. Samples of amethyst can be found in veins and old mine dumps at Rabbit Mountain (p. 89) and also in narrow veins cutting shales in the bed of the Current River in Port Arthur between Boulevard Lake and Trowbridge Falls Park. Fine specimens can be purchased from suppliers in Port Arthur.

Anthraxolite

Anthraxolite, a mineral substance resembling anthracite, occurs in narrow veins in rocks of the Gunflint Formation. Samples have been found at several localities in and near Port Arthur. Generally, the veins are so narrow and so erratically distributed that individual occurrences have not been recorded.

Argentite

Argentite was a common mineral of the silver ores mined in the region prior to 1913 at Port Arthur, Rabbit Mountain and Silver Mountain. Specimens, mostly of poor quality, are obtainable in the old mine dumps.

Barite

Excellent samples of barite are obtainable from a large, prominent vein exposed on South McKellar Island in Lake Superior about 12 miles southeast of the Canadian Lakehead. Barite can also be found in mine dumps and veins at Rabbit Mountain.

Calcite occurs in most mineral veins found in the vicinity of the Canadian Lakehead. Particularly good samples can be obtained from the dump at the Shuniah mine in Port Arthur. This mine is reached from the Scenic Lookout at Boulevard Lake Park, by taking the single-lane road for half a mile to the radio tower. The calcite here is fluorescent. Calcite also makes up small veins and lenses in highly altered volcanic rocks along Highway 11, 1.5 miles east of the bridge at Rocky Inlet, Rainy Lake.

Chalcopyrite

Good samples of chalcopyrite, associated in each case with one or both of pyrite and pyrrhotite, can be obtained at several sites in the region. Chalcopyrite is found along Highway 11, 1.8 miles and 2.1 miles west of Bear's Passage, Rainy Lake; at the Port Arthur Copper Mine; in a small pit at the junction of Highway 11 and the Foley Mine road near Mine Centre; in the Whalen sulphide deposit along the north shore of Upper Shebandowan Lake, midway between Three Mile Bay and The Narrows; and at the Tip Top mine (p. 74).

Chert

Three varieties of chert occur in the city of Port Arthur. One variety is a dark-grey thinly laminated (banded) type occurring as layers in sedimentary rocks. In structure, it resembles some varieties of onyx. Samples may be obtained from outcrops along Banning Street, in the lane below Hillcrest Park and at Trowbridge Falls Park. The second type of chert is oölitic. It is made up largely of oölites — tiny rounded bodies having concentric or radial structures or both, and resembling the roe of fish. Good samples, suitable for lapidary work, are found below the Black Bay bridge at the north end of Boulevard Lake. The third, and prettiest, type of chert is algal chert. It, too, can be obtained along the Current River north of Boulevard Lake. Exceptionally fine specimens are obtainable also from outcrops in the bed of the Whitefish River, near the bridge along Highway 588, about 1.8 miles west of Nolalu.

Chlorite

Soft, dark green chlorite occurs along a prominent fault exposed in the east and north walls of a large rock quarry near Highway 11, 0.7 miles southwest of the Rainy Lake Causeway.

Concretions

Small concretions, suitable for collectors, are found in shale quarries along the Oliver Road (Highway 130) about 4 miles west of the junction with Memorial Avenue (Highway 17-11) in Port Arthur. Pyrite nodules, up to 1.5 inches in diameter and displaying a distinct radiating texture, occur in shales along the Kaministiquia River below Kakabeka Falls. Small, pale grey, calcareous clay concretions, mostly of irregular shape, are reported to occur on the property of E. Spuldzeniks (Lot 47, Con. A, Dawson Road Lots), along Highway 17A-11A.

Conglomerate (Puddingstone)

Conglomerate, with pebbles small enough to make the rock suitable for collections, can be obtained in the lower part, and at the south end, of the large outcrop at the junction of Highways 17-11 and 590 at Kakabeka Falls Park.[1] Similar rock (Photo 9) is found making up boulders in the bed of the Kaministiquia River at the north end of the park and can be obtained here during periods of low water level.

Goethite

Goethite is a hydrous iron oxide, the chief ore mineral found on the properties of Steep Rock Iron Mines Limited and Caland Ore Company Limited. Representative samples have been distributed by the companies to tourists without charge.

Jasper

Oölitic jasper occurs in lenses in taconite along the bed of the McIntyre River in Port Arthur. Ordinary red jasper can be obtained in the creek bed behind Mokomon station on the Canadian National railway line and at a point along the track about 1 mile north of the station. Mokomon station can be reached by a motor road that branches from Highway 17-11 about 6 miles north of Kakabeka Falls.

Limonite

Good specimens of limonite are available in the rockcut at the junction of Highways 17-11 and 590 at Kakabeka Falls Park. This mineral is also found in a rock trench along the Reef Point road, 0.65 miles from the intersection with Highway 11, about ⅓ mile east of Commissioner's Bay and 1.8 miles west of Rocky Inlet, Rainy Lake.

1. To avoid the possibility of traffic accidents, the tourist is requested to leave his vehicle in the park and walk to the outcrop.

Magnetite

Magnetite is found in the same trench along the Reef Point road as limonite. It is easily distinguished from the limonite by its black colour, its black streak, and its magnetic quality.

Molybdenite

Molybdenite occurs in a quartz vein exposed in the southern part of Lot B, Concession III, Conmee Township. It lies along a motor road 0.8 miles east of the intersection with Highway 17-11. This intersection is found about 3 miles north of the entrance to Kakabeka Falls Park.

Molybdenite has also been found at the east end of the bridge over Bear's Passage, Rainy Lake. In addition, samples have been obtained in a roadcut through granite along Highway 11, 4.3 miles west of Bear's Passage (1.3 miles west of the Canadian National railway line).

Pectolite

Excellent specimens of pectolite in the form of sheaf-like aggregates of acicular crystals, have been found in the quarry of McNamara Construction Company Limited, about 1 mile northeast of the Port Arthur city limits. It is necessary to obtain permission from the company to search the quarry for samples of pectolite.

Pentlandite

Samples of the nickel-bearing mineral pentlandite, associated with chalcopyrite and iron sulphides, are obtainable from a rock trench about 200 feet north of the bridge over the railway line, 3 miles west of Bear's Passage. Pentlandite is also found on Discovery Point, Lower Shebandowan Lake.

Porphyry

Porphyry, suitable for cutting and polishing, makes up a small dike at the tip of Discovery Point, Lower Shebandowan Lake.

Prehnite

Prehnite has been found with pectolite in veins in the diabase at the quarry of McNamara Construction Company Limited.

Pyrite

Samples of pyrite suitable for collections are obtainable from a vein exposed in an outcrop at the intersection of Highways 17-11 and 590 at Kakabeka Falls Park.

Quartz

Small prismatic crystals, with pyramidal terminations, of the mineral quartz have been obtained from narrow veins in granite in the exposure at the intersection of Highways 17-11 and 590 at Kakabeka Falls Park. Usually, pyramidal crystals of transparent quartz are found associated with amethyst. These can be found in veins along the Current River north of Boulevard Lake.

Tourmaline

Pegmatite, containing small red garnets and black tourmaline, is exposed in a roadcut, along Highway 11, 1 mile east of Pilcher's Service Station between Kashabowie and Atikokan.

Vein Breccia

Samples of breccia, made up of angular fragments of black sedimentary rock cemented by quartz and calcite, are obtainable from mine dumps and veins at Rabbit Mountain (p. 89).

2. Lapidary Clubs and Shops

Rehabilitation Industries (Lakehead) Inc.
1000 Memorial Avenue,
Port Arthur.

Thunder Bay Lapidary Club
Mrs. A. Gilby, Secretary,
264 Ray Court,
Port Arthur.

3. Rock, Mineral, and Ore Displays

Bus Terminal
International Transit Ltd.,
269 Arthur Street,
Port Arthur.

Historical Museum
Thunder Bay Historical Society,
Fort William Public Library,
216 Brodie Street South,
Fort William.

Ontario Department of Mines
179 South Algoma Street (2nd floor),
Port Arthur.

4. Glossary

Acid Rock. An igneous rock containing 66 percent or more silica.

Agglomerate. Coarse fragmental debris resulting from explosive volcanic activity.

Amphiboles. Rock-forming minerals of complex composition. Hydrous silicates, usually with aluminum, calcium, iron, and magnesium.

Amygdaloidal Lava. A lava with numerous tiny gas cavities filled with late-formed minerals.

Anorthosite. An igneous rock made up largely of plagioclase feldspar.

Anticline. A fold structure, or arch, in which the rocks slope in opposite directions away from a common ridge.

Basalt. A lava made up chiefly of the minerals pyroxene and feldspar, with or without olivine, of basic composition and dark colour.

Basic Rock. An igneous rock with a low content of silica, generally less than 55 percent.

Batholith. A very large mass of igneous rock (e.g. granite), formed deep within the Earth.

Bedding. A layered structure in sedimentary rocks.

Boulder. A sedimentary rock fragment, usually rounded, having a diameter of over 256 mm (10 inches approx.).

Breccia. A fragmental material, the pieces being of angular shape.

Calcite. A vein mineral and rock-forming mineral having the composition of calcium carbonate.

Carbonate. A chemical compound which, when heated, yields the gas carbon dioxide (calcite, dolomite and siderite are examples of carbonates).

Carbonate Rock. A rock made up largely of carbonate minerals.

Chalcopyrite. An ore mineral of copper, the chemical formula for which is $CuFeS_2$.

Chert. An extremely fine-grained form of silica.

Chert-Carbonate. A sedimentary rock in which layers of carbonate minerals alternate with layers of chert.

Chlorite. A rock-forming mineral, usually greenish in colour and platy (like mica). A hydrous silicate of aluminum, iron, and magnesium.

Cobble. A sedimentary rock fragment, usually rounded, having a diameter of 64 to 256 mm (2½ -10 inches approx.).

Concretion. A rounded or nodular mass of seemingly foreign material in a sedimentary rock, resulting from the concentration of one or more rock constituents about a central nucleus.

Conglomerate. (sometimes called puddingstone). The hard, compacted equivalent of a sedimentary deposit, made up of pebbles and boulders in a matrix of sand, silt, or clay.

Cuesta. A ridge with a gentle slope on one side and a precipitous escarpment on the other.

Diabase. A basic igneous rock having the composition of gabbro and usually characterized by the presence of lath-shaped feldspar crystals.

Dike. A tabular mass of igneous rock extending obliquely or transversely across older rocks.

Diorite. An igneous rock, usually made up of the minerals feldspar and hornblende, and having a composition intermediate between syenite and gabbro.

Dolomite. A vein mineral and rock-forming mineral having the composition of calcium magnesium carbonate. Also a sedimentary rock made up largely of the mineral dolomite.

Epidote. A green rock mineral. A hydrous silicate of aluminum, calcium, and iron.

Epoch. A subdivision of a Period of geological time.

Era. A division of geological time of the highest order.

Erratic. A rock fragment or boulder that has been transported by glacier ice and usually differing from the bedrock on which it lies.

Fault. A fracture, or zone of fractures, along which a movement of the wall rocks has occurred. A normal fault is one where those rocks lying above a sloping fracture zone have apparently moved or dropped downward.

Feldspars. Common rock-forming minerals (e.g. orthoclase, microline, plagioclase). (See standard mineralogy texts for detailed information.) Aluminum silicates of one or more of calcium, sodium, and potassium.

Fissile Rock. A rock that is easily split along closely-spaced parallel or near-parallel planes.

Foliated Rock. (also referred to as schistose rock) A fissile rock in which platy minerals are arranged in thin, irregular, and generally undulating, crudely parallel sheets.

Gabbro. A coarse-textured igneous rock, having the same composition as basalt but occurring as dikes and sills.

Glacial Erratic. See "Erratic."

Goethite. An ore mineral of iron. A hydrous iron oxide.

Gossan. A deposit made up largely of hydrous iron oxide (limonite), formed at the surface by the weathering of iron-bearing sulphides in a rock.

Gneissic. Like a gneiss; the type of rock containing bands rich in granular minerals alternating with bands rich in platy or micaceous minerals.

Granite. A coarse-textured igneous rock made up of quartz, feldspar, and one or both of mica and hornblende; usually found in batholiths. It is an acid rock, with a high content of silica.

Greenstone. An altered or metamorphosed basic igneous rock, usually basalt, rich in greenish minerals such as chlorite and some amphiboles.

Greywacke. A variety of sandstone, with tiny fragments of rock and rock minerals (quartz and feldspar), resulting from rapid erosion and sedimentation.

Hematite. An ore mineral of iron. An iron oxide containing 70 percent iron by weight.

Homocline. The structure where bedded rocks slope uniformly over a wide area.

Hornblende. A variety of amphibole, dark green or black in colour.

Hornblende Schist. A schistose or foliated metamorphic rock having a high content of hornblende.

Igneous Rock. A rock formed by the crystallization of molten, or partially molten, matter or magma.

Intrusion. A body of igneous rock that has invaded older rocks.

Iron Formation. A sedimentary rock having an unusually high iron content.

Jasper. A variety of chert usually coloured red due to the presence of small amounts of the mineral hematite.

Joint. A fracture that interrupts the physical continuity of a rock.

Limestone. A sedimentary rock made up largely of the carbonate mineral calcite.

Limonite. Brown hydrous iron oxide, e.g. goethite.

Lineation. Parallel or subparallel orientation of elongated materials, such as prismatic mineral crystals, e.g. hornblende crystals.

Lit par lit Structure. A layered structure due to the alternation of layers of foliated or gneissic rock with layers of an igneous rock like granite.

Magma. A hot mass of molten, or partially molten, rock constituents, formed at high temperatures within the Earth.

Magnetite. An ore mineral of iron. A magnetic oxide of iron containing 72 percent iron by weight.

Marble. A limestone or dolomite hardened by recrystallization.

Mesa. A flat-topped hill bounded on one or more sides by steep cliffs.

Mica. A rock-forming mineral that splits into flat sheets.

Migmatite. A mixed rock made up of layers of abundant fragments of foliated or gneissic rock cemented by granite.

Olivine. A rock forming mineral. A silicate of one or both of magnesium and iron.

Oölite. A tiny spherical or ellipsoidal body having a radial or concentric structure, or both.

Pebble. A sedimentary rock fragment, usually rounded, having a diameter of 2 to 64 mm (up to about 2½ inches).

Pegmatite. A very coarse-grained igneous rock, usually of granitic composition, and occurring in such small bodies as dikes and sills.

Peridotite. An igneous rock made up largely of olivine and subordinate pyroxene.

Period. A fundamental unit of geological time, smaller than an Era.

Phenocryst. A large crystal in a porphyry.

Pillow Lava. A lava made up of an agglomeration of rounded masses resembling pillows.

Plagioclase. A variety of feldspar. An aluminum silicate containing one or both of sodium and calcium.

Porphyry. An igneous rock in which large crystals (phenocrysts) of early-formed minerals are embedded in a fine-grained groundmass. A feldspar porphyry has phenocrysts of feldspar; a quartz porphyry, phenocrysts of quartz.

Pothole. A deep, round hole worn into bedrock at falls and rapids by sand and gravel spun around by water currents.

Pyrite. A sulphide of iron having the formula FeS_2. Fool's gold.

Pyroxenes. Rock-forming minerals. Complex silicates, usually with aluminum, calcium, iron, and magnesium. Augite is an example.

Pyrrhotite. A weakly magnetic sulphide of iron, usually associated with pyrite.

Quartz. A vein mineral and rock-forming mineral having the composition of silica.

Quartz Diorite. An igneous rock, usually made up of the minerals plagioclase feldspar, hornblende or biotite, and quartz.

Residual Soil. Soil formed by the disintegration and decomposition by weathering of the underlying bedrock.

Rhyolite. A lava, having a composition similar to that of granite, usually light-coloured.

Sandstone. A compacted sediment made up largely of grains of quartz.

Schistose. See Foliated.

Serpentine. A green rock mineral (hydrous silicate of magnesium) formed usually at the expense of olivine in peridotite or related rocks.

Siderite. An iron-bearing carbonate mineral.

Shale. A laminated sedimentary rock composed of compacted or cemented mud.

Sill. A tabular mass of igneous rock occuring within, and parallelling, older rocks.

Siltstone. A sedimentary rock, not a shale, made up of very fine-grained mineral particles.

Slate. A very fine-grained metamorphosed sedimentary rock having a well-developed fissility that may or may not parallel the original bedding.

Stratification. See Bedding.

Striae. Minute, closely-spaced, parallel grooves or scratches on bedrock surfaces, usually resulting from glaciation.

Syenite. An igneous rock that, except for the absence of the mineral quartz, is similar to granite in both appearance and composition.

Syncline. A fold, the rocks of which slope inward, in opposite directions, to form a trough-like structure.

Taconite. A variety of iron formation made up largely of tiny rounded bodies or granules of iron-bearing minerals and chert in a groundmass of chert or carbonate.

Tuff. A rock made up of dust and fine rock fragments from explosive volcanic activity.

Unconformity. A surface of erosion separating young sedimentary rocks from older rocks.

Vesicle. A small cavity formed in a lava consequent upon the escape of gas upon extrusion at the surface.

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