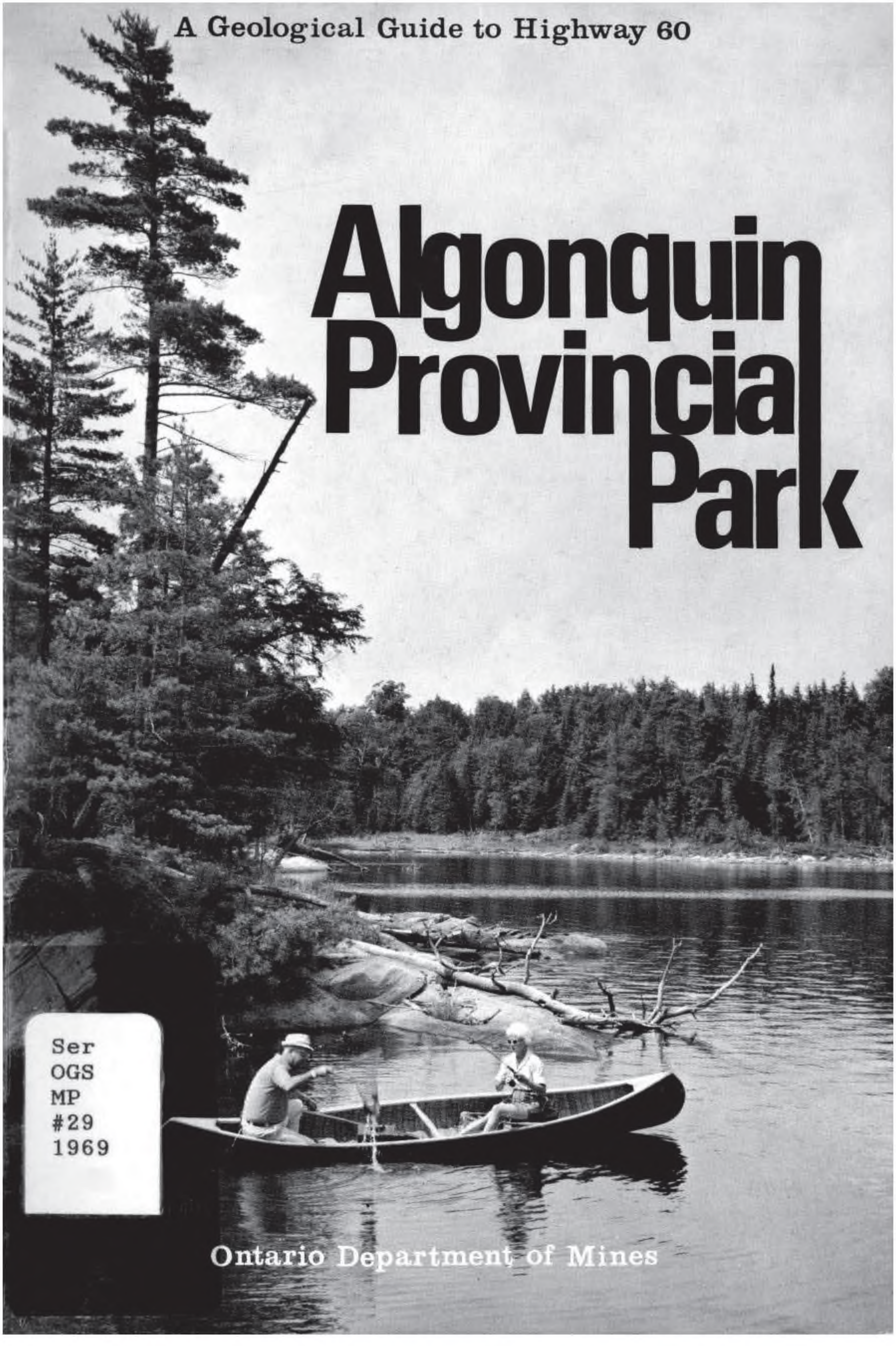
A Geological Guide to Highway 60

Algonquin Provincial Park



Ontario Department of Mines

ONTARIO

A GEOLOGICAL GUIDE TO HIGHWAY 60

ALGONQUIN PROVINCIAL PARK

By

G.R.Guillet

ONTARIO

DEPARTMENT OF MINES

Ontario Department of Mines

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Cover Photographs

Photographs on the front and back covers are courtesy of the Ontario Department of Tourism and Information.

Photo 1 Lake of Two Rivers from Highway 60 near mile 23. The rocks in the foreground are part of the Precambrian bedrock of Algonquin Park. Note the angular jointing.

A GEOLOGICAL GUIDE TO HIGHWAY 60

ALGONQUIN PROVINCIAL PARK

By

G.R. Guillet[1]

Part I INTRODUCTION

Materials and Evolution of the Terrain

The visitor to Algonquin Park will not only be impressed by its numerous lakes, streams, forested uplands, and marshy lowlands, but he should also be aware of two fundamentally different materials of which these features are composed - solid bedrock and loose rock debris (soil). These materials differ greatly in age: The bedrock is part of the great Canadian Shield of ancient crystalline rocks formed during the Precambrian Era, sometime between the beginning of the Earth 4,500 million years ago and the emergence of abundant primitive life 600 million years ago; rock debris and soil capping the bedrock is the result of extensive glaciation that culminated in this region a scant 15,000 years ago. The present land surface was sculptured by the glacial ice as it flowed southward, effectively removing most traces of geologic history between the Precambrian and relatively recent times.

The Glaciers

Algonquin Park was covered by ice when the first human visitors arrived in the area. The last of the great continental ice sheets, of which four were known during the last million years, covered all of Ontario 15,000 years ago and extended into northern United States. In Algonquin Park this glacier may have been several miles thick. Like a giant sluggish river the ice flowed southward, removing the soil and gouging the bedrock along its path.

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[1] Geologist, Ontario Department of Mines, Toronto. Manuscript accepted for publication by The Director, Geological Branch, 15 April 1969.

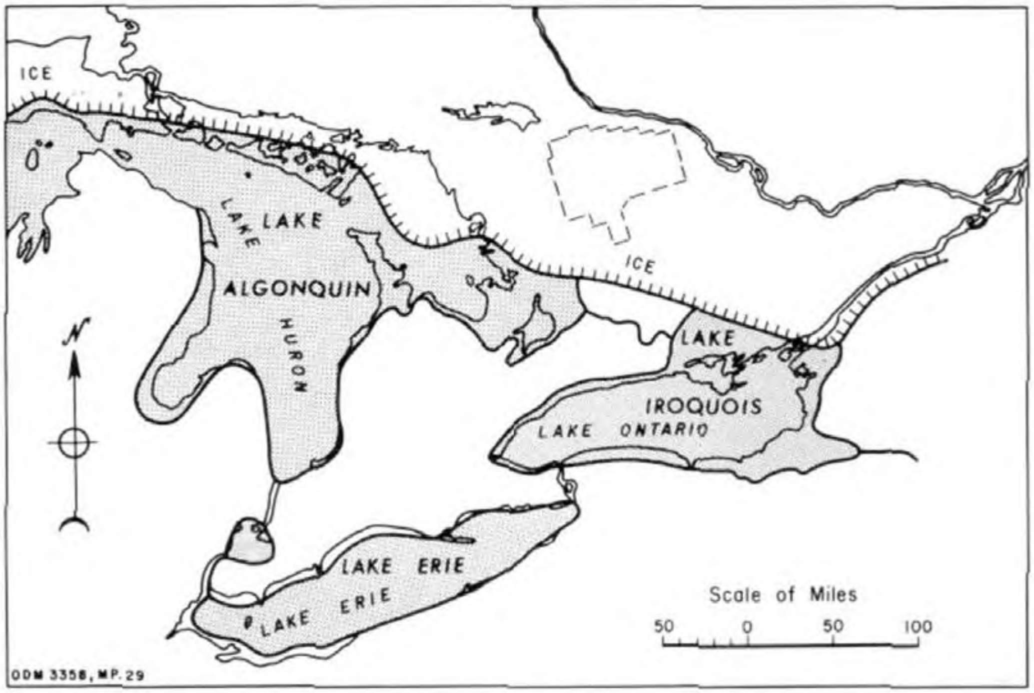


Figure 1 – Ice-front position in eastern Ontario 11,000 years ago.

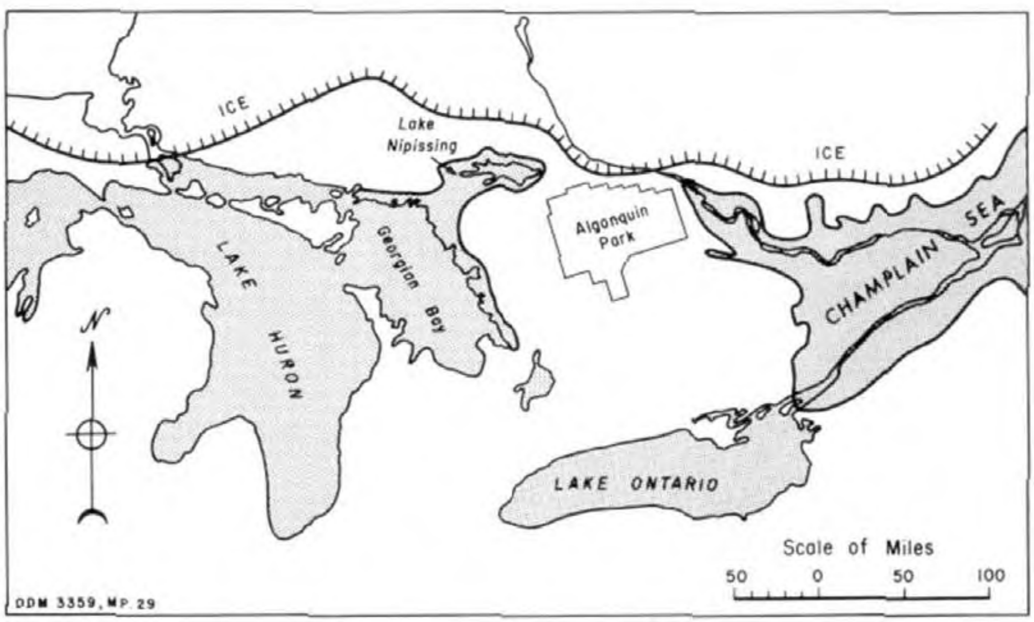


Figure 2 – Ice-front position at the time of the Champlain Sea 10,000 years ago.

Post-Glacial Lake Algonquin

Then the climate began to get warmer, and 10,000 years ago Algonquin Park was finally freed of its permanent ice cover. Vast quantities of water from the melting ice created great post-glacial lakes and river spillways. One of the largest of these lakes was known as Lake Algonquin. Lakes Huron, Nipissing, and Georgian Bay are the remnants of Lake Algonquin, all standing a hundred feet or more below the maximum water level of their ancestor. Some of the old shorelines of the high-level stages of Lake Algonquin may still be found in the north western part of Algonquin Park.

The Champlain Sea

Meanwhile, on the east side of the Park, an arm of the Atlantic Ocean had flooded the Ottawa valley, while the weight of the nearby glacial ice continued to hold this area below sea level. Known as the Champlain Sea, these marine waters extended to the edge of the Park near Petawawa and Pembroke. Shells that lived in the sea near Pembroke have been dated by the Radiocarbon Dating Laboratory of the Geological Survey of Canada as being 10,780 ± 130 years old.

Rivers of Algonquin Park

Algonquin Park is a highland region, and it largely escaped the widespread flooding that followed the retreat of the last ice-sheet. Rather, it was the site of feeder streams, spawned from its melting ice and heavy with sediment scoured from its rocks. To-day the Algonquin dome contains the headwaters of five major systems: Amable du Fond and Muskoka Rivers draining north and southwest respectively, and the Petawawa, Bonnechere, and Madawaska Rivers draining east and south. These rivers are the remnants of turbulent glacial spillways that fed Lake Algonquin and the Champlain Sea.

Precambrian Era

However, the geological history of Algonquin Park had its beginning long before the glaciers. Forming part of the Canadian Shield, the bedrock originated far back in geologic history, probably more than two billion years ago, during the Precambrian Era. This was a time of barren continents and seas that

Photo 2 Thin-bedded sedimentary gneisses at mile 22.1. The spruce tree is about 2 feet high.

Photo 3 Migmatite formed by the invasion of sedimentary gneiss by pegmatite at mile 12.6.

contained only the most primitive forms of life.

Sedimentary Gneisses

Oldest of these Precambrian rocks are represented now by a variety of layered rocks that originated as sandy and muddy sediments deposited on ancient ocean floors. These early sedimentary deposits were intruded by molten igneous rocks during several periods of mountain-building that took place during the Precambrian Era. Intense heat and pressure accompanying these disturbances caused partial melting and recrystallization of the sedimentary rocks, and this metamorphism reached a peak about 1,000 million years ago. The resulting gneisses have retained the layered structure of their sedimentary parents, but have developed a new interlocking texture of mineral grains, very unlike their original granular character.

In addition to recrystallization of minerals originally present in the sediments, such as quartz, feldspar, and various kinds of mica, there have also been new minerals formed during the metamorphism, notably hornblende, garnet, diopside, epidote, and more rarely scapolite, sphene, kyanite, and sillimanite. These sedimentary gneisses are therefore usually represented in Algonquin Park by layered rocks rich in feldspar, quartz, and biotite mica with one or more of the new minerals formed by the metamorphism. They are characteristically grey, green, black, or pink rocks depending upon which of the minerals predominate. Quartz is glassy, colourless to smoky grey; feldspar may be pink or grey; hornblende and biotite are black; and diopside and epidote are green.

Migmatites

Sometimes rocks of mixed character were formed during metamorphism. Migmatites are mixed rocks, having layers of obvious sedimentary origin interspersed with layers, lenses, or veins of igneous-looking rock. Such rocks can be formed in two ways: By injection of igneous rock along bedding planes and fractures in the sedimentary rock; by melting and recrystallization of certain portions of the sediment that have relatively low melting temperatures. Migmatites that have originated in both these ways are common in Algonquin Park, and any of the sedimentary gneisses mentioned previously can in places be seen to contain enough pink or white granitic material to be called migmatite.

Igneous Rocks

Numerous large masses of igneous rock originating at great depths within the earth were intruded into the sedimentary gneisses and migmatites of Algonquin Park during the Precambrian Era. These caused major folding and upheaval of the sedimentary rocks as they pushed their way upwards, and mountains were formed, only to be eroded away in succeeding ages. Several such cycles of mountain-building and erosion took place in those early times, but finally a condition of relative stability ensued which has lasted through the last 1,000 million years to the present. Today we see the roots of those ancient mountains, as they have been exposed by erosion of thousands of feet of rock. A series of low domes, each one several miles or more in diameter, is all that remains of the early intrusions, wrapped about and separated from each other by the sedimentary gneisses in which they were intruded. The domes themselves are composed most commonly of granite, each one distinctive by slight variations in composition, colour, or texture.

Granites are usually light coloured rocks - grey or pink. Less commonly the intrusions are dark coloured rocks - varying from purple or green to black - the colour indicative of a more mafic composition. The darker intrusive rocks are more likely to belong to a class of rocks we call gabbro.

Most intrusive igneous rocks are characterized by a coarse interlocking texture, and a more uniform structure, and these features should help distinguish them from sedimentary gneisses. However, early igneous intrusive rocks were also affected by later metamorphism, and a pronounced parallelism of mineral grains, developed in response to intense pressure, may look surprisingly similar to the bedding foliation of sedimentary gneisses.

When igneous rocks are intruded into other rocks, angular blocks of the latter may break off and sink into the hot liquid mass. Although some alteration of the fragment is likely, it can usually still be recognized as a foreign inclusion, and is substantial proof of the igneous origin of the enclosing rock.

Folds and Faults

The earth is constantly changing, and like the skin of an over-ripe apple, the surface rocks are constantly having to adjust to a cooling and shrinking interior. In weaker regions the rocks are slowly crumpled and broken, sometimes permitting molten igneous rock to burst through to the surface as volcanoes. Such features are recoznized by the geologist as folds, faults, and lava flows.

Most of the rocks in Algonquin Park were folded and faulted during the Precambrian Era. Folds may be observed in single rock exposures, but often the folding is on a larger scale and only uniformly tilted layers can be seen for many miles. Geologists use the terms "strike" and "dip" when describing the attitude of layered structures in rocks. Thus the strike is the direction the layering makes with the horizontal, and the dip is the angle of tilt.

Faults occur where the rocks are brittle, or where folding can no longer provide a release for the disrupting stresses within the earth. They may occur as a single break or a zone of parallel fractures. Lateral or vertical shifting of the rocks on either side of the break is common, so that formerly adjacent points may be displaced several hundred feet, or even miles.

Faults are conspicuous features of Algonquin Park, and they have contributed greatly to the shaping of Algonquin scenery. Deep narrow valleys, straight or gently arcing, and occupied by chains of lakes connected by creeks and streams, are typical of the surface appearance of faults. The faults of Algonquin Park are old, and the agents of weathering - wind, rain, and ice - have had much time to further the destruction of fractured rock in the fault zone, so creating valleys between resistant rock ridges.

Joints

Joints are a common feature of all rocks in Algonquin Park. They are closely-spaced parallel fractures that develop as a result of shrinkage. Igneous rocks have only partially cooled by the time they have crystallized to a rigid solid. Further cooling, and consequent shrinking, develops tension in the rock that literally pulls it apart, leaving narrow openings, or joints. Gneisses are also jointed. The heat and pressure of metamorphism is often sufficient to cause flowage and extensive recrystallization, so that in final cooling joints are developed through shrinkage in the same way as in igneous rocks.

Joints are usually spaced at intervals of 1 to 4 feet. A single joint system will be a series of fractures all trending in the same direction. But two, and sometimes three, joint systems are common in the same rock, trending in directions often nearly at right angles to each other.

Joints provide passageways for groundwater, and hence joint planes are always stained, bleached, or otherwise altered. Wider joint openings have sometimes been channelways for later igneous solutions. Veins and pegmatite dikes are often formed when these solutions have crystallized in joint openings.

Photo 4 Joint planes in migmatite at mile 32.0.

Photo 5 Well-developed jointing in a rockcut near mile 25.5.

Pegmatite Dikes and Veins

Pegmatite dikes and veins are often the last features of igneous activity. They crystallize from thin watery solutions that easily penetrate almost any natural opening in the rock. Thus they are particularly common as a filling for joints, where they appear on the surface as a series of thin pink or white ribbons, sometimes elevated an inch or so because of greater resistance to weathering. If they are very thin and discontinuous we call them "veinlets" or "stringers".

Pegmatite dikes consist of very coarse mineral grains. They have smooth straight walls or very irregular ones, sometimes pinching and swelling erratically and forming lenses of great size. Since they can be found cutting almost all other rocks, we know they represent one of the last stages in the igneous history of the area.

The large grain size of pegmatite dikes is one of their most interesting features. Here we may see many of the rock-forming minerals in grains up to 1 foot or more in size. Pink or cream-coloured feldspars, and glassy white or smoky grey quartz, are the most common minerals and also usually the largest. Biotite (black mica), muscovite (white mica), black hornblende, steel grey magnetite, blue-black ilmenite, and dark red garnet can also be found, although it would be rare to find all of them in the same dike. In some cases pegmatite dikes are banded or zoned, such that feldspars and other minerals are arranged near the walls while quartz may form a rib near the centre. The mineral grains are always smallest at the walls, where the hot igneous solutions have been "frozen" against the cool wallrocks permitting only a short time for crystals to grow. The thicker the pegmatite body, the greater the grain size of the minerals in the centre.

The Dawn of Life

During the long Precambrian history of the world, when the ancient crystalline bedrocks were being formed, we can find little record of any form of life. But suddenly, in sedimentary rocks 550 million years old, we find fossils of small shelled creatures that must have been living in the oceans in which these rocks were formed. And in sedimentary rocks from that time to the present, fossils of increasing complexity trace the evolution of Life.

The Geological Time Scale

Most people think of past events in terms of Man's history on earth, which can be traced back in time only about one million years. To the geologist on the other hand, the historical past reaches far beyond Man to the primitive beginnings of the earth. Materials from which this history is read are not Man and his works, but rocks exposed in the earth's crust. Through field and laboratory studies it has become possible to arrange these rocks in order of relative age to form a geologic column. Recent scientific advances now permit rocks to be dated also in terms of absolute age, by utilizing methods based on radioactive decay of their constituent minerals.

Although there is reason to believe now that soft-bodied primitive organisms may have lived in the late Precambrian seas, geologists distinguished that part of the earth's history commencing with the first obvious fossils as the Paleozoic Era, the Age of Early Life. During most of the Paleozoic, organic life consisted of water creatures: seaweeds and small shelled animals. But later, fishes evolved, soon to be followed by amphibians and reptiles, and vast tropical forests were destined to become the coal measures of to-day. The Age of Reptiles closed the Paleozoic Era 230 million years ago. The dominance of giant reptiles - the dinosaurs - characterized the Mesozoic Era, the Age of Middle Life. The Cenozoic Era commenced 70 million years ago when the mammals - warm-blooded animals - hastened the decline of the cold-blooded reptiles. The Cenozoic is the Age of Recent Life, and includes the arrival of Man and the earth's history to the present time.

The Last 500 Million Years

During these eras, when life was developing first in the oceans then on the continents, the lowland regions of the continent were periodically being flooded, and sedimentary rocks were being deposited. Algonquin Park, although mainly a highland region, may have been partly covered by these waters on a few occasions. Fossil-bearing limestones about 450 million years old are found inside the Brent Crater on the Park's north boundary. Sedimentary rocks such as these may have been more widespread, but if so they have been removed by the glaciers except where they were protected as in this case by the rim of the crater.

Throughout the earth's history the weathering forces of Nature have been constantly working towards levelling the land. Several ranges of mountains have succeeded one another in the Algonquin Park area, each formed by massive adjustments in the earth's crust only to be gradually torn down, grain by grain.

But at no time has erosion received so much assistance as during the last million years, when four continental glaciers have pushed across the land. All the soil was removed, and the rocks deeply gouged by these giant scrapers. And when the glaciers melted, the rock and soil debris was left strewn about the country: Rounded teardrop hills of soil and boulders are called drumlins; long serpent-like gravel ridges are called eskers; and rough irregular terrains of boulder clay, sand, and gravel are called moraines. The abundance of water from the melting ice created turbulent rivers and vast lakes, whose former existence is demonstrated by broad valleys of sand and gravel and elevated shoreline terraces.

Finally freed of its permanent cover of ice about 10,000 years ago, mosses and other low plants began invading the raw glacial soils that lay between the polished rock ridges. Soon the forests were renewed, and the humus from each decaying generation improved the soil for the next, so that a woodland, rich both in its variety of vegetation and abundance of wildlife, was developed in that part of Ontario that includes Algonquin Park.

Photo 6 The Oxtongue River below Tea Lake dam, mile 5.2. Flowing mainly between banks of sand, the river is rapid where ledges of bedrock protrude.

Part II POINTS OF SCENIC AND GEOLOGICAL INTEREST

Stop 1 West Gate; The Highway Route Mile 0.0

Having discussed the materials and processes that have shaped Algonquin Park, let us examine some of these features along the highway. Markers indicate each mile along Highway 60 from the West Gate to the East Gate, and we shall use these to help locate points of interest. Please exercise extreme care in examining outcrops along the highway. Not only is traffic heavy in the summer months, but there is danger also from falling rock at many of the roadcuts. Park on the shoulder of the highway only when there is good visibility in both directions. Rockhounds and mineral collectors: Please leave the rocks and minerals of Algonquin Park untouched for the benefit of all.

When the highway was planned it was natural that the engineers should pick the easiest route. Thus the road follows the valleys and avoids the domes and ridges wherever possible. But the valleys are there because the rocks are sedimentary gneisses, softer and more easily eroded than the massive more uniform igneous rocks that make up many of the highlands.

For the first seventeen miles the road lies within these sedimentary gneisses. The old sedimentary beds were tilted towards the southeast when a large mass of hornblende granite was intruded on the northwest. This granite is not exposed along the road, but it lies just west of the Oxtongue River. The gneisses flank this granite mass, their upturned beds paralleling the highway for 6 miles, then fanning northward they form the gently arcing west shores of Tea and Canoe Lakes. At mileage 10, at the north end of Smoke Lake, Highway 60 swings easterly from its previous northeast course, and then angles across the strike of the sedimentary gneisses.

The gneisses exposed in rockcuts in the west half of the Park are almost monotonous in their similarity. Originally sandstones with muddy interlayers, these rocks were metamorphosed to grey, green, black, brown, and pink gneisses, containing varying amounts of quartz, feldspar, biotite, and hornblende.

Rockcuts often expose massive blocky surfaces so badly stained by rust, or otherwise altered, that the true colour of the rock is not obvious. These smooth surfaces are joint planes. Note how common they are, how evenly spaced, and how parallel their trend. Where a joint plane parallels the road, a smooth flat surface may result where blasting has broken away the rock cleanly to it. But more often the walls consist of parallel ledges, terrace-like and tilted, or large angular blocks in stepped array.

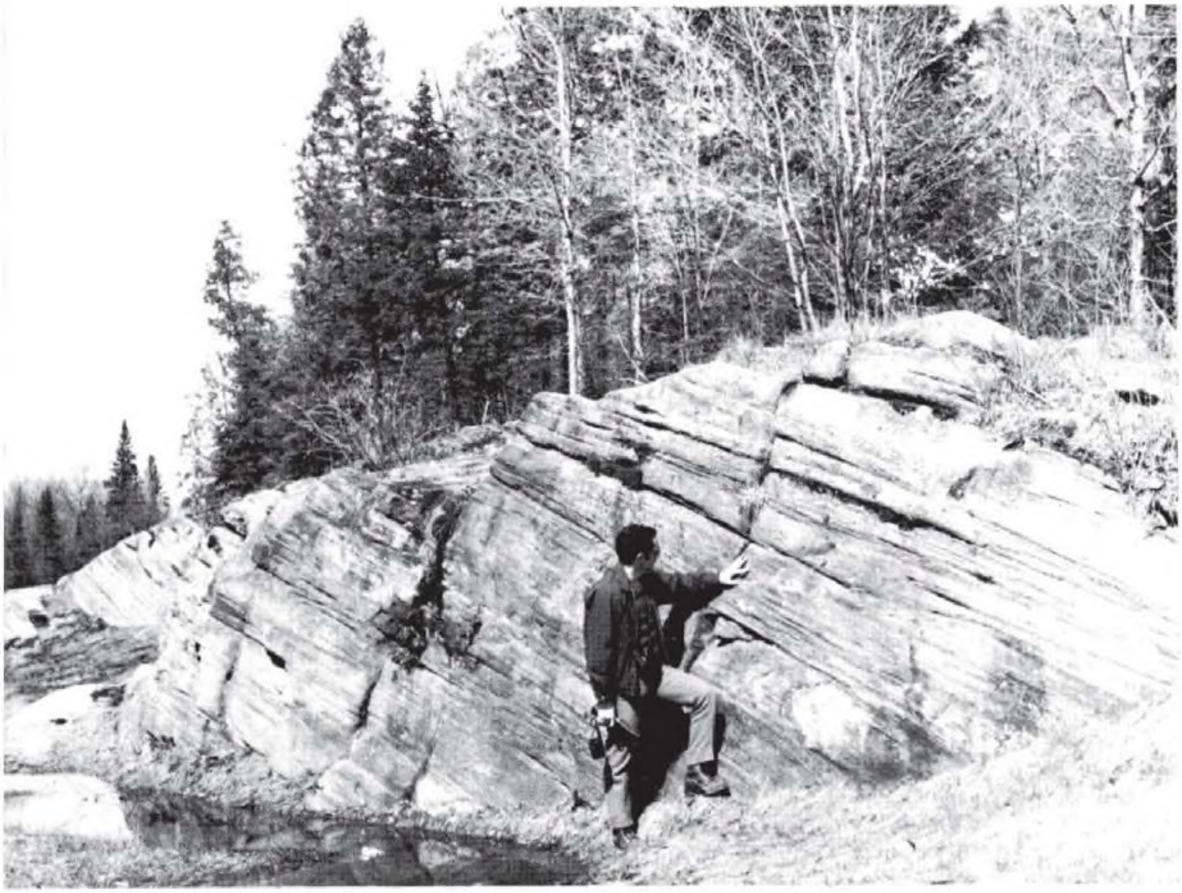
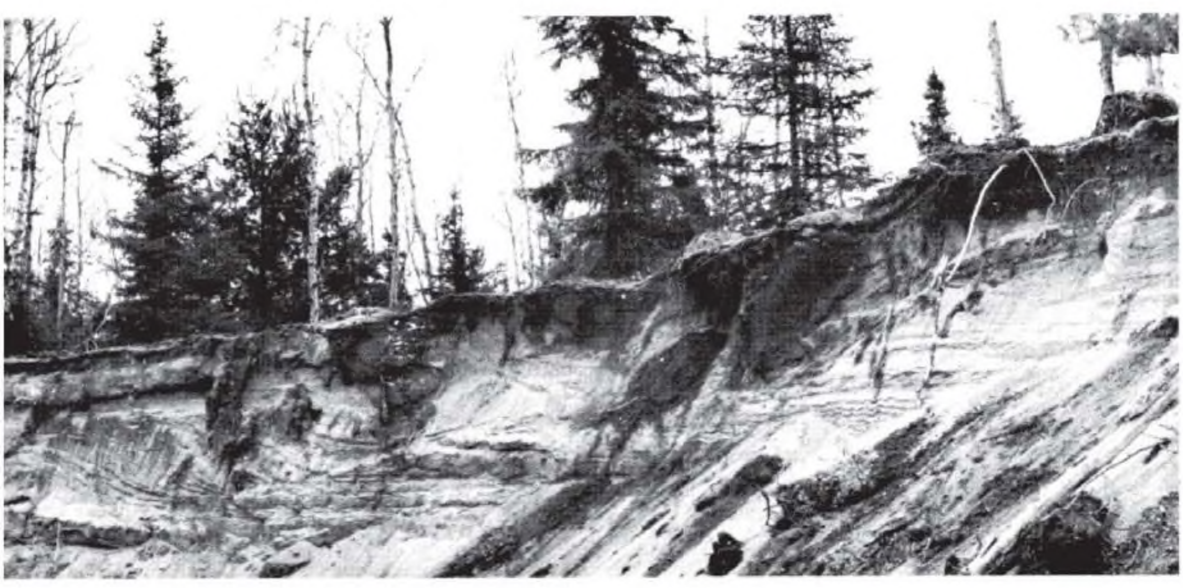


Photo 7 Sedimentary gneisses at mile 0.7.

Photo 8 Rippled beds of sand in a bank of the Oxtongue River near mile 2.0. This sand was deposited by the post-glacial ancestor of the present river.



Stop 2 Sedimentary Gneisses Mile 0.7

Just out of sight of the West Gate, and at the first rock exposed on the south side of the highway, are excellent examples of the ancient sedimentary gneisses through which the road passes over much of its route through the Park. Two adjacent vertical faces of rock, both facing northwesterly and 4 to 6 feet high, are conspicuous on the cleared right-of-way. They are joint surfaces, now sufficiently weathered to remove any secondary staining or alteration. Fortunately for us the highway was built around these rocks; the removal of rock that must have one time formed the other wall of the joint plane was the result of natural erosion, not blasting.

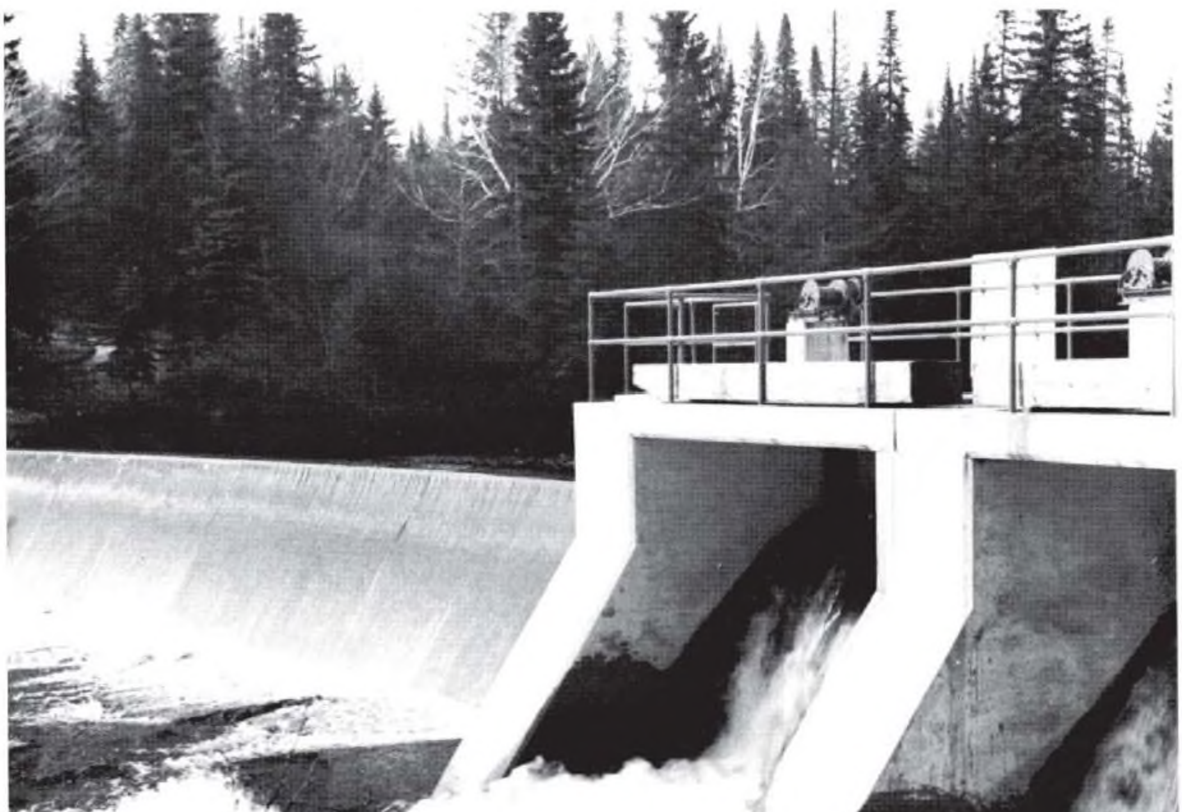
The rocks here are mostly biotite-quartz-feldspar gneisses, light-coloured when fresh, but here weathered to a uniform grey. Occasional thin lenses of black hornblende-quartz-feldspar gneiss are present as lenticles and small folds in the grey rock. Note how the softer black rock is more easily weathered, always occurring in grooves in the grey rock. On close inspection it should be possible to see that the most resistant rock contains the highest proportion of quartz, this mineral being most resistant to chemical and physical breakdown. Indeed, differential weathering accurately reflects even minor changes in composition, bringing out well the layered character of the original sedimentary rock. Note, however, that although the sedimentary layering has been preserved, the beds are now tilted from the horizontal, and the original impure sandy sediments have been recrystallized to sedimentary gneisses.

Stop 3 Oxtongue River Picnic Ground Mile 2.0

Within sight of the highway on the left side is a small cleared area located on a flat terrace of sand, 10 feet above the Oxtongue River. The Oxtongue is a meandering river, and in this vicinity it is difficult to see more than 100 yards of river from any vantage point. In general, the river flows gently, with many twists and turns, through a broad valley once occupied by a major glacial river. Ten thousand years ago this spillway, filled with glacial waters from the melting ice, emptied into Lake Algonquin via the Muskoka River. Soil and rock originally trapped in the glacier was deposited as a thick bed of sand along the spillway route. The picnic ground, and in some places the highway, is located on the old river bed. The present river, a fraction of its former size, has chosen its course at random, cutting its own channel in the sandy bed of its ancestor. In places where the banks have been freshly torn away, stratification or bedding, characteristic of most sediments, should be visible in the sand.

Photo 9 An elongated crystal of black radioactive allanite just to the right of the 25-cent coin; mile 3.9. Note the radial shattering in the adjacent feldspar.

Photo 10 Tea Lake dam, mile 5.2.



Stop 4 Sills of Dark Igneous Rock in Gneiss Mile 3.0

In rockcuts on both sides of the road two small sills of a metamorphosed gabbro, an igneous rock of basic composition, occur within the sedimentary gneisses. Technically now classed as amphibolite due to the mineral changes produced by metamorphism, it is a uniform, massive, black rock composed of red garnet, black hornblende, and grey feldspar.

Sills are flat tabular bodies of igneous rock. These sills were intruded in a hot molten condition into the layered sedimentary rocks, largely by forcing apart bedding planes but also to a lesser extent by cutting the beds themselves. On the north side of the highway a small sill can be seen in typical form lying between folded beds of the gneiss. Rusty-stained joint surfaces unfortunately tend to disguise the rock features. A samll pink granite pegmatite dike cuts the sill and gneiss.

Stop 5 Radioactive Pegmatites Mile 3.9

More than a dozen pegmatite dikes 1 to 4 feet thick occur at intervals of 50 to 100 feet in a continuous rockcut on the north side of the highway. Because of limited visibility along the road it is recommended you park east of the guard rails that line the south shoulder of the highway. These pegmatites are pink due to the abundance of pink feldspar. Other minerals present in order of abundance are: glassy quartz, shiny black mica, dull black hornblende, steel grey nuggets of magnetite, and occasionally bright black tourmaline.

Although by no means common, resinous brown-black crystals of radioactive allanite can be found in some of these pegmatites. Their presence is often indicated by a smoky red halo and by radial shattering of the feldspar for several inches around the allanite crystals. The red colour and radial shattering pattern are characteristics commonly associated with uranium minerals, and are believed due to bombardment of the host minerals by electrons, and volume changes brought about by normal radioactive decay of uranium and thorium. Although there is usually sufficient radioactivity associated with the allanite to give low readings on a geiger counter, these occurrences are of no commercial interest.

Stop 6 Oxtongue Group Campground Mile 5.2

This campground is located on the south side of the Oxtongue River just below the Tea Lake dam. It is reserved for

Photo 11 Quartz-feldspar-biotite pegmatite at mile 8.0. Note the gradational grain size, and large flakes of biotite mica on edge.

organized groups.

The campground occupies a sheltered sandy area dissected from the bed of the great post-glacial river that preceded the Oxtongue. Banks of sand to a height of 20 feet can be seen in places, interspersed with low rounded knolls of biotite-quartz-feldspar gneiss. Pine and spruce trees cling to the bedrock gneisses and overhang the dark waters of the river. The gneissic beds strike 40° east of north, approximately parallel to the river, and dip 20° southeast.

The Tea Lake dam marks the east end of the campground. Although the present dam is new, the site was a favourite spot of the Canadian painter Tom Thomson, and his "Tea Lake Dam" hangs in the National Gallery in Ottawa. A good exposure of the gneisses, polished smooth by the glaciers, may be seen in the south bank on the upstream side of the dam. Lenticles of black hornblende-rich rock are tightly folded within the more abundant light-coloured gneisses.

Stop 7 Pegmatites Mile 8.0

At the mileage 8 marker the road passes between high rockcuts of black to green-black hornblende-garnet-feldspar-quartz gneiss. Be particularly careful in stopping in this area, as the road is winding and visibility is poor. Near the start of the rockcut on the western end a 3-foot dike of quartz-feldspar pegmatite containing crystals of magnetite one inch in diameter may be seen cutting the gneisses at a sharp angle. More interesting pegmatites, however, are located a few hundred feet east of the large rockcut section. Here will be found pegmatites containing massive crystals of feldspar and quartz.

First at this point is a dike with an exposed width of about 8 feet which may be seen on both sides of the highway trending in a direction N15°E and dipping towards the west at about 60°, cutting the foliation of the gneisses almost at right angles. The dike contains masses of pink orthoclase feldspar, yellow-buff plagioclase feldspar, white to glassy quartz, books of black shiny biotite mica and large black nuggets of magnetite. Individual masses of feldspar and quartz approach several feet in diameter; the dark minerals about 6 inches. Note the sharp contacts this dike and the first one make with the host rocks.

The third dike in this group is located on the north side of the highway about 100 feet east of the dike just described. This is a dike about 4 feet in thickness that terminates abruptly against the dark gneisses about half way to the top of the rockcut. This dike is interesting because it shows a zonal arrangement of its minerals. The centre of the dike is predominantly white quartz; large crystals of pink feldspar

Courtesy National Air Photo Library, Ottawa, Canada.

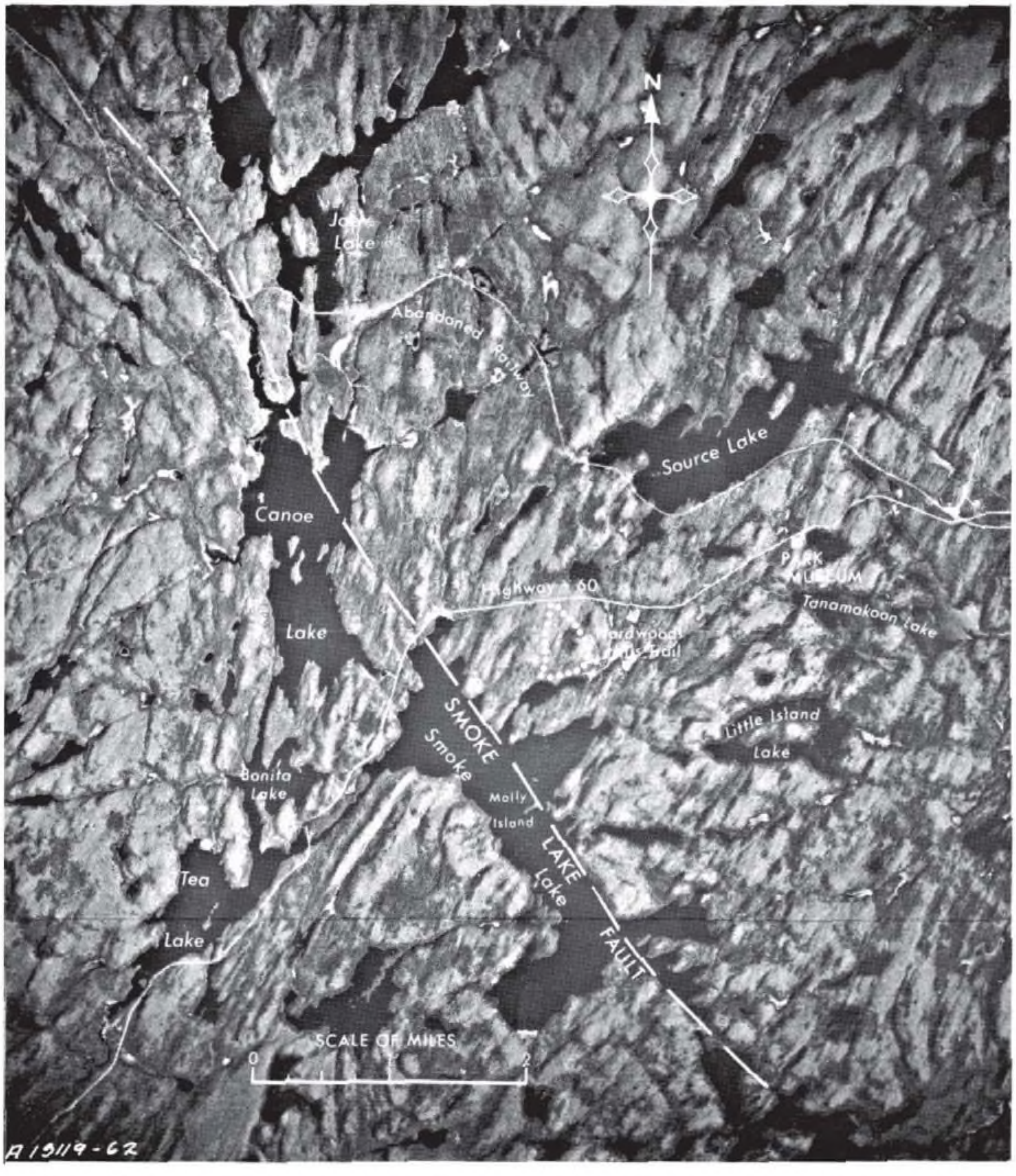


Photo 12 Aerial photograph of the Tea, Canoe, and Smoke Lakes area.

become more common towards the boundaries of the dike. Here also is found lesser amounts of the buff-yellow plagioclase feldspar, and in the feldspar zone generally are found numerous large flakes of black biotite mica, some of them 8 inches in length. Note the radiating pattern of the biotite flakes near the top of the dike exposure. Note also the fine grain size of the minerals adjacent to the walls and how they become progressively coarser towards the centre of the dike.

Stop 8 Douglas Hains Lookout and Picnic Ground Mile 8.9

Just before the mileage 9 signpost the Douglas Hains lookout and picnic ground is located on the north side of the highway. A short climb up through the hardwood bush is necessary to reach the stone cairn commemorating Mr. Hains' work in the Ontario tourist industry. The cairn sits atop a ridge of various feldspathic, biotitic, and hornblende gneisses. The lookout from the cairn affords an excellent view southeast across Smoke Lake.

Rockcuts along the highway show predominantly pink quartz-feldspar gneisses with numerous thin interlayers of black hornblende and biotite gneiss. Foliation in these rocks is pronounced at this point, showing a strike parallel to the highway and a dip in the direction of Smoke Lake to the south. Similar rocks are exposed further along near the foot of the hill at the turn-offs to the Portage Store and the Canoe and Smoke Lakes docks.

Stop 9 The Smoke Lake Fault Mile 9.6

Between miles 6 and 10 the highway is rarely out of sight of water, as it passes between Tea, Bonita, and Canoe Lakes on the north, and Smoke Lake on the south. Tea, Bonita, and Canoe Lakes are the headwaters of the Oxtongue River, and are essentially a broadening of it. The lakes occupy the same erosion trench in soft sedimentary gneisses, the depression larger in the lake basins due to the fanning-out of the gneiss sequence northward around the dome of hornblende granite that lies just to the west.

Smoke Lake owes its origin to a fault that cuts the strike of the sedimentary gneisses at right angles. The fault marks the long axis of the lake and is traceable to the northwest as a continuous valley that includes Canoe, Potter, and Brule Lakes. Much of the east shore of Smoke Lake is a low scarp remnant of the fault's east wall.

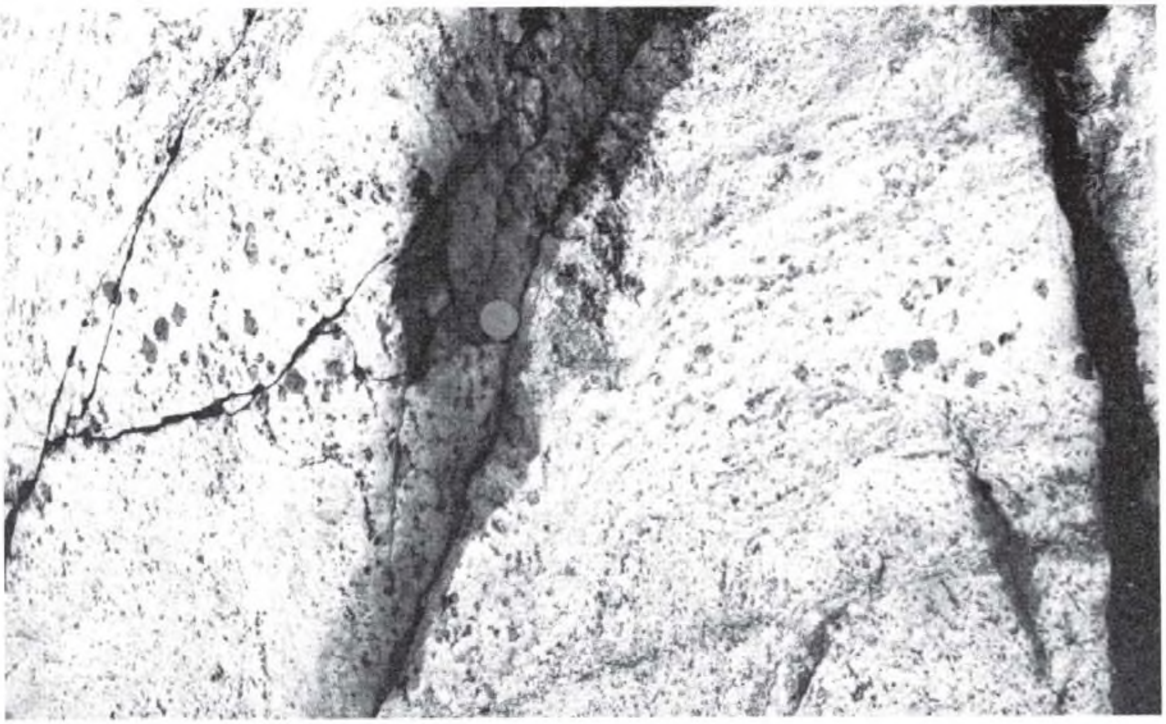


Photo 13 Red garnets, almost the size of a 10-cent coin, in sedimentary gneiss at mile 11.0.

Photo 14 A lens of black hornblende gneiss, folded and broken by pegmatite, in migmatite at mile 12.6.

A fault usually consists of a zone of parallel fractures, rather than a single break. The Smoke Lake Fault is such a zone, intense fracturing probably extending over a width of ¼ mile. On the west end of Molly Island, halfway down the lake, a segment of closely-spaced fracturing 20 feet in width crosses the island at the foot of the memorial plaque to Molly Colson. Such fracturing exposes the rock to the agents of weathering, with the result that a depression is formed as seen here. The Smoke Lake basin is a similar depression on a larger scale. The small but attractive roadside picnic site at the north end of Smoke Lake is contained within the fault zone.

Stop 10 Hardwood Hills Trail and Picnic Ground Mile 11.0

From Smoke Lake the highway ascends gradually to the top of the Hardwood Hills. A shaded picnic ground amid the tall hardwoods is located on the south side of the highway. If you plan to take the walking trail that starts from this point you should first examine the rocks exposed in the highway cut a few hundred feet west of the parking area.

Here will be found pink and grey gneisses of mixed sedimentary and igneous origin, some layers of which contain clusters of red garnets. Stretched, elongated, and irregular fragments of dark hornblende gneiss will be found scattered throughout the lighter-coloured feldspar gneisses. The dark coloured and strongly layered rocks are undoubtedly of sedimentary origin, whereas the more massive granitic-looking rocks are either truly igneous, or recrystallized portions of the gneiss itself, intruded along the bedding planes of the sedimentary gneiss. These then are migmatites; rocks of mixed origin.

Rock outcrops are scarce along the trail, but boulders are numerous, all similar to rocks seen in the highway cuts. They are therefore not true glacial "erratics", which by definition must be obviously foreign to the bedrock over which they lie. These boulders may have been shifted several hundred feet by the glaciers, or they may simply have been split off and raised from the bedrock by frost action.

Stop 11 Migmatite Mile 12.6

On the south side of the highway an exposure of pink and grey migmatite may be seen in a vertical face 5 feet high. Irregular patches of pegmatite have swamped the thinly layered sedimentary gneisses. Both pegmatite and gneisses consist mainly of pink feldspar, grey quartz, and minor black biotite. Lenses of black hornblende-rich gneiss have been distorted into

Photo 15 Margaret Lake at the foot of Tower Hill, mile 17.5.

small folds and broken by pegmatite. These features are typical of migmatite, a rock of mixed origin.

Stop 12 Tower Hill Syenite Mile 17.5

Since leaving the Hardwood Hills area, the highway has been crossing low ridges of sedimentary gneisses that strike nearly north and dip to the east. The shorelines of the nearby lakes - Source, Canisbay, Tanamakoon, and Cache - also reveal these rocks. Although they may vary from place to place in colour and texture, they are still composed of various proportions of quartz, feldspar, biotite, and hornblende.

Shortly after passing the Cache Lake turn a high hill dominates the eastern skyline and seems to block the highway route. A conspicuous clearing on its summit marks the former site of a radar tower that was part of the "Pinetree Line" in North America's air defence network. The highway rounds the steep north face of the hill, and suddenly the quiet waters of Margaret Lake come into view. This spot is worth a brief stop, and a small parking area on the north side of the road is convenient.

When you have admired the lake for a few minutes, take note of the rock at the side of the parking area, for this is the rock of which Tower Hill is composed. Note its coarse-grained massive structure, and attractive olive-green colour. This is an igneous rock. It is technically classed as syenite, which means it is composed mainly of feldspar (in this case green in colour) and very little quartz. Black hornblende and red garnet also are visible in the rocks. Partly because it has too little quartz, it cannot be called a granite. Note how weathering has formed a thin skin of bleached rock, pale-brown in colour, so unlike the attractive colour of the freshly-broken surface.

Stop 13 Hemlock Bluff Trail Mile 18.0

This is a shaded walking-trail of about 2 miles roundtrip, meandering through mature hardwoods and hemlocks, and affording the hiker striking views from an abrupt cliff 125 feet above the green waters of Jack Lake.

At the start of the trail, on the north side of the highway, is a low outcrop of brown-weathering grey-coloured biotite and hornblende gneiss. The rocks here dip at a very low angle to the east and strike approximately north. Note the pronounced layering due to compositional differences. Some of the layers are hornblende gneiss, but most consist largely of quartz and

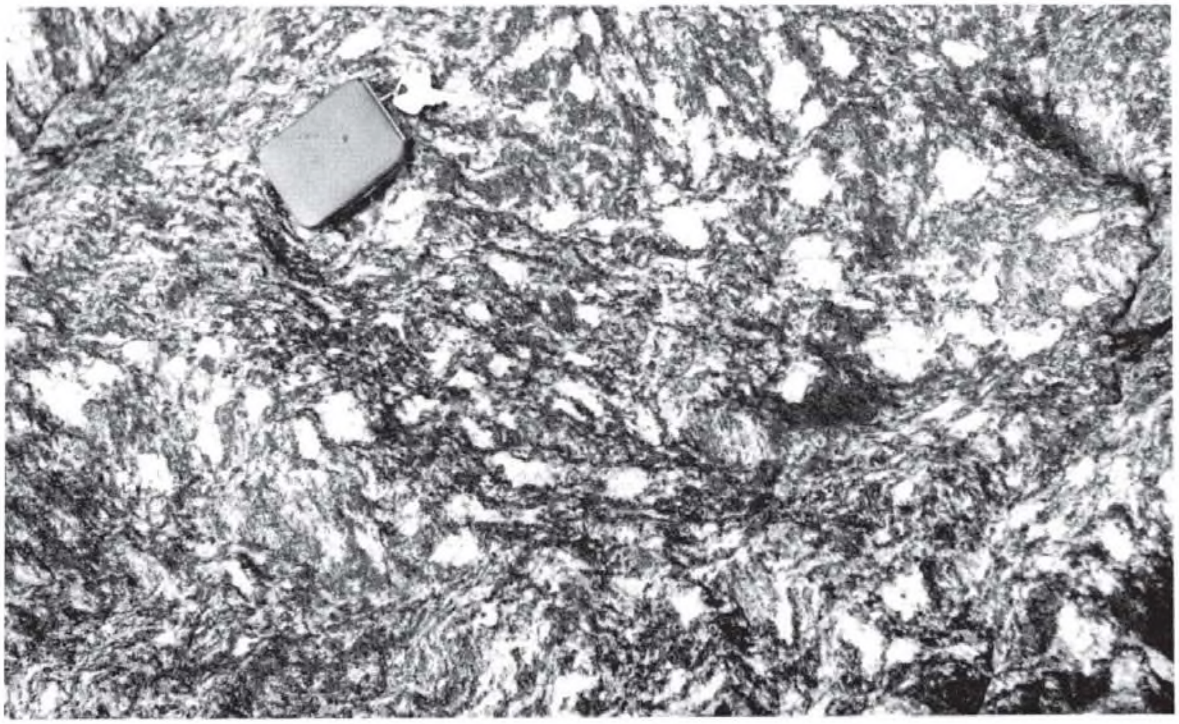
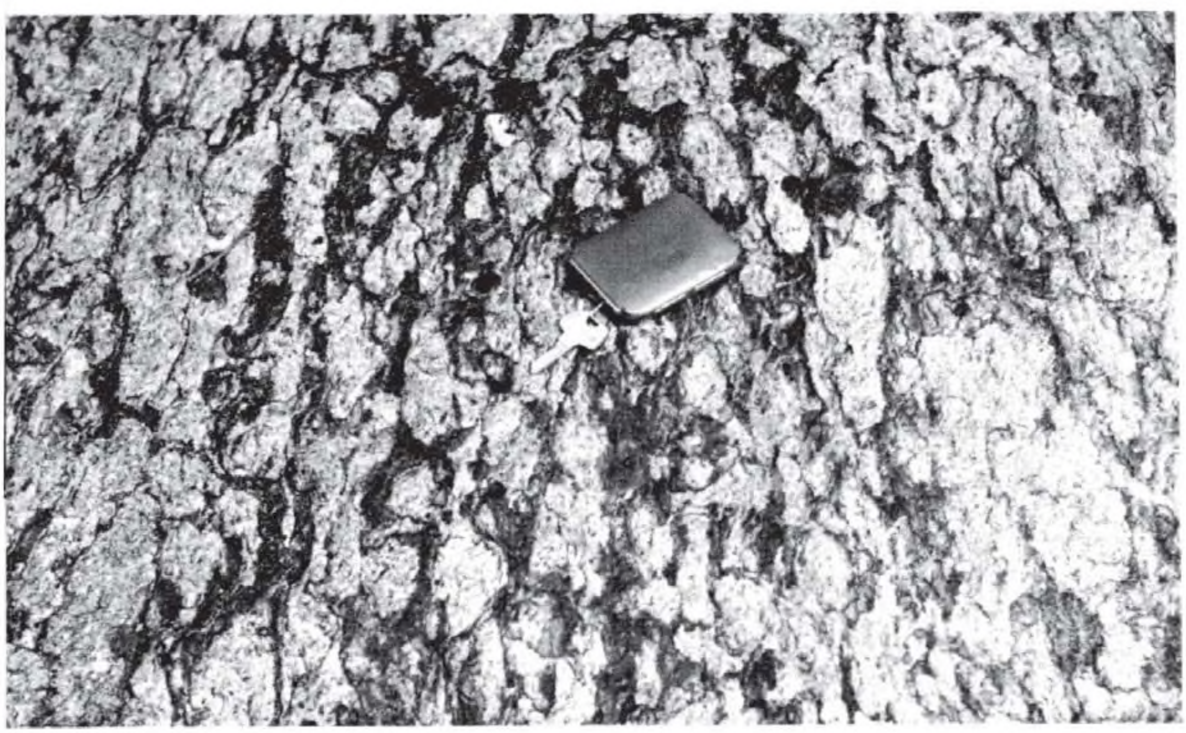


Photo 16 Phenocrysts of white feldspar in porphyritic granite at mile 18.8.

Photo 17 Elongated feldspar phenocrysts in porphyritic granite at mile 20.8.



feldspar. Some of the quartz-feldspar-rich layers are coarse-grained, whereas others are finer grained, possibly reflecting original grain size differences in the parent sandstone. The washboard character of this weathered surface reflects the different rates of weathering on layers of different composition.

The rocks that comprise Hemlock Bluff are similar gneisses. They are well-exposed in the lookout area, but watch your footing near the edge. The bluff itself is due to differential erosion of a soft rock that underlies the waters of Jack Lake and the hard weather-resistant gneisses that form the caprock of the bluff. Since both these rocks strike nearly north, parallel to the cliff edge, and dip gently to the east, the caprock is progressively undercut by erosion of the soft rock. Large overhanging blocks of the caprock gneisses fall from the cliff face every few years, maintaining it in a steep and fresh condition.

The attractive colour of the Jack Lake waters may be due to algae. Although individually microscopic, a prolific growth of certain blue-green or green algae may lend a characteristic colour to the water, and at the same time contribute an unusual clarity to it.

Stop 14 Pegmatites in Porphyritic Granite Mile 18.8

At the crest of a hill affording a long view to the east over the Madawaska valley, a roadcut on the south side consists of an interesting variety of rocks. Park well before or well after the crest so as not to be a hazard to other traffic. At the west end of the cut green garnet-hornblende granite contains 2-inch crystals of feldspar. Large crystals in a finer grained groundmass are called phenocrysts, and the rock in which they occur is referred to as porphyry. Thus, this rock is a granite porphyry containing feldspar phenocrysts. Note that the feldspar phenocrysts occur as raised individuals due to their superior resistance to weathering.

At the east end of the roadcut the rock is a black and white porphyritic biotite granite containing several narrow vein pegmatites that fill vertical joints up to 4 feet wide. These pegmatites almost parallel the road at this point, and several fine exposures can be seen where they have been opened lengthwise by the roadcut. The pegmatites consist of coarse masses of pink orthoclase feldspar, cream-coloured to greenish plagioclase feldspar, white quartz, and shiny black biotite mica.

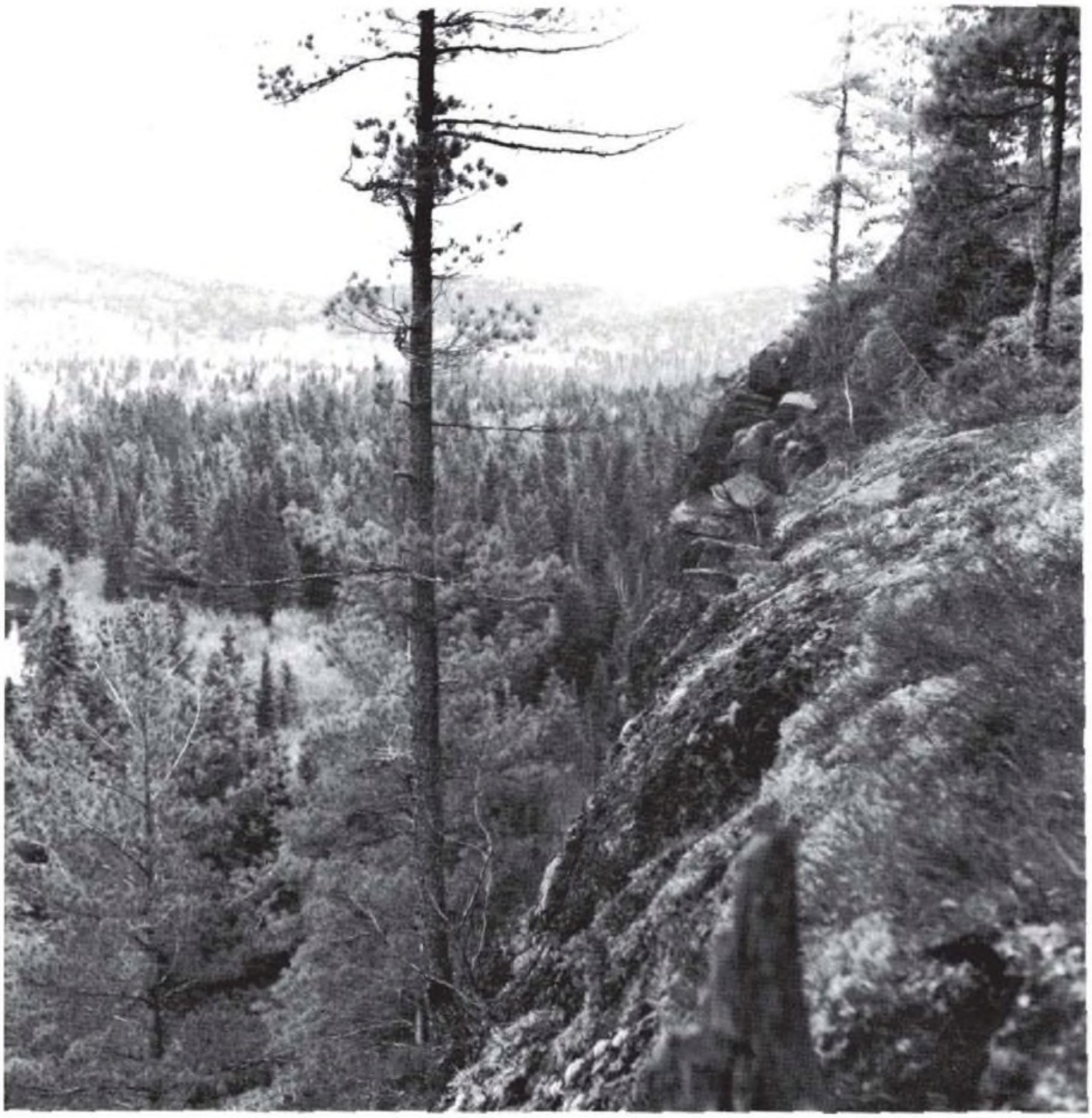


Photo 18 The North Madawaska River valley from a lookout on the Two Rivers trail, mile 20.2.

Stop 15 Two Rivers Trail Mile 20.2

Lake of Two Rivers occupies a depression in a sand plain that forms part of the route of a major glacial spillway. Ten thousand years ago vast amounts of water from the melting ice made the north and south branches of the Madawaska River into raging torrents that have seen no equal, even in the flash-flooding of a rapid spring break-up. At that time Lake of Two Rivers stood higher than at present, covering all of the airfield area and including Mew Lake to the west. The turbulent stream waters entered the quieter waters of this swollen lake and deposited their burden of sand as a delta, now occupied by the Two Rivers campground and airfield.

The Two Rivers trail leads through a forest of birch, aspen, and coniferous trees, making an easy ascent to a bluff overlooking the Wildlife Research Area, a roundtrip distance of 1 1/3 miles. The trail starts on the level sand delta, following it northeasterly along the bed of what was a narrow bay of the ancestral Lake of Two Rivers.

The rocks that comprise the Two Rivers bluff have a uniform texture composed of elongated clots or lenticles of hornblende and feldspar. Quartz and lesser amounts of garnet are also present. The uniformity of the rock suggests an igneous origin. The parallel elongation of the mineral grains is a gneissic feature that has been developed by the high pressures of later metamorphism; the gneissosity strikes northeast and dips to the southeast. The rock is a gneissic hornblende granite.

As with Hemlock Bluff, this bluff was caused by erosion. Softer, more easily weathered, hornblende-rich gneiss occupies the valley below, in sharp contact with the more durable granite. Since it also dips eastward beneath the granite, it progressively undercuts it. Erosion must have been rapid at the time of the melting glaciers because the bluff is a natural barrier, deflecting the waters of the North Madawaska River at right angles to their general flow. The steepness of the bluff, and the freshness of the rock exposed in its face, indicate that erosion and undercutting is still proceeding, and overhanging blocks of granite still break off every few years.

Stop 16 Kirkwood Memorial Mile 20.8

A bronze plaque commemorating Alexander Kirkwood, one of the prime figures in the establishment of Algonquin Park, is set into a large boulder of pink porphyritic granite on the north side of the highway. Phenocrysts of feldspar occur in a medium-grained matrix of quartz and minor biotite, hornblende, and garnet. The boulder is not a glacial "erratic" because it

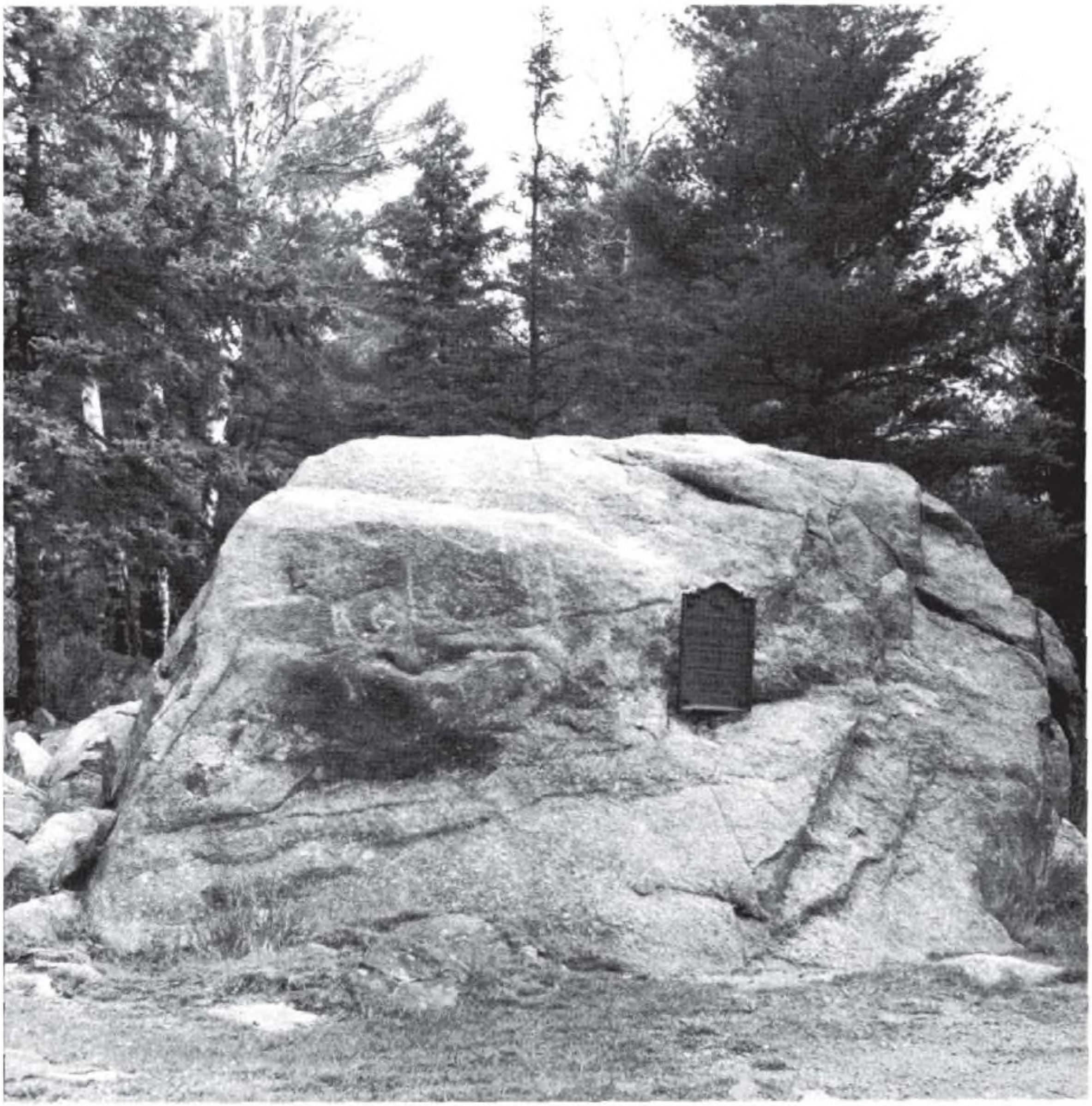


Photo 19 The Kirkwood memorial plaque in a boulder of porphyritic granite, mile 20.8.

originated nearby. By definition an erratic must be located in an area where the bedrocks are quite different, implying considerable dislocation of the boulder while trapped in the glacial ice.

Follow the path back of the Kirkwood boulder to the granite ridge 100 feet or so distant. Here you will find the same rock of which the boulder is composed. If you climb a few feet to the first ledge you will see the porphyritic character strikingly displayed by large white phenocrysts of feldspar rimmed with grey quartz.

Stop 17 Lake of Two Rivers Picnic Grounds Mile 22.1

An attractive picnic ground and swimming area at the mid point of the north shore of Lake of Two Rivers is well worth a stop, especially if the day is a little cool and the wind from the north. With a sheltered southern exposure a grassy slope dotted with spruce trees opens on to a fine sand beach. The view from the beach across a mile of open water is drawn to the high rocky hills of the south shore, where peaks 350 feet above the lake are common. Exploring these hills is part of the attraction of the 17-mile Highland Hiking Trail that starts from the south side of the airfield at the west end of the lake.

The view to the southeast is interrupted by a peninsula of low rock that marks the eastern limit of the beach and picnic area. The ridge is composed of thin-bedded sedimentary gneisses that strike parallel to the ridge and dip at a low angle to the east. Thus the broken upturned edges of the beds are exposed on the near side, and we can examine their composition. Feldspar, quartz, biotite, hornblende, and garnet are the minerals that comprise these gneisses. Note how the layers rich in quartz and feldspar form ribs of superior resistance on the weathered surface; conversely the hornblende-rich lenses, in places tightly folded, that occupy depressions. Narrow meandering pegmatites, composed of coarse grains of quartz, feldspar, biotite, and hornblende, vein the gneisses and give them a migmatitic character. These features are all particularly well exposed on a steep rock surface halfway between the lake and highway.

Stop 18 Zoned Pegmatite Dike Mile 22.6

At the first turn in the highway, ½ mile east of the picnic ground, a zoned and faulted pegmatite dike can be observed on both sides of the road. It is a white-weathering vertical dike, 9 feet thick, that cuts rusty-weathered green and grey sedimentary gneisses. It is exposed in the vertical face of a rockcut on

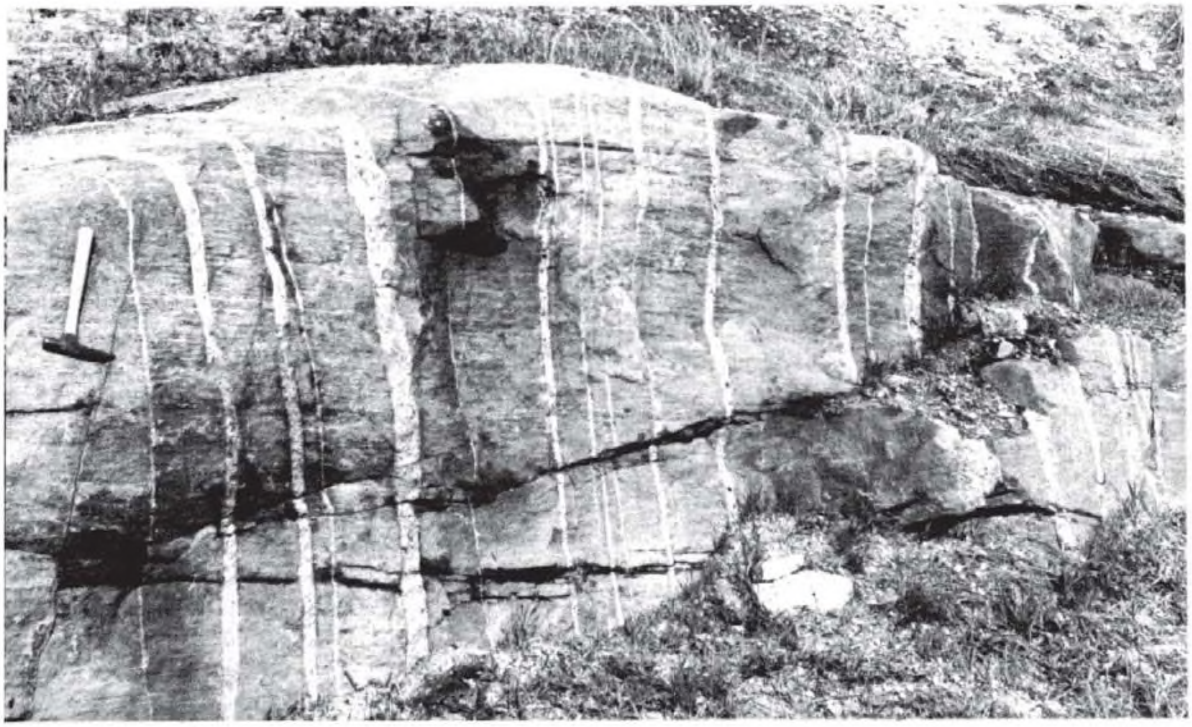


Photo 20 Vertical pegmatite ribbon dikes filling joint fractures in hornblende gneiss at mile 24.0.

Photo 21 Thick sand deposits at Pog Lake, deposited by the great post-glacial Madawaska River; mile 23.5.

the north side of the highway, and in a low outcrop on the south side. Park your car well before of beyond the turn so as not to be a hazard to other traffic.

Because there is a symmetrical arrangement of the minerals on either side of the centreline of the dike, we refer to it as a zoned pegmatite. A core of grey quartz occupies the centre of the dike; it is 5 feet thick north of the highway, but only 6 inches on the south. The core is bordered on either side by a thin zone of pink feldspar, followed in turn by a white and black mosaic of feldspar, quartz, and biotite. Note the large white elliptical crystals of plagioclase feldspar in a matrix of colourless to grey quartz and black biotite.

This pegmatite occupies a fault fracture along which there has been later movement. Tearing and slipping of the walls has resulted in a flowage texture in the outer zones, and a rounding of the feldspar crystals.

A pink and green pegmatite can also be seen in the same rockcut on the north side of the highway 50 feet west of the zoned dike. This is a typical unzoned, irregularly-shaped pegmatite, similar examples of which are fairly common along the highway route. It consists of pink feldspar, colourless quartz, black biotite, and red garnet.

Stop 19 Beaver Pond Trail Mile 24.0

Along the highway just west of the parking lot are low rockcuts of black hornblende-rich gneiss, cut frequently by narrow vertical dikes of pink and white feldspar pegmatite. These ribbon dikes, from one to three inches in thickness, occur every foot or so and are parallel to one another, trending in a direction of N40^{o}E. They occupy joint fractures. The dikes consist of pink and white feldspar, glassy quartz, minor black biotite, and occasional magnetite.

The Beaver Pond Trail leads northerly for a quarter of a mile through a dense reforested stand of jack pine. Bedrock is not observed until one crosses the beaver dam, where a low ridge of hornblende gneiss is found. Here too will be found the narrow pegmatite ribbon dikes cutting the rock just as we saw on the highway outcrops. After crossing the nose of the low rock ridge, the trail returns over a second beaver dam and reaches the highway along the same route through the jack pine forest. In the spring this shaded trail is carpeted with the small white star-shaped flower Bunchberry.

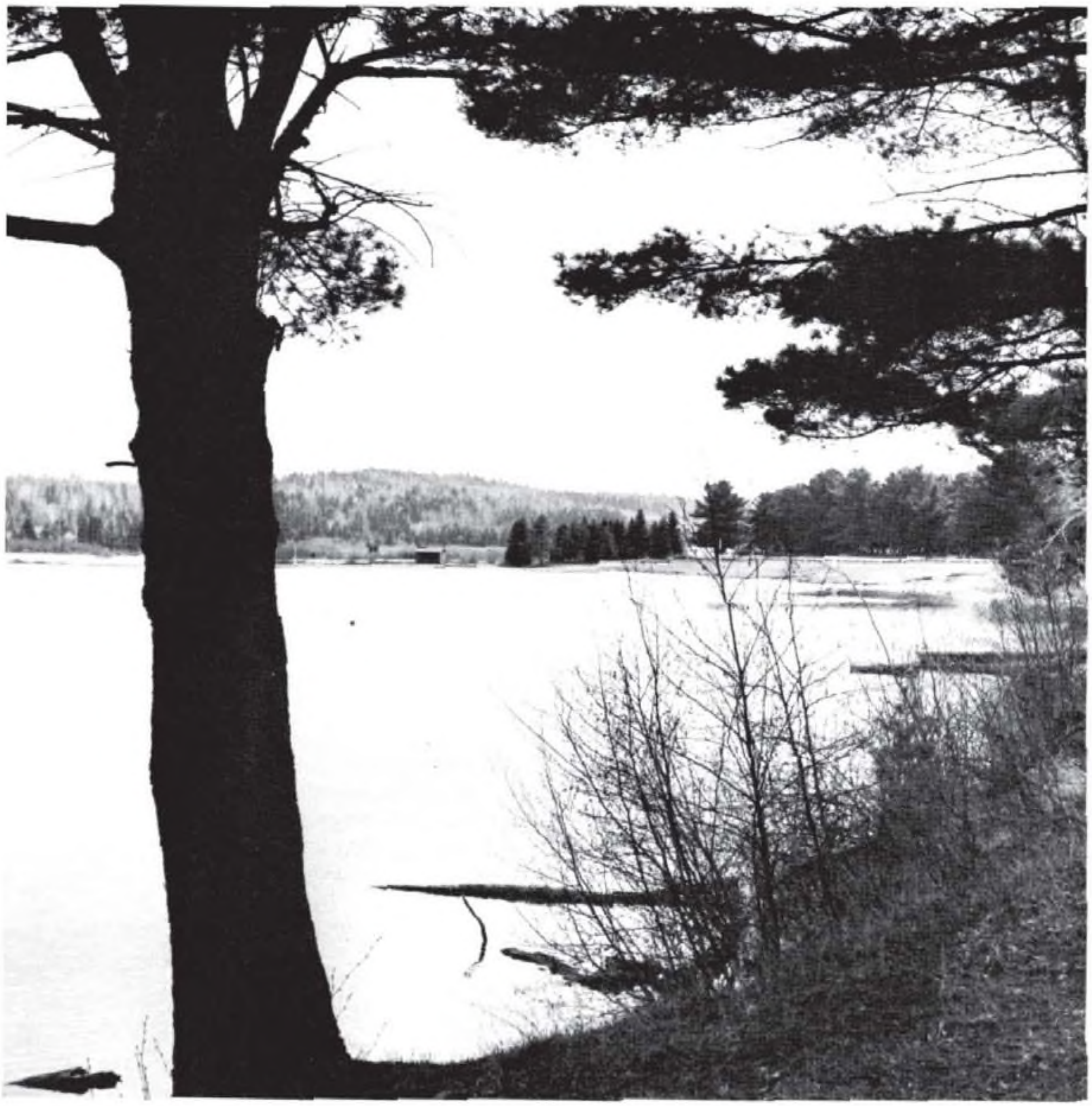


Photo 22 Lake of Two Rivers campground and beach at mile 20.8. An extensive sand plain in this area was formed as a delta about 10,000 years ago, at the confluence of the north and south branches of the ancestral Madawaska River.

Stop 20 Kearney Lake Campground Mile 24.4

Kearney Lake is a small secluded lake not visible from the highway. The campground at its south end is located on a sand plain attractively reforested with white, red, and scotch pine.

Kearney Lake occupies a part of the great glacial Madawaska River valley, and 10,000 years ago its waters were continuous with those of Whitefish and Pog Lakes, and Lake of Two Rivers. The extensive sand plains in the lowlands adjoining these lakes were built up by sediment, carried in the turbulent feeder streams from the highlands, and deposited in the broad, relatively quiet, pools of the ancestral Madawaska River.

The Pog Lake Campground and Madawaska Group Camp Area occupy similar sandy locations amid young pines. They also owe their existence to the great glacial river, of which the Madawaska is a remnant.

Stop 21 Lookout Trail Mile 26.2

The parking area for Lookout Trail is on the north side of the highway near the top of a long incline. The highway route was carefully chosen to avoid the crests of a series of high parallel rock ridges that extend for some miles north and south. These ridges form some of the most rugged scenery in Algonquin Park. They stand 450 to 550 feet above the nearby lakes, and are particularly striking at Rock Lake a few miles to the south.

Like a giant deck of cards protruding from the sand, the sharp crests of these ridges are undercut steeply on their west sides, sloping more gently away on their east sides. Thick layers of weather-resistant quartz-feldspar gneiss, alternating in a few instances with softer hornblende gneiss, are responsible for this ridge-and-valley topography. More rapid erosion of the hornblende layers has caused undercutting of the adjacent hard gneisses.

These ridges trend approximately north-south. Although they were not caused by faulting, they are cut by a series of crossfaults at intervals of about 1 mile. Thus the topography is characterized by a series of deep north-south valleys cut nearly at right angles by the less-precipitous valleys of the crossfaults. If you have a detailed map of the area, note how the creeks follow straight-line courses in these two directions.

The highway follows a valley made by a crossfault through the ridges; however, it is a valley partly filled by glacial till, so that there is still a considerable saddle to overcome. When you leave Lookout Trail and continue east over the saddle, notice the long graded slopes of clay and boulders on both sides

Photo 23 Thick deposits of glacial till near the start of Lookout Trail, mile 26.2.

of the road. Till is an unsorted mixture of clay, sand, gravel, and boulders pushed or carried by the glaciers. In this case the till is made up of soil and rock gathered from nearby; it was pushed up the gentle east slope, bulldozer fashion, only to be dropped abruptly into the fault valley and overridden by the ice.

Lookout Trail goes south from the highway, often tracing a moderately steep path, reaching finally a lookout on the steep crest of one of the parallel ridges. The return to the highway is over the same trail, a roundtrip distance of 1½ miles.

At the start of the trail are several large boulders of pink biotite-quartz-feldspar gneiss, similar to the bedrock to be seen along the trail.

The lookout area is a ledge of rock, 300-400 feet long, polished smooth by the glaciers, and plunging steeply on its west side. The rock is a uniform biotite-garnet-quartz-feldspar gneiss, rarely containing streaks and thin lenses of black hornblende gneiss. It probably originated several billion years ago as an extensive sand deposit on an ocean shelf. The streaks of hornblende gneiss may have been thin clay seams in the original sediment. Now the rock has been completely recrystallized by the three agents of metamorphism-heat, pressure, and time - to the extent where some remelting has even taken place, and small pegmatitic patches of white-weathering feldspar, grey glassy quartz, and black biotite and hornblende are common. When such igneous patches are sufficiently common we call the rock "migmatite", meaning mixed rock.

The distinctive feature of a gneiss is its strong foliation or linear character, like the grain in wood. Here the foliation trends north-south, parallel to the cliff edge, and dips at a shallow angle to the east.

At the summit you can enjoy an unobstructed view for about 15 miles to the north, west, and south. In the west foreground is the top end of Whitefish Lake; beyond it, Lake of Two Rivers and the airfield located on the sand plain at its west end. The lookout is nearly 500 feet above these lakes.

Stop 22 — Booth's Rock Trail — Mile 26.8

Booth's Rock Trail takes the hiker over another of the parallel erosion-ridges, 5 miles south of Lookout Trail. The general remarks concerning the bedrock and origin of these striking ridges applies equally to this area. Booth's Rock Trail is one of the most interesting Algonquin trails, visiting several small lakes and a fine scenic lookout, and providing information of both natural and historic interest.

Courtesy National Air Photo Library, Ottawa, Canada.

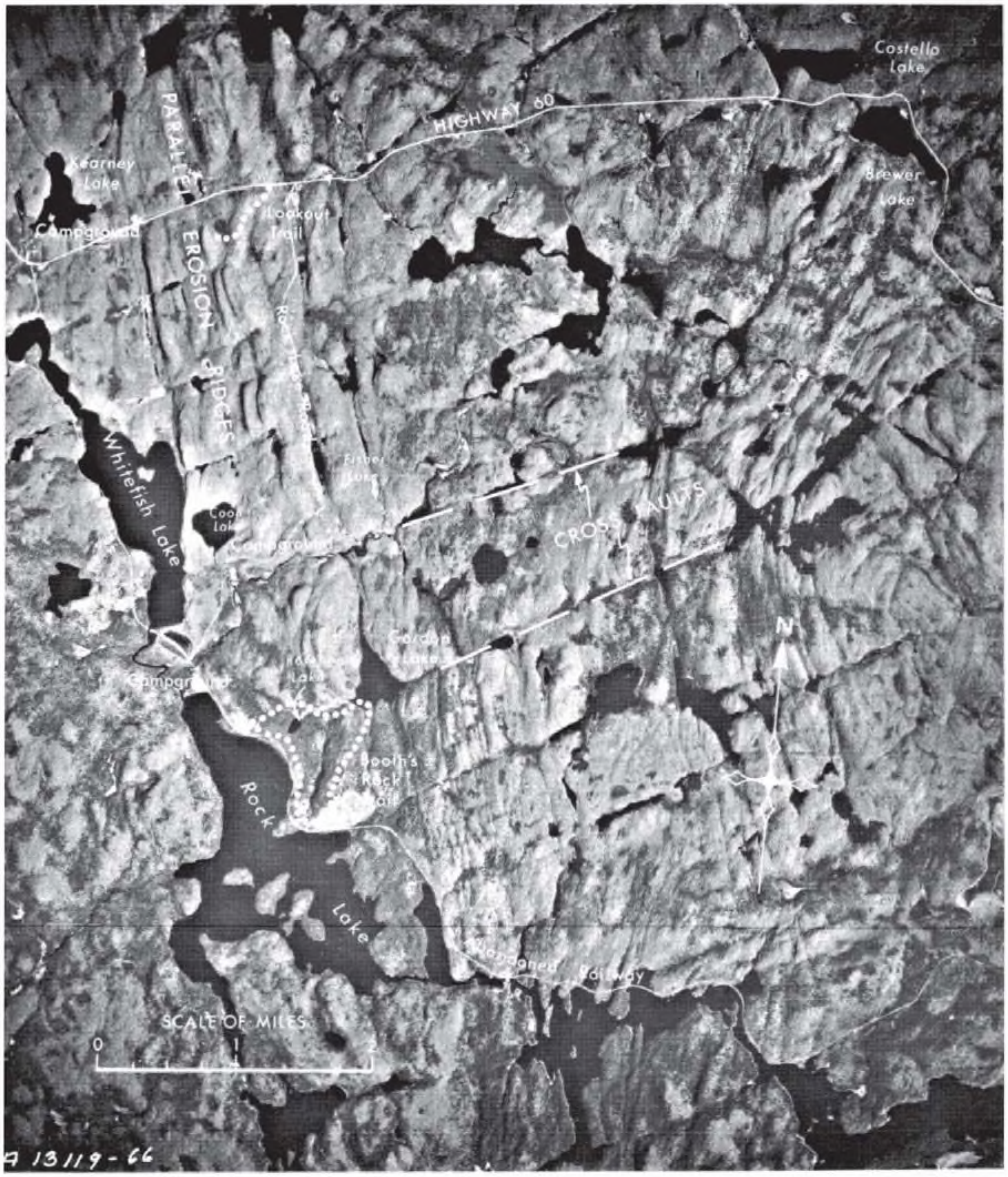


Photo 24 Aerial photograph of the Rock Lake area. Note the prominent north-south erosion ridges cut by east-west crossfaults.

The start of the trail is reached via the Rock Lake Road, leaving the highway at mileage 26.8, and finally turning left into the Rock Lake Campground. The road to the campground is a former railway roadbed, and the trail is reached by continuing on this road along the east side of Rock Lake a distance of ½ mile. A marker on the left side indicates the start of the trail.

From here you can see the old railroad bed swinging in a broad arc to the base of the ridge over which the trail passes. The trail descends the far end of the ridge and returns to this point along the roadbed, a total walking distance of about 3 miles.

Perhaps the first point of geological interest is Rosepond Lake, where the trail crosses a rather steep bank of sand and gravel at its east end. Well-rounded pebbles of both dark and light-coloured gneisses are abundant in the coarse brown sand, and a few fine specimens of red pine show their preference for the sandy soil.

When the last glacier finally melted from Algonquin Park 10,000 years ago, the Madawaska valley contained one of the major rivers fed by the melting ice. At that time the water levels were higher than they are now, and Rosepond Lake was merely a bay of a continuous body of water that included Rock and Whitefish Lakes and Lake of Two Rivers.

East from Rosepond Lake the trail ascends a gently-sloping valley floor to the rocky and rugged Gordon Lake that lies at the intersection of a crossfault and a deep north-south erosion valley. At the head of the trail from Rosepond Lake the shoreline is low; but elsewhere, high rocky shores prevail.

At the time of high water levels during the retreat of the glaciers, Gordon Lake spilled over and tumbled into Rosepond bay by way of the crossfault valley up which the trail passes. The deposits of sand and gravel are evidence of the former stream bed.

At the Booth's Rock lookout the open rock ridge is 350 feet above the waters of Rock Lake. To the northwest is Whitefish Lake, part of the Madawaska chain, and on the northern horizon you may be able to pick out the firetower at Whitegull Lake, 12 miles away.

The smooth glaciated rocks of the lookout area are quartz-feldspar gneisses, usually with black flakes of biotite as the dark mineral, but sometimes also hornblende. Small red garnets are also present in places. Stretched and folded lenses of hornblende-rich gneiss are occasionally seen in the lighter-coloured gneisses.

The trail continues for some distance along the edge of the bluff, and in places overhanging portions of the ridge can be seen. Large sections look as though they might fall at any time,

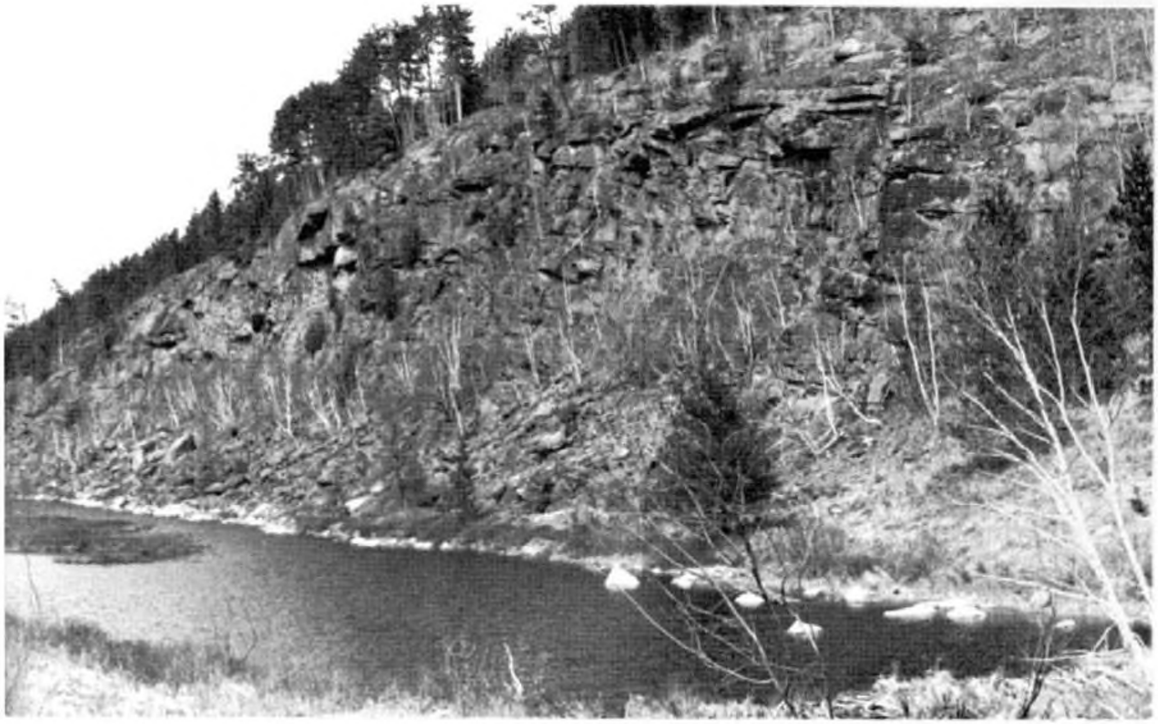


Photo 25 An erosion bluff at Fisher Lake along the Rock Lake Road, near mile 26.6.

Photo 26 White-weathering feldspar and black hornblende in coarse-grained igneous gabbro, mile 29.3.

to join the mass of blocks already piled at the base. And indeed they might fall at any time, though major falls are probably years apart; they are more apt to occur with the spring thaws, following the wedging and heaving of winter frost and ice.

We owe the spectacular beauty of these ridges to their slow but continuous breakdown. Periodic rockfalls are a self-cleaning process by which the cliff face maintains its fresh angular appearance. Without them Nature would soon round their sharp edges and reduce the fresh pink colour of the rock to a weathered and lichen-covered grey.

The self-cleaning mechanism by which the rugged beauty of these ridges is maintained, is brought about through the existence of a soft, more easily weathered, layer of rock that underlies the hard caprock gneisses with the same north-south strike and gentle easterly dip. Although obscured by the rubble at the base of the cliffs these soft layers are probably hornblende or biotite-rich gneisses. Their easy deterioration by natural weathering processes results in the harder caprock overhanging until the strength of the rock is exceeded, or until a joint fracture is uncovered, and the overhanging block falls.

After descending the ridge, an assortment of large blocky boulders can be seen by the railroad bed near the entrance to the former Barclay estate. These consist of biotite and hornblende-quartz-feldspar gneisses, similar to the rocks comprising the high ridge over which the trail passes. They have reached this location on rafts of ice, having fallen onto the ice during the high-level stages of the Madawaska River. At that time, with the glacier melting nearby, the winters were long and cold, and it is most probable that the ice at the base of the cliff froze solidly to the bottom.

Stop 23 Costello Lake Gabbro Mile 29.3

Returning to Highway 60 and continuing easterly, a coarse-grained dark-coloured igneous rock called "gabbro" is exposed in a low and almost continuous rockcut for ¼ mile, shortly after passing the mile 29 marker. Exposures of the same rock occur intermittently over the next several miles to the vicinity of Costello Lake near the junction of Highway 60 and the Opeongo Lake road.

The gabbro is a beautiful deep-purple rock, weathering to rust and black. It consists mainly of mauve-coloured feldspar, black hornblende, and steel-black magnetite, in individual grains to ½ inch. Concentrations of magnetite associated with some gabbro bodies are important sources of iron in many parts of the world. Note the very massive texture of this rock, typical of igneous rocks that have not suffered later deformation; it is

Photo 27 The Brewer Lake fault, mile 32.0.

Photo 28 Stratified sand and gravel near mile 35.6, deposited on a flood plain of the ancestral Madawaska River.

noticeably different from the strongly foliated gneisses with which we have become so accustomed.

Since leaving the Rock Lake area, where migmatites were beginning to show themselves as occasional streaks and veins of igneous material in the sedimentary gneisses, we have passed numerous rockcuts of migmatite. Throughout the gabbro area also, exposures of migmatite will be found close by exposures of gabbro.

Stop 24 Brewer Lake Migmatite and Fault Zone Mile 32.0

A parking area near the southeast end of Brewer Lake makes it convenient to study the migmatites in the rockcut across the road. Grey biotite-hornblende-quartz-feldspar gneisses are thoroughly mixed with layers, streaks, and lenses of pink granite and granite pegmatite.

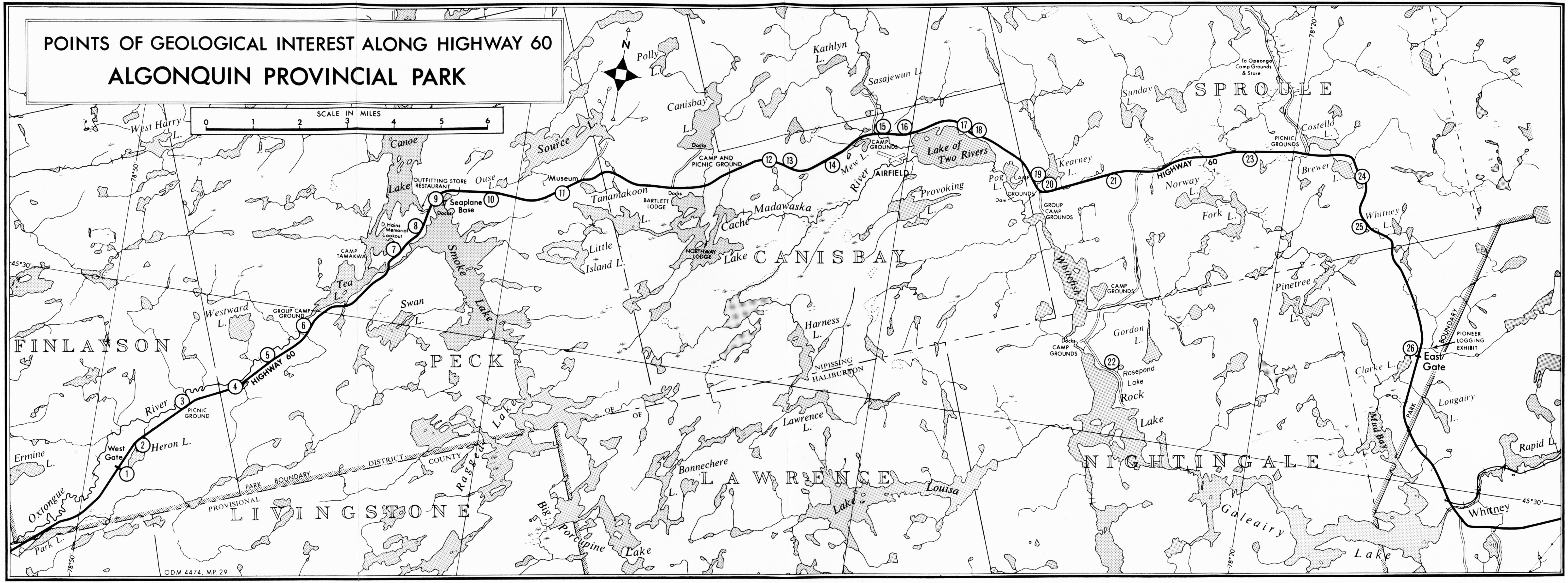
A 2-foot fault zone is exposed in the same rockcut 200 yards back (northwest) along the road. Note the crushed angular fragments and abundance of earthy olive-coloured mud. It is easy to visualize the grinding and crushing that produced these features. This is a small fault zone but it is otherwise similar to many larger faults of Algonquin Park. Because of the tremendous tearing and abrasion caused by the movement of the walls, faults rarely exhibit a single clean break, but rather a zone of fracturing.

Stop 25 Glacial Striations Mile 33.4

Leaving Brewer Lake the highway ascends a long grade in a southerly direction. Just past the summit, a series of low outcrops of gneiss on the west side of the road have been polished smooth by the glaciers. On one insignificant outcrop near the south end of the series are a number of smooth shallow grooves aligned in a north-south direction. These are glacial striations, caused by fragments of hard rock caught in the ice at the base of the glacier as it moved down from the north. Perhaps you can find more of them on the nearby outcrops.

Stop 26 East Gate Mile 36.5

Since leaving the last stop the highway gradually descended through rockcuts of gneiss and migmatite, before opening onto a level sand plain. This sandy area was part of the Madawaska flood plain during its highest level stages in the early post-glacial years. Now, as you leave Algonquin Park, you will cross the Madawaska River at Whitney. It is an impressive river even now, but think what a mighty waterway it must have been 10,000 years ago when its waters were 70 feet higher than they are to-day!


POINTS OF GEOLOGICAL INTEREST ALONG HIGHWAY 60
ALGONQUIN PROVINCIAL PARK
SCALE IN MILES
0 1 2 3 4 5 6
N
FINLAYSON
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NIGHTINGALE
LIVINGSTONE
HIGHWAY 60
West Gate
East Gate
Museum
OUTFITTING STORE RESTAURANT
Seaplane Base
D. Hains Memorial Lookout
CAMP TAMAKWA
GROUP CAMP GROUND
PICNIC GROUND
CAMP AND PICNIC GROUND
BARTLETT LODGE
NORTHWAY LODGE
AIRFIELD
CAMP GROUNDS
GROUP CAMP GROUNDS
PICNIC GROUNDS
PIONEER LOGGING EXHIBIT
To Opeongo Camp Grounds & Store
Docks
Dam
NIPISSING
HALIBURTON
PROVISIONAL PARK BOUNDARY
DISTRICT COUNTY
PARK BOUNDARY
Oxtongue River
Park L.
Ermine L.
Heron L.
West Harry L.
Westward L.
Canoe Lake
Tea L.
Swan L.
Smoke Lake
Ragged Lake
Big Porcupine Lake
Source L.
Polly L.
Ouse L.
Tanamakoon L.
Little Island L.
Cache Lake
Madawaska River
Canisbay L.
Kathlyn L.
Sasajewun L.
Mew L.
Lake of Two Rivers
Provoking L.
Harness L.
Lawrence L.
Bonnechere L.
Louisa Lake
Pog L.
Kearney L.
Whitefish L.
Gordon L.
Rosepond Lake
Rock Lake
Galeairy Lake
Sunday L.
Norway L.
Fork L.
Costello L.
Brewer L.
Whitney L.
Pinetree L.
Clarke L.
Longairy L.
Mud Bay
Rapid L.
Whitney
45°30'
78°50'
78°20'
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
ODM 4474, MP. 29